

Description and Ecological Distribution of a New Frog Crab (Crustacea, Brachyura, Raninidae) from Northern New Zealand Waters, with Keys to Recent Raninid Genera and *Notosceles* Species

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ABSTRACT: *Notosceles pepeke* n.sp. is described from 21 collections between depths of about 50 and over 300 metres off Norfolk Island and the Wanganella Bank on the Norfolk Ridge, from the southern end of the Three Kings Ridge, from the Bay of Plenty, from the East Cape Ridge, and off the Kermadec Islands on the Kermadec Ridge. It is closely related to *N. viaderi* Ward, 1942 from off Mauritius and Reunion in the western Indian Ocean, Hawaii, and French Polynesia, and to *N. ecuadorensis* (Rathbun, 1935) partially redescribed here, from off Ecuador, the Galapagos Islands and Baja California in the eastern Pacific. *N. pepeke* was taken from bottoms of mixed shell, sand, bryozoan rubble, and coral, and is partly sympatric with the only other known New Zealand raninid, *Lyreidus tridentatus* de Haan, 1841. Keys are provided for the recognition of 12 extant raninid genera and 6 extant *Notosceles* species.

RÉSUMÉ : *Notosceles pepeke* n.sp. est décrit à partir de 21 collectes faites à des profondeurs d'environ 50 à 300 mètres au large de l'île Norfolk et du banc Wanganella sur la dorsale de Norfolk, de l'extrémité sud de la dorsale de l'île Three Kings, de la Bay of Plenty (Baie de Plenty), de la dorsale d'East Cape (Cap Est), et au large des îles Kermadec sur la dorsale des Kermadec. Cette espèce est étroitement apparentée à *N. viaderi* Ward, 1942 du large des îles Maurice et de la Réunion dans l'Océan indien de l'ouest, des îles Hawaii et de la Polynésie française, et à *N. ecuadorensis* (Rathbun, 1935) partiellement redécrit ici, au large de l'Équateur, des îles Galapagos et de la Basse Californie dans le Pacifique est. *N. Pepeke* a été collecté sur des fonds à composition mixte de coquillages, sable, débris de bryozoaires et de corail, et est en partie sympatrique avec le seul autre raninide connu de Nouvelle-Zélande, *Lyreidus tridentatus* de Haan, 1841. Des clés sont incluses pour permettre l'identification de 12 genres existants de raninides et de 6 espèces existantes de *Notosceles*.

KEYWORDS: New Zealand Brachyura, Raninidae, identification key to raninid genera, *Notosceles pepeke* new species, identification key to *Notosceles* species, frog crabs.

Introduction

The Raninidae, or frog crabs, are a small, exclusively marine, brachyuran family of low diversity, regarded since the classic research on their morphology by Bourne (1922) as forming the distinctive subtribe *Gymnopleura*. They are easily recognised by a combination of features: the carapace, which is more or less longitudinally oval in outline ("urn-shaped" as described by Rathbun 1937: 4), does not cover the terga (or upper surface) of the abdominal segments, which are very narrow in most species, leaving most of the upper surface of the abdomen clearly visible in dorsal view. The buccal cavity is elongate and completely closed by the 3rd maxillipeds. The walking legs (2nd to 5th pereopods) are more or less flattened and modified, in most species, for digging backwards (as distinct from burrowing forwards) into soft sediment. The last pair of legs (5th pereopods) is raised dorsally although not held over the back as in most dromiid, homolid, and dorippid crabs, and is reduced in size and complexity in some genera.

From their shape and structure raninid crabs were first regarded as being derived from the *Macrura* (see Bourne 1922) and have been grouped with the dromiid sponge crabs and some other small brachyuran families (including *Homolidae*, *Latreillidae*, *Homolodromiidae*, *Cymonomidae*), as the so-called "primitive" or "lesser" crabs. Much discussion and speculation have taken place subsequently as to their proper phylogenetic position in the history of the origin and evolution of the *Brachyura*, a matter yet little resolved since Bourne's (1922) historical survey of opinion.

Guinot (1977) has since placed the raninids in a new taxonomic group, the *Podotremata*, based on the further character of their male and female genital openings being on the coxae of the second walking legs. New studies involving spermatozoal ultrastructure and RNA sequencing (Spears *et al.* 1992, Jamieson *et al.* 1994) may help towards further clarification of the relationships of the *Raninidae*. Guinot *et al.* (1994) found little evidence of a relationship between raninids and homolids on the basis of spermatozoal characters and the study of Jamieson *et al.* (1994) has been even less conclusive. However, Feldmann *et al.* (1996) have found what may be evidence for a relationship with homolid crabs. Tucker (1998) has now applied

modern techniques of parsimony analysis to both fossil and recent species towards resolving the question of phylogenetic relationships within the *Raninidae*. (This study, although based on 32 genera and 190 species, yet reveals the need for further studies on extant species, many of which are, regrettably, poorly represented in collections.) Nevertheless, as Feldmann *et al.* (1996) stated in summary, the phylogenetic position of the raninid crabs remains unresolved. Hence, any new information concerning the *Raninidae* from any aspect is most welcome.

Their common name "frog crabs" comes from their characteristic elongate shape and the hunched-up appearance of the legs. The family name *Raninidae* de Haan, 1841 follows the type genus *Ranina* named by Lamarck in 1801, based on the species *Cancer raninus* described as early as 1758 by Linnaeus, the trivial name being taken from the Latin *rana*, a frog.

The palaeobiogeography of one genus of raninid in particular, *Lyreidus*, has been well discussed by Feldmann (1986, 1992) with the proposition that the Southern Hemisphere has been the evolutionary centre not only for the *Raninidae* but for the *Brachyura* as a group. In particular, the comparatively rich Eocene history of *Lyreidus* in New Zealand (Feldmann & Keyes 1992) gives evidence towards this hypothesis. In contrast, Newman (1991) postulated a Tethyan origin for *Lyreidus* as well as for the other genus, *Notosceles*, now found living in New Zealand waters but, as yet, unrepresented in the local fossil record. This genus has, however, a fossil record in the Northern Hemisphere, where comparisons have recently been made between fossil and living species of the genus (Beschin *et al.* 1988). At present, 12 genera and 42 species of frog crabs are known to live in the seas of the world, almost exclusively in tropical and warm-temperate waters. A summary of the world species and their literature has been compiled by Dawson & Yaldwyn (1994).

In the New Zealand Region, one species, *Lyreidus tridentatus* de Haan, 1841, which ranges widely throughout the Western Pacific from Japan to Australia and has been studied morphometrically in detail by Griffin (1970), has been known to occur since 1904, when a specimen was collected at 200 metres in the Hauraki Gulf, north of Cuvier Island,

during one of the first dredging expeditions carried out by local scientists (Chilton 1906). Some 43 years later, Powell (1947) recorded it again as a supposed new species that had been brought in by the warm-water East Australian Current. Subsequently *L. tridentatus* has been found in appreciable numbers in New Zealand waters, although within a geographically-restricted range from northern New Zealand to Taranaki on the west coast and to Cook Strait in the east (recorded by Richardson & Krefft (1949) from a dogfish stomach as the supposed first instance of a raninid in New Zealand waters, the authors noting it "of interest in adding to our fauna a representative of a group of lesser Brachyura notable for a blending of brachyuran and macruran features") and off Banks Peninsula (McLay 1988: 84), also from a fish stomach.

Within recent years, as the benthic sampling programme of the New Zealand Oceanographic Institute expanded to cover deeper and more offshore waters to the northwest and northeast of New Zealand, specimens of a second species of frog crab were found in the crustacean collections made during these cruises and on two cruises made by staff of the then National Museum of New Zealand [now the Museum of New Zealand Te Papa Tongarewa] using the Institute's research vessel *Tangaroa*. Dr Geoff Hicks of the Museum's Crustacea section first noted these small raninids as being close to *Notosceles chimmonis* Bourne, 1922, originally described from the Sulu Sea in Indonesia, and to *N. ecuadorensis* (Rathbun, 1935) from the eastern Pacific, and he has kindly allowed us to follow up their taxonomic identity in detail. We present our results in the present paper, including a partial redescription of *N. ecuadorensis*. In contrast to the abundance of material of fossil species of frog crabs, many present-day species are represented only rarely in collections, so that the extension of geographic ranges or the collection of rare species, and especially the recognition of a new species of the Raninidae, are matters of considerable significance in our attempts to understand the origin and evolution of the Brachyura.

Order Decapoda

Infraorder Brachyura

Section Podotremata Guinot, 1977

Subsection Archacobrachyura Guinot, 1977

Superfamily Raninoidea (previously known as Gymnopleura)

Family RANINIDAE de Haan, 1841

There are generally considered to be about 12 extant frog crab and frog crab-like genera in the world with some 21 further fossil genera (Guinot 1993, Tucker 1998). At least 8 of the extant genera have fossil representatives. Following on from our species list and bibliographic index of Recent raninid crabs (Dawson & Yaldwyn 1994), we present the following key to extant raninid genera. In this key we now accept *Lysirude* Goeke as a full genus, rather than as a subgenus of *Lyreidus* de Haan, and will use *Umalia* Guinot for all Indo-West Pacific species previously placed in *Ranilia* H. Milne Edwards, even though the two Australian "*Ranilia*" species have not as yet been confirmed as falling within the limits of *Umalia*. In our usage then, following Guinot (1993), *Ranilia* s.s. has been restricted to include only eastern Pacific and Atlantic species. The number of extant species credited for each genus remains the same as listed in Dawson & Yaldwyn (1994) except for the single addition of *Raninoides intermedius* Dai & Xu, 1991, omitted in that publication.

Although there have been several regional keys to extant raninid genera (e.g. Alcock 1896, Indian, 4 genera; Rathbun 1937, American, 4; Tyndale-Biscoe & George 1962, western Australian, 4; Sakai 1976, Japanese, 7; Dai & Yang 1991, Chinese, 5; Werding & Müller 1990, western Atlantic, 4), only Serène & Umali (1972) included all extant raninid genera known at that time, Goeke's later key (1986) to Indo-West Pacific genera (including his new genus *Lysirude*) excluded *Symethis* Weber, then known only from the western Atlantic and eastern Pacific. Davie (1989) has more recently described a species of *Symethis* from the Indo-West Pacific (Coral Sea), thus with the addition of *Umalia* by Guinot in 1993, there is no key available to all recognised extant raninid genera.

In the present key to Recent raninid genera, intended as a practical, "working" key for curators and collection managers rather than as a true phylogenetic

and relationship key, the 12 genera have not been grouped into subfamilies. The subfamily placement of the genera included here (following Guinot 1993, with her particular subfamily spellings) is as follows:

Ranininae de Haan, 1841—*Ranina* Lamarck

Cyrtorhinae Guinot, 1993—*Cyrtorbina* Monod

Lyreidinae Guinot, 1993—*Lyreidus* de Haan, *Lysirude* Goeke

Notopodinae Serène & Umali, 1972—*Notopus* de Haan, *Ranilia* H. Milne Edwards, *Cosmonotus* White, *Umalia* Guinot

Raninoidinae Lörenthey & Beurlen, 1929—*Raninoides* H. Milne Edwards, *Notosceles* Bourne, *Notopoides* Henderson

Symethinae Goeke, 1981—*Symethis* Weber.

