

REVISION OF THE INDO-WEST PACIFIC SPONGE CRABS
OF THE GENUS *PETALOMERA* STIMPSON, 1858
(DECAPODA: BRACHYURA: DROMIIDAE)

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ABSTRACT. – Despite having more than 20 species assigned to the genus *Petalomera* Stimpson, 1858, at one time or another, only four species are now recognized: *P. granulata* Stimpson, 1858, *P. pulchra* Miers, 1884, *P. indica* Alcock, 1900, and *P. longipes* Ihle, 1913. Specimens from the 1914 Mortensen Expedition and the 1922 Danish Kei Islands Expedition are also reported. A key to these species is provided. The species of *Petalomera* have an Indo-West Pacific distribution, from Sri Lanka to New Caledonia and from Japan to Australia. Although previously synonymized, *P. indica* Alcock, 1900, from the Indian Ocean is here regarded as a valid species. *Petalomera pulchra*, previously known from northern Queensland, Australia, is newly reported from Western Australia, thus making it the only species of *Petalomera* that occurs in both the Pacific and Indian Oceans. *Petalomera granulata* is a north Pacific species while *P. longipes* is a south Pacific taxon; their distributions not overlapping.

KEY WORDS. – Revision, sponge crab, *Petalomera*, Indo-West Pacific.

INTRODUCTION

The sponge crab genus *Petalomera* was established by Stimpson (1858) for *P. granulata* Stimpson, 1858, collected by the Ringgold and Rogers Pacific Expedition from a depth of 37 m, Kagoshima Bay, Japan. The second species, *P. pulchra* Miers, 1884, was collected by Coppinger, on the voyage of H. M. S. "Alert", from the Prince of Wales Channel, Northern Australia, at a depth of 15 m. Alcock (1901) described a third species, *P. indica* Alcock, 1901, from Sri Lanka and the Andaman Islands, from a depth of 51 to 62 m. Finally, a fourth species *P. longipes* Ihle, 1913, was obtained during the Siboga Expedition, from Rote (Rotti) Island, Indonesia, from between 18 to 45 m. After these reports, various authors added some 15 species to *Petalomera* largely on the basis that all small dromiids with an epipod on the cheliped should be transferred to the genus (see Ihle, 1913). All these species, however, lack the petaloid meri on the first three pairs of pereopods and were excluded from *Petalomera* by McLay (1993).

Petalomera indica was first described by Alcock (1900) as a variety of *P. granulata* because the meri of the third pereopods

were not petaloid. Subsequently, Alcock (1901) elevated the variety to full species status. However, Sakai (1965) treated *P. indica* as a synonym of *P. granulata* without explanation, and the synonymy has been followed ever since. However, careful comparison of *P. granulata* with Alcock's (1900) figure and description suggests that there are sufficient differences to regard *P. indica* as a valid species. Specimens of *P. indica* were not available for the present study, so a close examination of *Petalomera* specimens from the Andamans and Sri Lanka should eventually be undertaken to confirm their identity.

The genus *Petalomera* was last reviewed by McLay (1993) based on material from New Caledonia, and only two species were included in the genus: *P. pulchra* and *P. granulata* with *P. longipes* placed in synonymy with *P. pulchra*. The synonymy of *P. indica* and *P. granulata* was not questioned. With more material now at hand, we now conclude that *P. longipes* is actually a valid species and that the material identified as *P. pulchra* from New Caledonia and the Chesterfield Islands should be re-identified as *P. longipes*. Thus this is an opportune time to re-evaluate all the species of *Petalomera* and to clarify the taxonomic composition of the genus.

Table 1. List of species assigned to the genus *Petalomera* at one time or another.

Species	Current Name
<i>Petalomera acutidens</i> Sakai, 1983	<i>Epigodromia acutidens</i> (Sakai, 1983)
<i>Petalomera angulata</i> Sakai, 1936	<i>Stindromia angulata</i> (Sakai, 1936)
<i>Petalomera atypica</i> Sakai, 1936	<i>Frodromia atypica</i> (Sakai, 1936)
<i>Petalomera atypica reticulata</i> Sakai, 1974	<i>Frodromia reticulata</i> (Sakai, 1974)
<i>Petalomera depressa</i> (Baker, 1907)	<i>Fultodromia nodipes</i> (Guérin-Méneville, 1832)
<i>Petalomera fukuii</i> Sakai, 1936	<i>Cryptodromia fukuii</i> (Sakai, 1936)
<i>Petalomera granulata</i> Stimpson, 1858	<i>Petalomera granulata</i> Stimpson, 1858
<i>Petalomera indica</i> Alcock, 1900	<i>Petalomera indica</i> Alcock, 1900
<i>Petalomera japonica</i> (Henderson, 1888)	<i>Paradromia japonica</i> (Henderson, 1888)
<i>Petalomera kosugei</i> Takeda & Miyake, 1972	<i>Stindromia kosugei</i> (Takeda & Miyake, 1972)
<i>Petalomera laevis</i> Kensley, 1970	<i>Hemisphaerodromia monodus</i> (Stebbing, 1918)
<i>Petalomera lamellata</i> (Ortmann, 1894)	<i>Stindromia lamellata</i> (Ortmann, 1894)
<i>Petalomera lateralis</i> (Gray, 1831)	<i>Stindromia lateralis</i> (Gray, 1831)
<i>Petalomera longipedalis</i> Dai, Yang, Song & Chen, 1986	<i>Stindromia longipedalis</i> (Dai, Yang, Song & Chen, 1986)
<i>Petalomera longipes</i> Ihle, 1913	<i>Petalomera longipes</i> Ihle, 1913
<i>Petalomera nodosa</i> Sakai, 1936	<i>Epigodromia nodosa</i> (Sakai, 1936)
<i>Petalomera pulchra</i> Miers, 1884	<i>Petalomera pulchra</i> Miers, 1884
<i>Petalomera sheni</i> Dai, Yang, Song & Chen, 1981	<i>Paradromia sheni</i> (Dai, Yang, Song & Chen, 1986)
<i>Petalomera wilsoni</i> (Fulton & Grant, 1902)	" <i>Dromia</i> " <i>wilsoni</i> (Fulton & Grant, 1902)
<i>Petalomera yamashitai</i> Takeda & Miyake, 1970	<i>Tunedromia yamashitai</i> (Takeda & Miyake, 1970)