Tucker (1998: 321) elevated the Symethinae to full family rank as the Symethidae within the superfamily Raninoidea, but this refinement is not followed here in our more conservative grouping of extant frog crab genera.

Key to the Recent genera of the family Raninidae

- 1 (16) Eye stalks never very long, folding almost transversely or longitudinally; 3rd maxilliped without an oblique ridge on ischium.
- 2 (3) Carapace very broad (heraldic-shield-shaped in large specimens), width to length ratio 5:6, greatest width near anterior margin; eye stalk 3-segmented; walking legs (2nd to 5th pereopods) similar in form and size; characteristically with 2 trifid processes on each anterolateral carapace margin—*Ranina* Lamarck, 1801
1 extant species (adults of large size, carapace length up to at least 130 mm), Indo-West Pacific (South Africa to Japan, Hawaii, Marquesas, New Caledonia, Norfolk Island, Lord Howe Island, and Australia).
- 3 (2) Carapace elliptical, greatest width at about middle of carapace; eye stalk of one segment; 2nd to 4th pereopods similar in form and

size, 5th pereopod usually slender and smaller in size than 2nd to 4th.

- 4 (7) Fronto-orbital margin of carapace tridentate with one spine (external orbital) on each side of rostrum; abdomen with median dorsal spine or tubercle on 3rd and/or 4th segment(s); sternum modified to allow abdomen to "lock" into sternum (this feature is sexually dimorphic—see Feldmann & Wilson 1988: 478).
- 5 (6) Rostrum wider at base than long; external orbital spine typically as long as wide, subequal with rostrum; anterolateral margin of carapace, i.e. margin between external orbital spine and lateral spine (as in Feldmann & Wilson 1988: fig. 8) if present, smooth or finely beaded; width of lateral expansion of sternum anterior to base of chelipeds subequal to width of lateral expansion of sternum between chelipeds and 2nd pereopods; 4th pereopod dactyl with width about half length, propodus with spine—
—————*Lyreidus* de Haan, 1841
3 extant species, Indo-West Pacific (East Africa to Japan, Hawaii, Fiji, New Caledonia, Kermadec Islands, northern New Zealand, and Australia).
- 6 (5) Rostrum longer than width at base; external orbital spine typically elongate, subequal or longer than rostrum; anterolateral margin of carapace coarsely corrugated, or with tubercle, or spine (in addition to lateral spine); width of lateral expansion of sternum anterior to base of chelipeds distinctly less than width of lateral expansion of sternum between chelipeds and 2nd pereopods; 4th pereopod dactyl with width more than half length, propodus lobate but without spine—
—————*Lysirude* Goeke, 1986
3 extant species, Indo-West Pacific (Arabian Sea to Philippines), western Atlantic (eastern United States to Suriname).
- 7 (4) Fronto-orbital margin of carapace with 2 spines (supraorbital and external orbital) on each side of rostrum (rostrum itself may be trilobate or tridentate, supraorbital spine may be lobate or truncate); abdominal segments without median dorsal spines or tubercles; sternum not

- modified to allow abdomen to "lock".
- 8 (9) First to 3rd pereopods with corresponding bases almost meeting at midline of sternum; 3rd to 5th pereopods with dactyls more or less sickle-shaped; cheliped with a strong spiniform tooth proximally on upper margin of free finger, as well as spiniform teeth on hand at base of free finger and on inner margin of fixed finger—
 —————*Cyrtorbina* Monod, 1956
 2 extant species, Indo–West Pacific (Indonesia), eastern Atlantic (West Africa).
- 9 (8) First pereopods with corresponding bases widely separated, 2nd pereopods with bases widely separated or almost meeting at midline of sternum, 3rd pereopods with bases almost meeting; 3rd to 5th pereopods, some species with dactyls sickle-shaped, others not; cheliped without a strong spiniform tooth proximally on upper margin of free finger (some *Raninoides* species have one or 2 small teeth proximally on upper margin of free finger), teeth present or absent on hand at base of free finger, teeth present (but usually not spiniform) on inner margin of fixed finger.
- 10 (11) Rostrum extends anteriorly well beyond level of external orbital spines; fronto-orbital margin narrow, distinctly less than half width of carapace; 1st to 4th walking legs (2nd to 5th pereopods) with dactyls all strongly sickle-shaped or uncinat (shaped like a hook); only 7 pairs of gills present—
 —————*Symetbis* Weber, 1795
 3 extant species, Indo–West Pacific (Coral Sea), eastern Pacific (Gulf of California to western Panama), western Atlantic (eastern United States to Brazil).
- 11 (10) Rostrum barely extending anteriorly beyond level of external orbital spines; fronto-orbital margin relatively broad, almost half or more than half width of carapace; 1st to 4th walking legs never with dactyls all sickle-shaped, 1st to 3rd with dactyls usually acute, often more or less sickle-shaped, 4th with dactyl simple, ovate, or weakly sickle-shaped; 8 pairs of gills present (as in all other raninid genera with the exception of *Symetbis*).
- 12 (13) Neither anterolateral spine ("extraorbital" of Goeke 1986:226) nor lateral spine (as in Feldman & Wilson 1988: fig. 8) present on lateral margin of carapace, but anterolateral margin granulated in some species; cheliped with upper margin of hand without spines or carinae; 4th walking leg (5th pereopod) subequal in size with 1st to 3rd walking legs—
 —————*Notopoides* Henderson, 1888
 1 extant species, Indo–West Pacific (East Africa to Japan, Hawaii and French Polynesia, eastern Australia and Norfolk Island).
- 13 (12) An anterolateral spine, but no lateral spine, present on lateral margin of carapace; cheliped with spine or carinae on upper margin of hand; 4th walking leg distinctly more slender than 1st to 3rd walking legs.
- 14 (15) Cheliped with spine, but without a double carina, on upper margin of hand; sternum with an anterolateral process (acute in some species) between bases of 1st and 2nd pereopods; 1st abdominal tergum narrow in dorsal view (length in midline half, or more than half, width) appearing distinctly narrower than posterolateral margin of carapace—
 —————*Raninoides* H. Milne Edwards, 1837
 9 extant species, Indo–West Pacific (Madagascar to Japan and western Australia), eastern Pacific (Gulf of California to Ecuador), western Atlantic (eastern United States to Brazil), eastern Atlantic (West Africa).
- 15 (14) Cheliped without spine, but with a double carina, on upper margin of hand; sternum not produced into a distinct anterolateral process between bases of 1st and 2nd pereopods; 1st abdominal tergum broad in dorsal view (length less than half width) appearing almost as wide as posterolateral margin of carapace—
 —————*Notosceles* Bourne, 1922
 6 extant species (including a new species from New Zealand), Indo–West Pacific (South Africa to Japan, Hawaii, South Pacific and northern New Zealand), eastern Pacific (Gulf of California to Peru and the Galápagos).
- 16 (1) Eye stalks (elongate in *Cosmonotus*) folding obliquely, ventrally, and slightly posteriorly;

- 3rd maxilliped with an oblique setose ridge proximally on ischium (if ischium is setose then ridge may be hard to see).
- 17 (18) Rostrum absent, front with median V-shaped incision; carapace narrow anteriorly, dorsal surface with a distinct median longitudinal roof-like ridge; eye stalks slender and elongate, longer than half width of carapace—*Cosmonotus* White, 1847 (generic attribution following Takeda & Miyake 1970: 198) 2 extant species, Indo–West Pacific (East Africa to Japan and western Australia).
- 18 (17) Rostrum present; carapace broad anteriorly, dorsal surface evenly convex from side to side (except anteriorly in *Notopus*); eye stalks stout and distinctly shorter than half width of carapace.
- 19 (22) No traverse spinulated ridge on dorsal surface of carapace between anterolateral spines.
- 20 (21) Dactyl of 3rd walking leg (4th pereopod) distally acute—*Ranilla* H. Milne Edwards, 1837
5 extant species, eastern Pacific (Gulf of California to Ecuador and the Galápagos), western Atlantic (eastern United States to Brazil), eastern Atlantic (Ascension Island and West Africa).
- 21 (20) Dactyl of 3rd walking leg large and truncate—*Umalia* Guinot, 1993
6 extant species, Indo–West Pacific (Indian Ocean to Japan and eastern Australia).
- 22 (19) A transverse spinulated ridge on dorsal surface of carapace between anterolateral spines—*Notopus* de Haan, 1841
1, possibly 2, extant species, Indo–West Pacific (East Africa and Red Sea to Japan, and Australia).

Genus *Notosceles* Bourne, 1922

Material Examined

ABBREVIATIONS: cl, carapace length; cw, carapace width; det., identified by; r/v, research vessel; Stn, station; NMNZ, Museum of New Zealand Te Papa Tongarewa; NZOI, New Zealand Oceanographic Institute (now National Institute of Water and Atmospheric Research); BS, Museum of New Zealand station.

Stations listed in latitudinal sequence.

Notosceles pepeke n.sp.

NZOI Stn P49, 28° 43.3' S, 167° 53.6' E, northern edge of the Norfolk Island shelf, 116–85 m, bottom of gorgonian corals with algal balls, r/v *Tangaroa*, rock dredge, 30 January 1977, 2 paratype females, cl 13.5, 16.5 mm.

NZOI Stn P26, 28° 54.9' S, 167° 44.8' E, off northwest edge of the Norfolk Island shelf, 130–301 m, bryozoan rubble and coral, r/v *Tangaroa*, rock dredge, 26 January 1977, 1 paratype male, cl 13.0 mm, 4 paratype females, cl 12.5, 13.0, 14.8, 15.5 mm.

BS 438, 29° 13.23' S, 177° 54.15' W, off Nugent Island, Kermadec Islands, 164–145 m, r/v *Acheron*, dredge, 28 October 1975, 2 paratype males, cl 14.0, 12.0 mm, 1 paratype female, cl 10.0 mm. NMNZ Cr. 9547.

NZOI Stn K818, 29° 13.3' S, 177° 56.4' W, off Raoul Island, Kermadec Islands, 95–116 m, r/v *Tangaroa*, rock dredge, 24 July 1974, 1 paratype male, cl 15.5 mm.

BS 570, 29° 14.73' S, 177° 50.34' W, east of Dayrell Island, Herald Islets, off Raoul Island, Kermadec Islands, 135–146 m, pumice bottom, r/v *Acheron*, 10 September 1976, 1 damaged, sex indeterminable, cl not measurable. NMNZ Cr. 9545.

NZOI Stn I87, 29° 25.0' S, 167° 50.0' E, southwest edge of the Norfolk Island shelf, 89–170 m, coral and bryozoan bottom, r/v *Tangaroa*, rock dredge, 23 July 1975, 1 paratype female, cl 16.0 mm.

NZOI Stn P16, 29° 36.3' S, 168° 05.0' E, southeast edge of the Norfolk Island shelf, 310–301 m, coral bottom, r/v *Tangaroa*, rock dredge, 26 January 1977, 2 paratype females, cl 16.5 mm, one damaged, not measurable.

BS 882, 32° 31.8' S, 167° 29.5' E, northern summit of the Wanganella Bank, Norfolk Ridge, 113–118 m, coralline algae and stones, r/v *Tangaroa* [NZOI Stn O628], rock dredge, 29 January 1981, 1 paratype male, cl 19.0 mm. NMNZ Cr. 2358.

NZOI Stn P2, 32° 35.62' S, 167° 31.74' E, central summit of the Wanganella Bank, Norfolk Ridge, 122 m, large algal balls, r/v *Tangaroa*, rock dredge, 24 January 1977, 2 paratype males, cl 19.6, 22.9 mm, 1 damaged paratype female, cl not measurable.

NZOI Stn P4, 32° 36.32' S, 167° 30.7' E, central summit of the Wanganella Bank, Norfolk Ridge, 126 m, large algal balls and gorgonian corals, r/v *Tangaroa*,

rock dredge, 25 January 1977, 1 damaged paratype female, cl not measurable.

NZOI Stn P5, 32° 36.4' S, 167° 30.6' E, central summit of the Wanganella Bank, Norfolk Ridge, 126 m, Bryozoa, sponges, algal balls and gorgonian corals, *r/v Tangaroa*, rock dredge, 25 January 1977, 2 paratype females, cl 15.7, 19.7 mm.

NZOI Stn P6, 32° 36.8' S, 167° 30.6' E, Wanganella Bank, Norfolk Ridge, 127 m, algal balls, sponges and gorgonian corals, *r/v Tangaroa*, rock dredge, 25 January 1977, 1 paratype male, cl 18.5 mm.

NZOI Stn P7, 32° 41.0' S, 167° 28.6' E, southwestern edge of the Wanganella Bank, Norfolk Ridge, 150–134 m, algal balls, sponges and soft corals, *r/v Tangaroa*, rock dredge, 25 January 1977, 1 paratype male, cl 16.5 mm.

BS 904, 33° 57.0' S, 172° 19.0' E, King Bank, northeast of the Three Kings Islands, 128 m, Bryozoa, pebble and shell bottom, *r/v Tangaroa* [NZOI Stn O650], rock dredge, 1 February 1981, 1 paratype male, cl 20.5 mm. NMNZ Cr. 2356.

BS 898, 34° 01.2' S, 171° 44.4' E, Middlesex Bank, northwest of the Three Kings Islands, 206–211 m, Bryozoa, shell and sponge bottom, *r/v Tangaroa* [NZOI Stn O644], rock dredge, 31 January 1981, 1 paratype male, cl 15.0 mm. NMNZ Cr. 2357.

BS 911, 34° 20.2' S, 172° 21.8' E, southeast of the Three Kings Islands, 121 m, sponges, hydroids and shell, *r/v Tangaroa* [NZOI Stn O657], rock dredge, 2 February 1981, 1 paratype male, cl 16.5 mm. NMNZ Cr. 2355.

NZOI Stn E385, 34° 22.5' S, 172° 50.0' E, off Tom Bowling Bay, Northland, 53 m, coarse shell debris with fine green-grey sand, *r/v Tangaroa*, 16 April 1965, 1 paratype female, cl 15.0 mm.

BS 702, 37° 30.6' S, 177° 09.7' E, off White Island, Bay of Plenty, 73–59 m, Bryozoa and shell bottom, *r/v Tangaroa* [NZOI Stn R60], rock dredge, 19 January 1979. Holotype male, cl 22.0 mm (Figs 1–5). NMNZ Cr. 9544.

BS 681, 37° 32.8' S, 178° 48.7' E, Ranfurly Bank, off East Cape, 94 m, live bryozoan/hydroid bottom, *r/v Tangaroa* [NZOI Stn R39], rock dredge, 17 January 1979, 1 damaged, sex indeterminate, not

measurable. NMNZ Cr. 9543.

BS 768, 37° 33.1' S, 178° 49.5' E, Ranfurly Bank, off East Cape, 94–98 m, Bryozoa and shell bottom, *r/v Tangaroa* [NZOI Stn R126], rock dredge, 25 January 1979, 3 paratype males, cl 18.0, 20.0 (Fig. 6), 21.5 mm. NMNZ Cr. 9548.

BS 770, 37° 33.4' S, 178° 48.3' E, Ranfurly Bank, off East Cape, 106–163 m, Bryozoa and shell bottom, *r/v Tangaroa* [NZOI Stn R128], rock dredge, 25 January 1979, 1 damaged paratype, sex indeterminate, cl not measurable. NMNZ Cr. 9546.

***Notosceles chinmonis* Bourne, 1922**

"Jalan idhi" Cruise 1963, 4° 35' S, 120° 40' E, Flores Sea, Celebes, near Watampone, collected by Kasijan, 18 June 1963, 1 female, cl 25.0 mm (det. by Raoul Serène). National University of Singapore Zoological Reference Collection, NMS 1968.1.25.25.

***Notosceles ecuadorensis* (Rathbun, 1935)**

Allan Hancock Stn 1034–40, Outer Gorda Bank, Baja California, Mexico, 107–173 m, *r/v Velero III*, 20 June 1940, 1 male, cl 23.0 mm, 1 female, cl 20.5 mm (det. J.S. Garth). NMNZ Cr. 4047 (R.L.C. Pilgrim Collection).

Allan Hancock Galapagos Expedition Stn 212–34 (type locality), La Plata Island, Ecuador, 82–100 m, sand, shale and rock, *r/v Velero III*, 10 February 1934, 3 males, cl 10.0 (Fig. 9), 10.0, 11.0 mm, 9 females, cl 7.5, 7.5, 8.0, 8.0, 9.0, 10.0, 11.0, 13.0 (Figs 7–8), 15.5 mm, 7 damaged, sex indeterminate and not measurable (all part of the paratype series of 50 specimens). National Museum of Natural History, Smithsonian Institution, USNM 81933.

***Notosceles serratifrons* (Henderson, 1893)**

Mariel King Memorial Moluccas Expedition 1970, southeast of Tanjong Ratu, Maikoor Aru Island, 45 m, sand and rubble bottom, *r/v Pele*, 18 June 1970, 1 male, cl 20.0 mm (det. R. Serène). National University of Singapore Zoological Reference Collection, 1970.11.6.1.

***Notosceles viaderi* Ward, 1942**

Île de Réunion, Possession, 200 m, 10 June 1973, collected by Paul Guézé, 1 male, cl 27.4 mm (det. A.

Crosnier). Muséum National d'Histoire Naturelle, Paris, MP B16967.

Notosceles pepeke n.sp.

Notosceles n.sp. Dawson & Yaldwyn 1994: 2, 13

DESCRIPTION

Carapace (fig. 1) longitudinally ovate and distinctly convex from side to side, widest at middle, tapering towards each end; carapace width to carapace length (orbit to midpoint posterodorsal margin) usually about 1:1.5 plus (i.e. cl usually a little more than one and a half times cw). Frontal regions of carapace (i.e. dorsal surface anterior to level of anterolateral spines) and surface extending laterally a little posterior to base of each anterolateral spine, distinctly and irregularly granulate; a median longitudinal row of granules from level of anterolateral spines extending along rostrum to tip with a smooth furrow along each side of this mid-dorsal row; remainder of dorsal surface of carapace (as distinct from lateral margins of carapace) smooth. A pair of relatively strong anterolateral spines arising at about one eighth of cl posterior to level of orbit; anterolateral spines curving slightly anteriorly, or in some cases even recurring a little inwards towards base of external orbital spines; level of tips of anterolateral spines reaching, or just failing to reach, midway between level of inner base of anterolateral spines and level of orbits.

Rostrum (figs 1, 6) extending anteriorly distinctly beyond level of tips of external orbital spines (left external orbital spine in fig. 6 with tip broken off) to reach anterior level of folded back portion of antennules; anterior portion of rostrum rather slender and usually with acute tip; rostrum with rounded (as in fig. 1) or right-angled (as in fig. 6) shoulders at a level usually a little posterior to level of tips of external orbital spines. Rostrum can be described as "shouldered" rather than tridentate, compare shouldered rostrum in fig. 6 with the tridentate rostral form of *N. chimmonis* as shown in Serène & Umali 1972: fig. 23 and Manning 1975: fig. 1a.

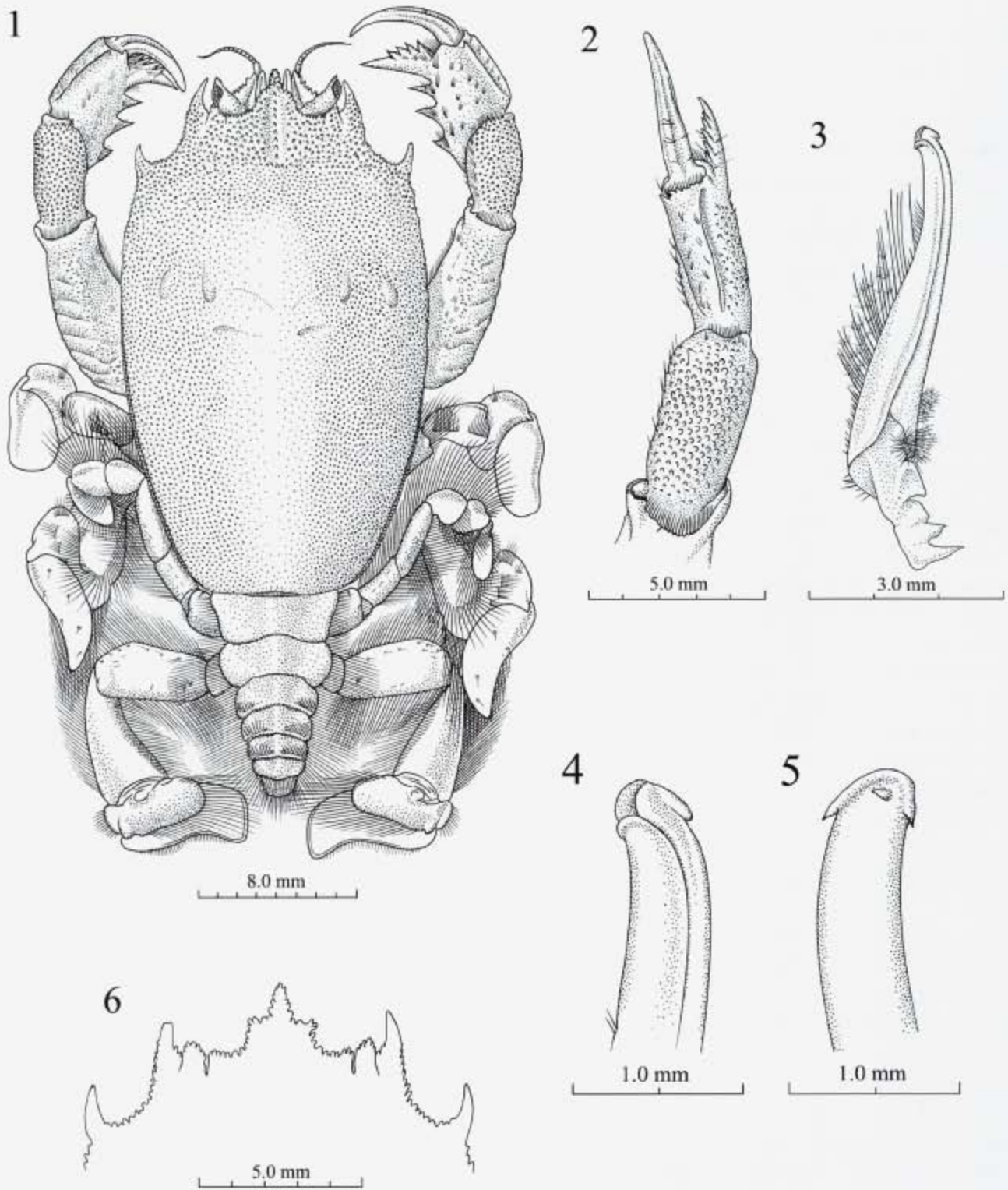
Fronto-orbital margin in *Notosceles* consists of the shouldered (or tridentate) rostrum and on each side an inner orbital angle, a supraorbital spine and an

external orbital spine. The supraorbital spine is separated from the inner orbital angle medially, and from the external orbital spine laterally, in each case by a narrow longitudinal fissure (cf. Griffin 1966: 23), or sinus (cf. Rathbun 1937: 8). The fronto-orbital margin in *N. pepeke* (fig. 6) is beaded with rounded tubercles along entire margin from partway up inner base of left external orbital spine to similar level on right external orbital spine. Around the rostral shoulders these rounded tubercles can have the superficial appearance of "baby's toes". The inner orbital angle is a low, flattened (but beaded) right angle that never develops into a projecting lobe or spine; the supraorbital spine can vary from a beaded lobe, through a beaded acute angle to a beaded blunt spine, while the external orbital spine is strong, usually projecting straight forwards, but in some cases is slightly recurved. The external orbital spine reaches anteriorly nearly to, or level with, even in a few specimens distinctly beyond, level of rostral shoulders.

Anterolateral margin of carapace (fig. 6) has similar tubercles to those on fronto-orbital margin extending from outer base of external orbital spine to inner base of anterolateral spine, though these tubercles are usually more pointed than rounded. Posterior to anterolateral spine, the carapace margin (fig. 1) bears an irregular longitudinal patch of low tubercles grading posteriorly at about midpoint of carapace into a single, continuous, slightly raised, weakly serrate or milled ridge extending around posterolateral margin to overlap of 1st abdominal segment.

Abdomen (fig. 1) of 7 segments. First abdominal tergum broad in dorsal view with length in midline about, or less than, one-third anterior width. Second abdominal tergum with strongly convex lateral margins in dorsal view, greatest width exceeding posterior width of 1st tergum. Third to 7th terga progressively narrower than 2nd tergum.

Eyestalks narrowing distally, extending beyond external orbital spine but capable of lateral retraction beneath this spine, not extending beyond level of rostrum. Cornea relatively small but distinct, situated obliquely distolaterally on eyestalk. Folded back basal portion of antennules reaching anteriorly to about the same level as the prominently laterally serrated, antennal scale (fig. 1).



Figs 1–6 *Notosceles pepeke* n.sp. Fig. 1, holotype, male cl 22 mm, BS 702, dorsal view; fig. 2, holotype, right cheliped, upper margin hand and carpus; fig. 3, holotype, right 1st pleopod, ventral view; fig. 4, holotype, right 1st pleopod, ventral view of extremity; fig. 5, holotype, right 1st pleopod, reverse view of extremity; fig. 6, paratype, male cl 20 mm, BS 768, fronto-orbital margin. Separate scales for fig. 1, fig. 2, fig. 3, figs 4 and 5, and fig. 6 as indicated. Drawings by W.R. Webber.

Third maxilliped with no oblique ridge on outer face of ischium; heavily setose merus considerably shorter than ischium; exagnath, or exopod of 3rd maxilliped, extending as far anteriorly as ischium. **Sternum** broad between chelipeds (1st pereopods), expanded with bluntly rounded, lateral edges between bases of chelipeds and 1st walking legs (2nd pereopods), narrowing between 1st walking legs, and more or less triangularly expanded (apex anterior) between bases of 1st and 2nd walking legs (3rd pereopods). Sternum with blunt expansion between bases of chelipeds and 1st walking legs not extended into a blunt or acute anterolateral process (cf. Chopra 1933: fig. 1c sternum of *Notosceles*—there captioned *Raninoides*—*serratifrons* with fig. 1b sternum of *Raninoides bendersoni*).

Cheliped (fig. 1, 2) merus sparsely granulate with several short, irregular, transverse rugae dorsolaterally; carpus (wrist) distinctly granulate dorsally with an obvious dorsodistal *medial* process, ranging in various specimens from a granulated lump, through a blunt enlarged tubercle, to a distinct low spine, a little behind inner distal dorsal margin (fig. 2). There is an enlarged dorsodistal *lateral* process on the outer distal dorsal margin which ranges from a rounded process as fig. 2 to a pointed process in some other specimens. This dorsodistal *lateral* process in *N. pepeke* never develops into a distinct spine as in some other *Notosceles* species (e.g. *N. serratifrons* see Chopra 1933: pl. 3 fig. 3a, or *N. viaderti* see Ribes 1990: pl. 1 fig. c and Poupin 1996: pl. 14 fig. a). Cheliped hand (propodus) without an obvious and strong dorsodistal spine (as present in *Raninoides* spp.) but with a pair of dorsal longitudinal carinae extending almost full length of upper margin of palm. In *N. pepeke* these two carinae (often termed a "double carina" in *Notosceles* spp.) are parallel for most of their length then converge slightly proximally, but do not meet proximally (fig. 2). Distally the medial longitudinal carina of the pair is usually weakly spined while the lateral longitudinal member of the pair is usually bluntly rounded. Ventral margin of palm with 3 forwardly-projecting strong spines, in some specimens the most proximal of these 3 spines may be distinctly smaller than the other two. Inner margin of fixed finger with about 4 or 5 pointed teeth; curved free finger (dactyl) untoothed on inner margin, but with

two weak longitudinal carinae on dorsal margin, dorsolateral carina less developed than true dorsal carina.

First to 3rd **walking legs** (2nd to 4th pereopods) are shown in obvious lateral outline in fig. 1, with reduced 4th walking leg (5th pereopod) shown above and forward of 2nd walking leg. Dactyls of 1st to 3rd walking legs more or less crescentic in shape with the concave curve of the crescent facing anteriorly; 1st walking leg dactyl with distal edge rounded or bluntly pointed, 2nd walking leg dactyl with distal edge acutely pointed, 3rd walking leg dactyl with distal edge bluntly pointed. Dactyl of 4th walking leg subovate.

Male 1st pleopod (figs 3–5) relatively large and obvious, somewhat outwardly, i.e. laterally, curved with fringe of long setae along lateral edge. Fig. 3 is described as "ventral view" as this is how the right pleopod appears when viewed *in situ* with the frog crab lying supine, however the drawing shows the appendage turned slightly laterally so the view is almost ventromedial. This so-called "ventral view" illustrates what would be termed the "abdominal aspect" of the 1st pleopod by Garth (1958: 14) and Griffin (1966: 24) as this is the surface of the pleopod which *in situ* would be lying against the abdomen in most crabs. In raninid frog crabs however, the abdomen does not fold down and ventrally around so as to lie under the 1st male pleopods. Fig. 3 shows clearly the line curving towards the medial edge of the 1st pleopod which is the overlap of the longitudinal fold that covers over the groove within which the narrow elongate male 2nd pleopod lies *in situ*. Tip of 1st pleopod has an expanded lip extending around the terminal aperture, shown laterally and medially in ventral view (fig. 4), and in terminal profile in the reverse or "sternal" view of the tip (fig. 5). There is a small subterminal hook on the sternal side of the tip (cf. similar hook shown in Crosnier 1976: fig. 6h).

Female with 4 pairs of biramous **pleopods**, one pair on each of abdominal segments 2 to 5. No ovigerous females available so it is not known if females carry eggs on all, or only some, of the pleopod pairs.

ETYMOLOGY: The specific name *pepeke* is the Māori name for frogs of the endemic New Zealand genus *Leiopelma*. *A Dictionary of the Maori Language*

(Williams 1957) gives *peke* as the upper part of the arm, the shoulder, forequarter, a limb in general, or twitching in the shoulder (regarded as an omen), and *pepeke* as a noun meaning *Leiopelma* frogs, insects, beetles, certain types of fish, or the branch or limb of a tree. *The Reed Dictionary of Modern Māori* (Ryan 1995) gives *pēpeke* as a frog, or in a crouched position, and *pepeketua* as the name for *Leiopelma* frogs.

TYPE MATERIAL: Holotype—BS 702, off White Island, Bay of Plenty (data as in *Material examined* list) male, cl 22.0 mm (Figs 1–5), NMNZ Cr. 9544; paratypes—all other specimens in *Material examined* list except BS 570 and BS 681.

SIZE RANGE: Of 15 males, 12.0–22.9 mm; of 13 females, 10.0–19.7 mm.

DEPTH RANGE: The overall range of depths from which *Notosceles pepeke* is so far known is 53 to 310 metres, geographically summarised thus—Norfolk Island area, 4 stations, 85–310 m; Wanganella Bank (Norfolk Ridge), 6 stations, 113–150 m; Kermadec Islands, 3 stations, 95–165 m; Three Kings/North Cape, 4 stations, 53–211 m; Bay of Plenty, 1 station, 73–95 m; off East Cape (Ranfurly Bank), 3 stations, 94–163 m.

LATITUDINAL RANGE: 28° 43.3' S (north of Norfolk Island) to 37° 33.4' S (off East Cape, New Zealand).

SUBSTRATE RANGE: Live bryozoan/hydroid/sponge bottoms, gorgonian corals with algal balls, coralline algae, coral and bryozoan rubble, bryozoan and shell, pebbles, pumice, coarse sand with fine sand.

Notosceles ecuadorensis (Rathbun, 1935)

References to morphology (full references in Dawson & Yaldwyn 1994)

Raninoides ecuadorensis. Rathbun 1937: 15, pl.80 figs 5–7.—Garth 1946: 344, pl.49 figs 1–5.

Rathbun (1937) gave a short but reasonably comprehensive description of the main features of this eastern Pacific species, illustrated with three photographic figures of type material from Allan Hancock Foundation (AHF) stn 212-34 taken off La Plata Island, Ecuador (dorsal view carapace, dorsal and ventral views

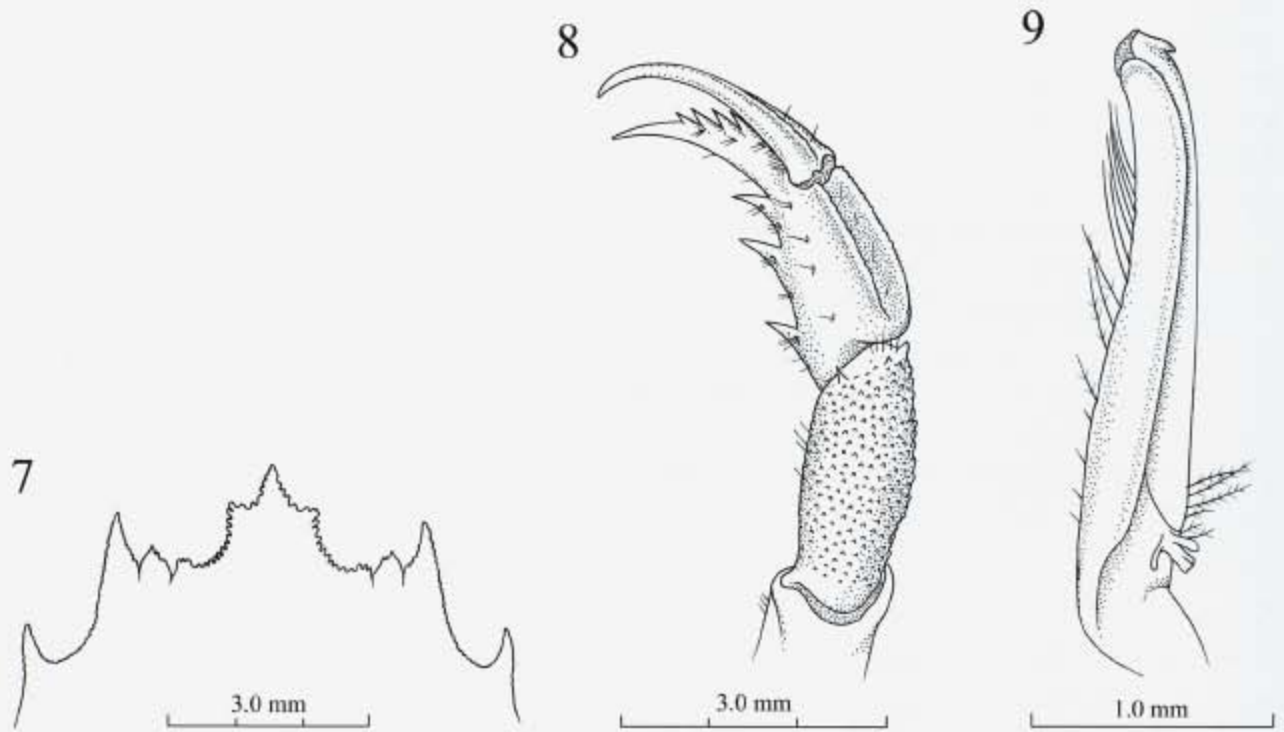
whole animal). Garth (1946) did not add new descriptive information, but figured the whole animal dorsal view, outline of fronto-orbital margin, medial outline of right cheliped hand and wrist, and outlines of 1st and 4th walking legs, all from an AHF stn 212-34 paratype. We provide here new figures, again from AHF stn 212-34 paratypes, of the fronto-orbital margin in outline, right cheliped upper surface hand and wrist, and right male 1st pleopod ventral view.

Further descriptive details of *N. ecuadorensis*, with emphasis on comparison with *N. pepeke*, follow.

Carapace dorsal surface with frontal regions and surface extending laterally a little posterior to base of each anterolateral spine, distinctly and irregularly granulate (as in *N. pepeke*); a median longitudinal row of granules from somewhat in advance of level of anterolateral spines (from level of anterolateral spines in *N. pepeke*) extending along rostrum to tip with a smooth furrow along each side of this mid-dorsal row (as in *N. pepeke*); remainder of dorsal surface of carapace smooth.

Rostrum (fig. 7) extending anteriorly distinctly beyond level of tips of external orbital spines (as in *N. pepeke*) to reach a little beyond anterior level of folded-back portion of antennules (not reaching beyond this level in *N. pepeke*); anterior portion of rostrum rather slender and usually with acute tip (as in *N. pepeke*); rostrum with rounded or right-angled (as shown in fig. 7) shoulders, but (unlike *N. pepeke*) even virtually tridentate in some specimens. Rostral shoulders at a level somewhat anterior to level of tips of external orbital spines (unlike *N. pepeke*, where level of shoulders usually falls short of level of external orbital spines).

Fronto-orbital margin (fig. 7) beaded with rounded, but (unlike *N. pepeke*) rather irregularly shaped, tubercles along entire margin from partway up inner base of left external orbital spine to similar level on right external orbital spine. The inner orbital angle is a low rounded (not quite “flattened” as in *N. pepeke*) right angle that never develops into a projecting lobe or spine; the supraorbital spine (unlike *N. pepeke*) ranges from a rounded lobe to a broad low spine or even to a distinct spine, while the external orbital spine is a strong, forwardly projecting spine (as in *N. pepeke*).



Figs 7–9 *Notosceles ecuadorensis* (Rathbun). Fig. 7, paratype, female cl 13 mm, AHF stn 212–34, USNM 81933, fronto-orbital margin; fig. 8, same paratype female as in fig. 7, right cheliped, upper margin hand and carpus; fig. 9, paratype, male cl 10 mm, AHF stn 212–34, USNM 81933, right 1st pleopod, ventral view. Separate scales for fig. 7, fig. 8, and fig. 9 as indicated. Drawings by W.R. Webber.

Anterolateral margin of carapace (fig. 7) from outer base of external orbital spine to inner base of anterolateral spine tuberculate, but (unlike *N. pepeke*) with tubercles smaller, less obvious and less bead-like, than those on fronto-orbital margin. Posterior to anterolateral spine, the carapace margin (as in *N. pepeke*) bears an irregular patch of low tubercles grading posteriorly at about midpoint of carapace into a single, continuous, slightly raised, weakly serrate or milled ridge.

Eyestalks as described for *N. pepeke*, but with the anteromedial extension of eyestalk around the obliquely situated cornea rounded apically (as distinct from pointed apically as shown in fig. 1 for *N. pepeke*).

Cheliped (fig. 8) merus as described for *N. pepeke*; carpus distinctly granulate dorsally with a very distinct dorsodistal medial spine (as distinct from the variable process described for *N. pepeke*) a little behind inner distal dorsal margin. There is a somewhat less distinct dorsodistal lateral process on the outer

distal dorsal margin which in some specimens is a rounded tubercle (as in *N. pepeke*), but unlike *N. pepeke* is a distinct spine (as shown in fig. 8) in some of the specimens examined. Cheliped hand (as in *N. pepeke*) with a pair of dorsolongitudinal carinae extending almost full length of upper margin of palm, these carinae are parallel for most of their length then converge slightly proximally, but do not meet proximally. Distally the medial longitudinal carina of the pair usually terminates in a distinct spine (a weak spine in *N. pepeke*) while the lateral longitudinal member of the pair is distinctly rounded or (unlike *N. pepeke*) terminates in a distinct but weak spine. Ventral margin of palm with 3 strong spines (as in *N. pepeke*), these spines are somewhat rounded (rather than acute) in some specimens. Rathbun (1937: 15) gives the range of ventral palm spines as 3 to 4 in the full AHF stn 212–34 paratype lot.

Male 1st pleopod (fig. 9) as in *N. pepeke*, relatively large and obvious, somewhat outwardly, i.e. later-

ally, curved with fringe of long setae along lateral edge. The longitudinal fold that covers over the groove within which the elongate male 2nd pleopod lies *in situ* is clearly visible towards the medial edge (as in *N. pepeke*). Tip of 1st pleopod has an expanded lip extending around the terminal aperture and (as in *N. pepeke*) there is a small subterminal hook on the sternal side of the tip (not shown in the fig. 9 ventral view).

Female with 4 pairs of biramous pleopods (as in *N. pepeke*), one pair on each of abdominal segments 2 to 5. None of the *N. ecuadorensis* specimens examined were ovigerous.

Other species of *Notosceles*

References to morphology (full references in Dawson & Yaldwyn 1994)

Notosceles barnardi (Sakai, 1974)

Raninoides serratifrons. Barnard 1950: 399, fig. 75 e, f, g (NOT *R. serratifrons* Henderson, 1893).

Raninoides barnardi Sakai, 1974: 87–88.—Sakai 1976: 51, fig. 24.—Sakai 1977: 54, frontispiece fig. 2.

Notosceles chimmonis Bourne, 1922

Notosceles chimmonis Bourne, 1922: 74, pl. 4 figs 2, 3; pl. 6 figs 24, 40–43; pl. 7 figs 44–47, 57.—Manning 1975: 297, fig. 1 (holotype of *Raninoides fossor*, a synonym of *N. chimmonis*).—Ribes 1990: pl. 1 fig. B.—Poupin 1996: pl. 13 fig. h.

Notosceles chimonis (misspelling of *chimmonis*). Serène & Umali 1972: 43–44, figs 23–30, 33, pl. 3 figs 4–6.

Notosceles serratifrons (Henderson, 1893)

Raninoides serratifrons Henderson, 1893: 408, pl. 38 figs 10–12.—Chopra 1933: 86, fig. 1c, pl. 3 figs 3, 3a.—Sakai 1976: 49–50, figs 22–23, pl. 20 fig. 2.—Chen & Xu 1991: 51, figs 1–6.—Dai & Yang 1991: 44–45, fig. 18.1–3, pl. 4 fig. 3.

Notosceles serratifrons. Serène & Umali 1972: 44–45, fig. 34, pl. 3 figs 7–10.—Goeke 1986: 227.

Notosceles viaderi Ward, 1942

Notosceles viaderi Ward, 1942: 47–48, pl. 4 figs 5, 6.—Crosnier 1976: fig. 6.—Ribes 1990: pl. 1 fig. c.—Poupin 1996: pl. 14 fig. a.

Selected morphological features differentiating *Notosceles* species

The six described species of *Notosceles* are very similar but there are a number of minor morphological characters that can be used to differentiate them. Each species shows some degree of variation in these characters and the range of this variation in some species (see for example Serène & Umali's comments on *N. serratifrons*—1972: 47) is probably not fully stated in the lists given below.

1. Rostral shape

N. barnardi—triangular and weakly serrate

N. chimmonis—tridentate

N. ecuadorensis—ranging from shouldered (rounded or right-angled) to almost tridentate

N. pepeke—shouldered (ranging from rounded to right-angled)

N. serratifrons—triangular and strongly serrate

N. viaderi—shouldered (rounded)

2. Inner orbital angle

N. barnardi—flattened right angle (i.e. a right angle with the anterior margin straight)

N. chimmonis—flattened right angle

N. ecuadorensis—ranging from rounded right angle to low rounded lobe

N. pepeke—flattened right angle

N. serratifrons—distinct serrated spine

N. viaderi—beaded flattened right angle

3. Supraorbital spine

N. barnardi—beaded truncate lobe

N. chimmonis—acute spine

N. ecuadorensis—ranging from rounded lobe to broad low spine or even distinct spine

N. pepeke—ranging from beaded lobe to blunt spine

N. serratifrons—acute spine almost as long as external orbital spine

N. viaderi—beaded truncate lobe

4. External orbital spine

A strong acute spine in all known *Notosceles* species

5. Fronto-orbital margin

N. barnardi, *N. chimmonis*, *N. ecuadorensis* and *N. pepeke*—all tuberculate

N. serratifrons—ranging from strongly tuberculate to serrate

N. viaderi—weakly tuberculate

6. Margin between external orbital spine and anterolateral spine

N. barnardi—tuberculate

N. cbimmonis—strongly tuberculate

N. ecuadorensis—weakly tuberculate

N. pepeke—strongly tuberculate

N. serratifrons—serrate and sometimes with additional low spines

N. viaderi—strongly tuberculate

7. Cheliped carpus: dorsodistal spines

N. barnardi—a distomedial spinule and a distolateral spinule

N. cbimmonis—a distomedial spine and a pointed distolateral process

N. ecuadorensis—a very distinct distomedial spine and a less distinct distolateral process ranging from rounded tubercle to distinct spine

N. pepeke—a distomedial process ranging from rounded tubercle to low spine, and a rounded distolateral process

N. serratifrons—carpus serrated dorsally with both distomedial and distolateral spines

N. viaderi—a distomedial spine and a distolateral spine

8. Cheliped hand: dorsolongitudinal double carina

N. barnardi—carinae converge and meet proximally; carinae serrated and terminate distally in spines

N. cbimmonis—carinae parallel

N. ecuadorensis—carinae converge somewhat proximally but do not meet; medial carina usually with a distinct spine at distal end, lateral carina bluntly rounded distally or with a weak distal spine

N. pepeke—carinae converge somewhat proximally but do not meet; medial carina usually weakly spined at the distal end, lateral carina usually bluntly rounded distally

N. serratifrons—carinae parallel

N. viaderi—carinae parallel distally then become indistinct proximally as they merge with the small dense granules on upper sur-

face of propodus, they do not meet proximally; medial carina with a distinct spine at distal end, lateral carina with a granulated distal tooth (Alain Crosnier pers. comm. December 1998).

9. Cheliped hand: number of ventral spines

N. barnardi—3

N. cbimmonis—2

N. ecuadorensis—3 to 4

N. pepeke—3 (proximal may be smaller than other two)

N. serratifrons—3

N. viaderi—3 to 4.

The northern New Zealand *Notosceles* then differs from *N. barnardi* and *N. serratifrons* in having a shouldered rostrum rather than a simple triangular rostrum, and from *N. barnardi* in having the two longitudinal carinae on the hand not meeting proximally. *N. pepeke* differs from *N. cbimmonis* in having a shouldered rostrum rather than a clearly tridentate rostrum, in not having the supraorbital spine developed as an acute spine, and in having 3 rather than 2 ventral spines on the hand. *N. pepeke* differs from *N. ecuadorensis* in having the rostral shoulders either rounded or right-angled rather than rounded (rarely), right-angled (usually) or almost tridentate (in some specimens), in having the rostral shoulders usually at a level a little posterior to the level of the tips of the external orbital spines rather than usually a little in advance of the level of the tips of the external orbital spines (as in *N. ecuadorensis*), and in having the distal part of the rostrum (the part in advance of the rostral shoulders) usually appearing to be relatively shorter than it is in *N. ecuadorensis*. *N. pepeke* differs further from *N. serratifrons* in having a flattened inner orbital angle rather than having this angle developed as a serrated spine, in having the supraorbital spine developed either as a lobe or a blunt spine, but never as an acute spine almost as long as the external orbital angle, and in never having additional low spines on the margin between the external orbital spine and the anterolateral spine. *N. pepeke* differs from *N. viaderi* in having the supraorbital spine developed as a distinct beaded lobe or as a blunt spine in contrast to the beaded truncate lobe of *N. viaderi*, and in not having fully developed medial and lateral dorsodistal spines on the cheliped carpus.

Key to extant species of the genus *Notosceles*

- 1(4) Rostrum triangular (i.e. not tridentate and without shoulders); ventral margin of hand with 3 spines.
- 2(3) Inner orbital angle a flattened right angle; supraorbital spine a beaded truncate lobe; margin between external orbital spine and anterolateral spine tuberculate and never with additional spines; cheliped carpus not serrated dorsally and with relatively weak distomedial and distolateral dorsal spinules; cheliped hand with the two dorsolongitudinal carinae converging and meeting proximally——
—— *N. barnardi* (Sakai)
Indo–West Pacific (South Africa and Japan).
- 3(2) Inner orbital angle a serrated spine; supraorbital spine acute and almost as long as external orbital spine; margin between external orbital spine and anterolateral spine serrate and sometimes with additional low spines; cheliped carpus serrated dorsally and with relatively strong distomedial and distolateral dorsal spines; cheliped hand with the two dorsolongitudinal carinae not meeting proximally—*N. serratifrons* (Henderson)
Indo–West Pacific (Sri Lanka to Japan and north-west Australia).
- 4(1) Rostrum shouldered or tridentate; ventral margin of hand with 2 or more spines.
- 5(6) Rostrum clearly tridentate; ventral margin of hand with only 2 spines——
—— *N. chimmonis* Bourne
Indo–West Pacific (Indian Ocean to Philippines and French Polynesia).
- 6(5) Rostrum shouldered (ranging from rounded to right-angled, and in some few cases to almost tridentate); ventral margin of hand with 3, or occasionally 4, spines.
- 7(8) Inner orbital angle a flattened right angle, never a lobe; supraorbital spine a truncate lobe, never a spine; cheliped carpus with distomedial and distolateral dorsal spines; 1st male pleopod with terminal aperture open (i.e. terminal tip funnel shaped)——
- *N. viaderi* Ward
Indo–West Pacific (Mauritius and Reunion Islands, Indian Ocean, Hawaii, and French Polynesia).
- 8(7) Inner orbital angle ranging from flattened right angle to low rounded lobe; supraorbital spine ranging from a rounded lobe to a distinct spine; cheliped carpus seldom with distinct dorsal spines both distomedially and distolaterally, usually one or other of these distodorsal positions is tuberculate rather than developed into a spine; 1st male pleopod with terminal aperture closed (i.e. terminal tip rounded).
- 9(10) Rostral shoulders ranging from rounded to right-angled, never almost tridentate; rostral shoulders usually at a level a little posterior to the level of the tips of the external orbital spines; inner orbital angle a flattened right angle; supraorbital spine ranging from a beaded lobe to a blunt spine, never a distinct spine; cheliped carpus dorsally with a distomedial process ranging from a rounded tubercle to a low spine, and a rounded distolateral process (never a distinct distolateral spine); cheliped hand with medial dorsolongitudinal carina usually weakly spined at distal end, and lateral dorsolongitudinal carina usually bluntly rounded distally——
—— *N. pepeke* n.sp.
Indo–West Pacific (northern New Zealand and Norfolk Island waters).
- 10(9) Rostral shoulders ranging from rounded through right-angled to almost tridentate; rostral shoulders usually at a level a little in advance of the level of the tips of the external orbital spines; inner orbital angle ranging from a rounded right angle to a low rounded lobe; supraorbital spine ranging from a rounded lobe to a distinct spine; cheliped carpus dorsally with a distinct distomedial spine, and a distolateral process ranging from a rounded tubercle to a distinct spine; cheliped hand with medial dorsolongitudinal carina usually with a distinct spine at distal end, and lateral dorsolongitudinal carina either bluntly rounded distally or with a weak distal spine——
—— *N. ecuadorensis* (Rathbun)
Eastern Pacific (Gulf of California to Peru and Galapagos).

Ecological Distribution of the New Zealand Frog Crabs

Both species of frog crabs known in New Zealand waters show curiously restricted patterns of distribution which invite some speculation as to the possible limiting factors. Based on collections to date, each species has a clear latitudinal limit: *Lyreidus tridentatus* is known from northern New Zealand down the east coast as far south as Banks Peninsula (there recorded only from the stomach of a Red Cod) and on the west coast to the end of the Lord Howe Rise at the western approach to Cook Strait. Its known depth range is 27–382m. Within some areas *L. tridentatus* has been found in relative abundance, both in numbers of localities sampled and in numbers of individuals collected. *Notosceles pepeke* is similarly limited in southward distribution from the Norfolk Island and Kermadec regions, having been collected around the Three Kings Islands and only as far south on the east coast as East Cape. These patterns are unlikely to be artifacts of inadequate or restricted sampling. The

benthic sampling programme of the New Zealand Oceanographic Institute carried out from 1955 to 1989 as part of its survey of the marine benthos of the EEZ resulted in over 8000 benthic stations (Dawson 1992: fig. 2) at which both species of frog crab could have been collected had they been present. This is particularly so for the intensively sampled areas of the northern Taranaki Bight, the Bay of Plenty, Hawke Bay, and the Chatham Rise. Hence, a pattern of negative records for raninid crabs within the New Zealand Region is evident. However, the reasons for such a pattern are not necessarily immediately obvious. There is, however, a likelihood that temperature, in the first instance, is a limiting factor. Sediment type might also be significant because of the known burrowing habits of most species of frog crab. The role of water movements for dispersal of larvae, and perhaps adults also, is another important consideration.

These two species of raninid are broadly sympatric in New Zealand waters; that is, they occur together in the same general geographic areas. However, in detail, they are, in fact, allopatric; the two have

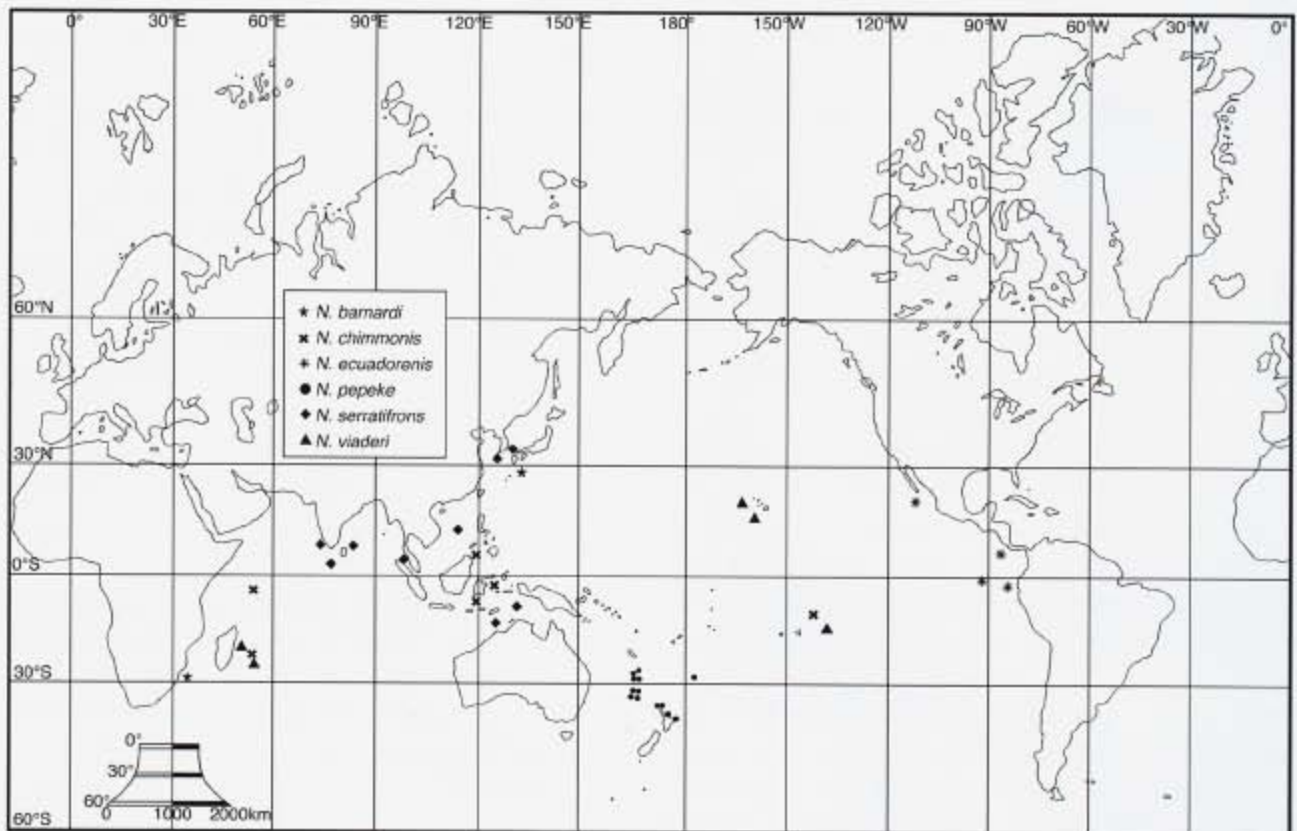


Fig. 10 Distribution of the species of *Notosceles*. Note: The identity of the *Notosceles* from off south-east Africa, recorded as *N. barnardi* by Sakai (1974), needs re-examination.

not been collected at one station. Over the extensive range of stations from which *Lyreidus tridentatus* has been collected there are no records of *Notosceles pepeke* occurring with it. Again, this is unlikely to be an artifact of collecting or sorting since, in the case of material collected on the cruises of the New Zealand Oceanographic Institute, the total catch at each station was sorted and preserved. It is likely that, although both species are frog crabs presumably with ecological requirements in common, there are differences between them that are worth trying to elucidate. Such differences might be attributable to the effects of temperature, water movement, availability of certain sediment grades, or a combination of these factors or their special influence at particular stages of the crabs' life cycles. There is very little direct evidence available which would enable us to indicate direct correlations between distribution and physical factors. However, even such first attempts as we can make here could be of help in future palaeobiological interpretations of the fossil

record, with respect to the origin and evolution of the Raninidae, and, indeed, could contribute towards resolving some of the questions of the origin of the marine fauna of the Southern Ocean and Antarctica as posed, for instance, by Clarke & Crame (1989).

TEMPERATURE: Ekman (1953: 3) postulated that temperature is the most important factor in the zoogeography of the sea. In fact, he demonstrated many cases in the Brachyura where this was undoubted. At least one much more recent study (Soto 1985) has shown that the distribution patterns of some deeper-water crabs are reflections of temperature conditions as ecological barriers. Ekman (1953: 112) showed that the temperature at the reproductive period was highly significant and that the maximum temperature attained within the possible area of occurrence of a species was more important than the annual means.

We have no direct information on the tempera-

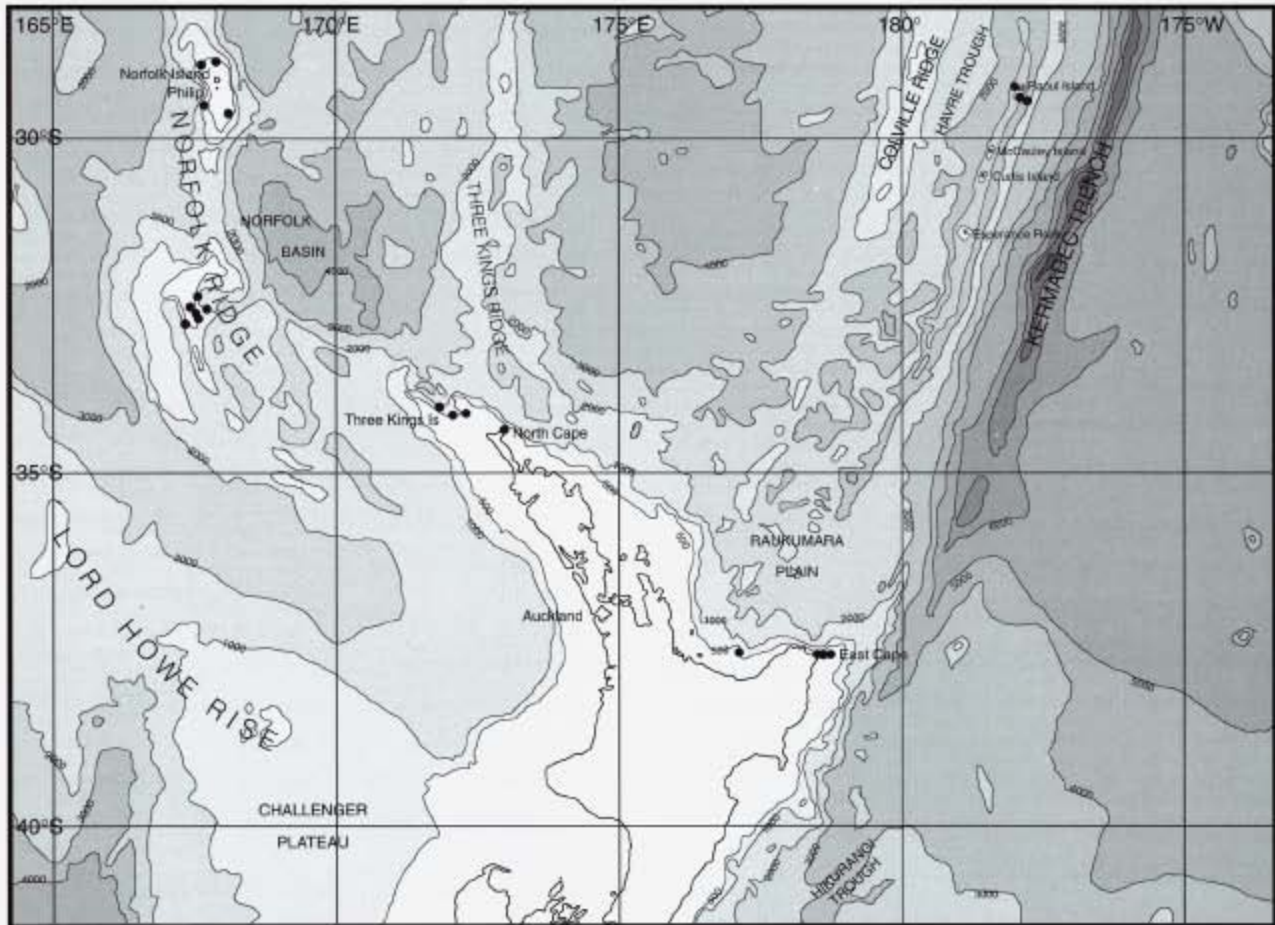


Fig. 11 Distribution of *Notosceles pepeke* n.sp.

ture tolerances of *Notosceles pepeke* except to be able to note what temperature range might be expected seasonally at the particular geographic localities where it has so far been found to occur. There is, however, some data for *Lyreidus tridentatus* which may be relevant here. From his study of *L. tridentatus* as a component of the benthos off the coast of New South Wales, MacIntyre (1963, 1965) found that it occurred there in a depth range of 50–400 m through a temperature range of 10°–20° C with a “sharp” breeding season with females ovigerous in early June, larvae emerging in September and metamorphosing in early November (MacIntyre 1968). The range of temperature encountered in the coastal waters of New South Wales during this breeding season (June–November) would be 17°/18° C in June to 19°/20° C in November according to Dakin & Colefax (1940). This temperature range is also covered in New Zealand seas. Sea-water temperatures mapped at the ocean floor (Ridgway 1968) show that the range of both *Lyreidus* and *Notosceles* in New Zealand lie within a considerably variable temperature range of up to 8° C. The temperature at 200 metres depth between October and March (Ridgway *et al.* 1979) shows a 10° C isotherm lying to the north of the Chatham Rise on the east side of New Zealand and further south on the west at the latitude of Fiordland. The 20° C isotherm lies very far north of New Zealand in the latitude of New Caledonia (about 22°–23° S) with the known northern limit of *Notosceles pepeke* between the 16° and 17° isotherms. However, no detail is available for shelf depths less than 200 metres. On the other hand, surface waters show a clear sequence of changes throughout the year which could influence the timing of egg production, hatching, and metamorphosis, as well as the dispersal, of larvae. If the average temperature for breeding activity is taken as 15° C (based on Dakin & Colefax 1940), then the annual progression of this isotherm can be followed through New Zealand waters from the coloured charts derived from the four-times-daily NOAA satellite records and published by NIWA in sequence from June 1997 to November 1998 (NIWA 1997/98).

The 15° C isotherm moves through the New Zealand Region progressively south from its northern limit in July/September at about latitudes 35° to 37° S on both the west and east coasts of New Zealand to a southern limit in February/March south of Fiordland

and Stewart Island at about 45°S in the west and eastward off Otago Peninsula. There are, however, considerable annual fluctuations in position of all isotherms as noted in the NIWA commentaries for each chart. The 20° C isotherm marks the extension of tropical warm sea surface into the New Zealand Region, reaching about the latitude of Cook Strait in the east and the Taranaki Bight in the west in the months of February and March but from July to November remaining well to the north of the New Zealand Region, and moving southwards again from December to January. Garner's (1969a, b) mapping of midshelf temperatures showed a summer range of 14°–16° C as far south as Cook Strait, with increasingly colder water to 12°C and less further to the south beyond the known range of either frog crab species. On the west coast, colder waters appear at midshelf depths about the latitude of Raglan Harbour, indicating a generally colder regime on this coast.

There is no information on the breeding of *Notosceles pepeke* since neither ovigerous females nor larvae have been found as yet. Very little has been recorded about the breeding of *Lyreidus tridentatus* locally. The information given by Wear & Fielder (1985) in their summary of the larvae of New Zealand Brachyura is largely derived from Williamson's (1965) study of New South Wales material. Ovigerous females of *L. tridentatus* have been seldom recorded—June 1963, July 1967, off New South Wales; June 1949, June 1960, in New Zealand waters (Griffin 1970: 96), August 1949 (Powell 1949: 371). Bennett (1964: 26) recorded an ovigerous female with over 1000 eggs (MacIntyre 1968 noted up to 8000 eggs on New South Wales females) taken near Whale Island in the Bay of Plenty in December 1914. Wear & Fielder (1985: 26) reported on two megalopas dredged in the Bay of Plenty in January 1979 (NMNZ Cr. 2464). Similar megalopas were collected by one of us (E.W.D.) near White Island from a crayfish pot (NZOI Stn D91) and a trawl (Stn D92) in May 1963.

If the main breeding season of *Lyreidus tridentatus* is over the same period of 4 to 5 months from June to November as in New South Wales waters, then the area of reproduction at the required temperature around 15° C is limited to Cook Strait from May to August progressively moving northwards to northern New Zealand. On the other hand, in the December to March period the maximum southerly

extension of the 15° C isotherm indicates that a wide breeding area according to temperature is available in southern New Zealand waters. This, combined with the considerable seasonal fluctuations in water temperature level as discussed in each of the commentaries accompanying the NIWA charts, could account for the apparently anomalous records of an ovigerous female of *Lyreidus tridentatus* in December and megalopas in January. Although the water temperature in summer extends sufficiently far south in December to March for breeding to occur, the establishment of an adult population capable of breeding seems to be restricted in other ways, possibly by surface water movements preventing larval movements to extended areas.

Ekman (1953: 317) drew attention to areas in which a species is found in abundance and those in which it appears to barely manage to exist—the former termed the “reproduction area” and the latter the “sterile expatriation area”. He commented:

In some cases where a species occurs in a region with very few individuals, it may nevertheless reproduce itself to a sufficient extent and thus have its home there. But in other instances it remains questionable whether the species is able to exist independently in the unfavourable region or whether it would not die out if it were not continuously reinforced from the more favourable regions. This would naturally happen if reproduction cannot take place at all, or only to an insufficient extent. In such a case the unfavourable region is obviously outside the real home of the species, and it would be possible to contrast the autochthonous main mass of the species which lives in the reproductive area with an allochthonous sterile expatriated contingent in an expatriation area.

Spoel & Heyman (1983: 30) have since developed this concept into a model with both horizontal and vertical components to interpret the ranges of a variety of plankton taxa. This is an attractive hypothesis to account for the extreme southern limits of the ranges of the two species of frog crabs known in New Zealand waters, and, especially, for the limited evidence of their breeding activity. It is a challenge now to discover and be able to differentiate recognisable breeding and expatriate populations. In the case of *Notosceles pepeke*, it may well be that the “real home” (as Ekman termed it) of this species lies right outside the New Zealand geographic region and the New Zealand specimens so far known

may be representatives of an “allochthonous sterile expatriated contingent” (to use Ekman’s expression).

WATER MOVEMENTS: The pattern of surface water movements in the New Zealand Region (Carter & Garlick 1998) clearly provides a mechanism for the introduction of subtropical marine species and their dispersal further south. Carter *et al.* (1998) have illustrated this general pattern, showing how the East Australian Current off New South Wales forms a northerly branch across the Tasman Sea as the Tasman Front, then extends round the Three Kings and Northland as the East Auckland Current. This current moves along the northeast coasts of the North Island past the Bay of Plenty towards East Cape, where a branch turns northwards towards the Kermadec Islands, with another branch diverting southwards as the East Cape Current as far as the northern edge of the Chatham Rise. It seems clear that recruitment stock of *Lyreidus tridentatus* could reach the North Island of New Zealand through the Tasman Front and be carried progressively by the East Auckland Current through the Hauraki Gulf and the Bay of Plenty to the Kermadec Islands in a northeasterly direction and past East Cape to Hawke Bay and Cook Strait by its southern branch. In this way larvae could spread through what has been shown by the collection of both adults and megalopas to be the range of distribution of this species. The paucity of *Lyreidus tridentatus* on the west coast of New Zealand can be explained in a similar way. From the mid-Tasman Sea the bulk of the surface water movements on the west side of the North Island are derived from the long sweep of the East Australian Current towards the west coast of the South Island, evolving into the Westland Current and the Durville Current, reaching into the southern Taranaki Bight and further to the north. The surface water system appears irregular and confused in this part of the Tasman, and this, combined with the lower temperatures, may mean that only the weaker West Auckland Current, moving close inshore southwards off the west coast of Northland towards the northern Taranaki Bight for a limited distance, could effectively or regularly aid larval dispersal on this side of the New Zealand coastline. This apparent combination of water movement and the effect of temperature on reproduction is a further illustration of what Ekman (1953: 310) has said about

how a species can pass out of the temperature range within which it can reproduce and finally disappear, the total extent of its geographic range depending on the length of life of the dispersing larva or the migrating adult, and the rate of the water movement.

SEDIMENT: *Notosceles pepeke* has been collected on a variety of substrates, ranging from coral debris and living coelenterates and sponges to coarse shell with sand. However, most of the specimens were collected by rock dredge, a device from which most fine material can be washed out while being hauled up from depth. Hence, the habitat sampled might have had more fine sediment present than was found in the catch. In contrast, most collections of *Lyreidus tridentatus* have come from soft sediment areas, the first specimen of 1904 having been dredged in a soft, sticky, green mud. MacInyre (1965: 35) correlated the abundance of *L. tridentatus* with increasing depth and sediment character off New South Wales, showing that it was commonest in fine sand and silts and less abundant or absent as the sediments became coarser. Although the form of the appendages of *Notosceles* appear to be related to the sediment burrowing, typical of other raninid species, there is evidence that species of frog crabs vary in their relative burrowing and swimming adaptations and consequent behaviour. Bourne (1922: 66) described a progressive series of morphological modifications, especially concerning the second and third walking legs, in a number of genera of the Raninidae, which indicated their use as swimming organs in contrast to their supposedly characteristic use in burrowing. For *Notosceles*, he concluded that it was a fast efficient swimmer and less adapted to burrowing than some other genera. On the other hand he found evidence that *Lyreidus* should be regarded as a deep burrower [as subsequently confirmed by Kok (1964) in a study of its habits off New South Wales]. Perhaps these differences in morphological adaptations can be correlated with the apparent differences in substrate preference indicated by *Notosceles* and *Lyreidus* in New Zealand. There is some evidence that other species of raninids occur on areas of predominantly hard sediment. For instance, Soto (1985: Table 1) listed three species of raninid from the Straits of Florida, one of which, *Raninoides lamarcki* A. Milne Edwards & Bouvier, he noted as occurring on "rocky"

bottom, whereas the two other species had been found on "mud-shell rubble" and "mud-coral-rubble". He noted that *Raninoides lamarcki*, which he nonetheless regarded as a burrowing crab, "probably takes advantage of the few smooth bottoms present in an otherwise rough and irregular region where the shelf habitat is extremely limited". Interestingly, Bourne (1922) had already linked *Raninoides* with *Notosceles* as an efficient swimmer rather than a burrower. These two genera are also taxonomically close.

The general sediment chart of the New Zealand Region (Mitchell *et al.* 1989) shows midshelf areas around the east coast of New Zealand to be largely dominated by mud, with patches of gravel/sand mixtures in the Hauraki Gulf and off eastern Northland, whereas extensive areas of gravel/sand mixture lie off the west coast of the North Island and the northern part of the South Island, both areas in which raninid crabs have not been collected. The Three Kings area and the sea floor around Norfolk Island are dominated by calcareous gravel/sand mixtures. The general absence of raninid crabs on the west coast of New Zealand, their limit being approximately the northern Taranaki Bight (an area which has been intensively sampled), may perhaps be correlated with a lack of suitable sediment, the soft sediments in this region being of iron sand composition.

ECONOMIC INTEREST: *Lyreidus tridentatus* is quite significant as the prey of several species of commercially important demersal fish (Godfriaux 1969, 1974), but there is no evidence yet of the use of *Notosceles pepeke* as a food item. This may be a further indication that these two species differ in their sediment/bottom preference, since Godfriaux's samples were from silt and mud bottoms. Williamson (1965) had also found that the stomach contents of many tuna caught off southern-eastern Australia during the months of September, October, and November contained megalopas of *Lyreidus tridentatus*, characteristically bright red in colour.

Discussion

The occurrence of a second species of the Raninidae in New Zealand waters is particularly interesting in relation to the hypothesis that that the Southern Hemi-

sphere was a centre of origin and dispersal of the early Brachyura. *Notosceles* is not represented in the comparatively rich fossil record of the Raninidae in the Cretaceous and early Tertiary of New Zealand. However, further knowledge about *Notosceles* and its ecological requirements may well assist palaeoecological interpretations of allied genera of raninids known as fossils. It would be exciting, indeed, if *Notosceles* were also found to be of southern origin.

On the other hand, the occurrence of *Notosceles* living in the New Zealand Region may be attributable to the transporting influence from northern tropical waters of the southward-flowing, warm-water East Australian Current, as first proposed by Powell (1947) to account for the presence of what he regarded as a new species of *Lyreidus*. There is no evidence so far of breeding individuals of *Notosceles pepeke* and there are remarkably few ovigerous females of *Lyreidus tridentatus* in New Zealand collections. This may, perhaps, be an artifact of sampling in particular seasons, although the number of adults in collections suggests otherwise. It is tempting to consider the peculiarly limited known distribution of *Notosceles pepeke* as another example of the reproduction/expatriation area phenomenon demonstrated for other animals by Ekman (which, similarly, may be shown in New Zealand by the northern extensions of range of such colder-water species as the giant Southern Spider Crab *Jacquiniotia edwardsii* and the Subantarctic Scallop *Zygoclamys delicatula*; Beu *et al.* 1977, Beu 1985). Further sampling along the Norfolk Ridge may well show the true "reproduction area" or "home" of *Notosceles pepeke*. Hydrological conditions and the nature of the substrate may be other limiting factors to account for the sharp southerly cut-off in distribution pattern, which seems to be a real feature rather than a matter of inadequate sampling.

Notosceles pepeke, described here, is similar to, but distinct from, *N. ecuadorensis* and *N. cbimmonis*, and certainly distinct from *N. viaderi* and other members of the genus. It appears that we may be recording here only the southern non-breeding fringe of the *N. pepeke* population. It is in fact the southernmost representative of the wide-ranging, Indo-West Pacific/eastern Pacific genus *Notosceles*, with the bulk of its records lying between 30° and 40° South. This southern range is matched in the 30° to 40° North zone

only by the records of *N. serratifrons* and *N. barnardi* in Chinese and Japanese waters.

We hope that the use of the new generic and specific keys which we present here will encourage a closer look at smaller specimens of frog crab which may be collected in the future and might otherwise be casually regarded as young *Lyreidus tridentatus*. Further sampling within known areas of occurrence of the raninid species, especially seasonally, and specifically related to water temperatures and sediment habitat, would give useful evidence for more meaningful palaeontological interpretation of fossil Raninidae and would contribute usefully towards resolving still-continuing questions of the origin of the Southern Ocean marine fauna.

Guinot (1993: 1324) described the present-day existence of the Raninidae as "The persistence of a relatively small number of extant genera, distributed in almost all the seas, [that] clearly indicates a formerly vast and ancient group, in a phase of decline." The discovery of a new species of raninid hence provides another taxon from which we may develop further understanding of the history and ecology of this quite venerable group of crabs.

Whakarāpopotonga

Kua whakaahuatia a *Notosceles pepeke* n.sp. i roto i ngā kohinga rua tekau mā tahi; ka kitea mai i ngā hōhonutanga rima tekau mita ki te toru rau mita, ki te takiwā ki te motu o Norfolk me te tahataha o Wanganella (Wanganella Bank) i runga i te ranga o Norfolk (Norfolk Ridge), mai i te pito tonga o te ranga o Three Kings (Three Kings Ridge), ki Te Moana a Toi-te-huatahi mai i te ranga o Te Araroa (East Cape Ridge) ki waho o ngā moutere ki Kermadec, ki runga i te ranga o Kermadec (Kermadec Ridge). Ka noho tata tēnei ki *N. viaderi* Ward, 1942, nō Reunion, ki te Tai Hauāuru o Te Moana o Īnia, me *N. ecuadorensis* (Rathbun, 1935), mai i Ecuador me ngā moutere o Galapagos, ki te Tai Rāwhiti o Te Moana-nui-a-Kiwa. I tangohia mai a *N. pepeke* i te papa moana, mai i ngā para angaanga, oneone, me te bryzoan rubble, ka noho whirinaki ki te raninid, *Lyreidus tridentatus* de Haan, 1841, e mōhiotia ana ki Aotearoa. Kua whakatūria ngā whakaahua mō ngā raninid genera tekau mā rua, me ngā momo *Notosceles* e ono, kei te ora tonu i ēnei ra.

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