Carapace dimensions are reported as CW x CL (carapace width and length respectively) measured at the greatest dimension. P4 and P5 refer to the fourth and fifth pereopods, respectively. The abbreviation ED refers to the egg diameter. The following abbreviations are used for collections: AM – Australian Museum, Sydney; ASIZ – Academia Sinica, Institute of Zoology, Taipei, Taiwan; NHM – The Natural History Museum (ex British Museum of Natural History), London; NTM – Museum & Art Galleries of Northern Territories; MNHN – Muséum national d'Histoire naturelle, Paris; NSMT – National Science Museum, Tokyo; SMF – Senckenberg Museum, Frankfurt; WAM – Western Australia Museum, Perth; ZMC – Zoologische Museum, Copenhagen; ZRC – Zoological Reference Collection, Raffles Museum of Biodiversity Research, National University of Singapore.

TAXONOMY

Petalomera Stimpson, 1858

Petalomera Stimpson, 1858: 226; 1907: 179; Alcock, 1900: 147; 1901: 55; Borradaile, 1903a: 300 (in part); Ihle, 1913: 48; Sakai, 1936: 28 (in part); Sakai, 1965: 9; Sakai, 1976: 20 (in part); Barnard, 1950: 312; McLay, 1991: 474; McLay, 1993: 164; Dai & Yang, 1991: 25 (in part).

Cryptodromia – Ortmann, 1894: 34 (in part); Ihle, 1913: 32 (in part).

Diagnosis. – Carapace width about equal to or less than length, surface slightly to strongly convex, granulated, may be areolate. Lateral rostral teeth prominent, anterolateral teeth

small, obscured by granules or absent. Antennal articles granulated. Coxae of third maxillipeds closely approximated, separated from tip of sternum by deep trough. Female sutures 7/8 end apart between or behind base of first walking legs. Cheliped with epipod. Chelipeds and first 2 pairs of walking legs usually with petaloid meri, carpi and propodi may be crested. Legs not knobbed, inner margins of dactyli of first 2 pairs of legs armed with up to 7 small spines. Last 2 pairs of legs reduced, third pair shortest, dactyli opposed by single propodal spines with sometimes another spine on outer propodal margin. Abdomen of 6 free segments. Uropod plates well developed, visible externally, used in abdominal locking mechanism by fitting in front of large tuberculate knob on bases of first legs. Telson wider than long, tip bluntly rounded. Vestigial pleopods absent on male abdomen abdominal segments 3–5. (Modified from McLay, 1993)

Type Species. – *Petalomera granulata* Stimpson, 1858, by original designation and monotypy.

Other Species. – *Petalomera indica* Alcock, 1900, *Petalomera longipes* Ihle, 1913, and *Petalomera pulchra* Miers, 1884.

Remarks. – Twenty species have been assigned to the genus *Petalomera* over the years (Table 1). Of these, 15 species were originally described in this genus while the other five species were transferred in from two other genera: *P. depressa*, *P. japonica*, *P. lamellata*, *P. wilsoni* (from *Cryptodromia*), and *P. lateralis* (from *Dromia*). After the revision by McLay (1993), only two species, *P. granulata*

Stimpson, 1858, and *P. pulchra* Miers, 1884, remained in the genus; both of which have petaloid meri on their first three pereopods. *Petalomera longipes* Ihle, 1913, was placed in synonymy with *P. pulchra*. However, we here show that *P. longipes* is in fact a valid species. Thus, we now recognise four species of *Petalomera*. The other 16 species (number in parenthesis) previously placed in *Petalomera* are now included in 10 other genera (number of species in parenthesis): *Cryptodromia* (1 species), "*Dromia*", (1), *Epigodromia* (2), *Frodromia* (2), *Fultodromia* (1), *Hemisphaerodromia* (1), *Paradromia* (2), *Stimdromia* (5), and *Tunedromia* (1). *Petalomera wilsoni* (Fulton & Grant, 1902) was tentatively assigned to *Dromia* Weber, 1795, by McLay (1993), but this should be regarded as temporary, pending a review of the genus (D. Guinot, pers. comm.) (see also McLay et al., 2001).

Many dromiid crabs typically carry pieces of sponge or ascidians as camouflage, using their last two pairs of pereopods, but only one instance of carrying behaviour has been reported in the genus, in *Petalomera longipes* by McLay (1993: 167) (as *P. pulchra*).

Species of the genus *Petalomera* are confined to the vicinity of India, Australia, New Caledonia, Indonesia, Philippines, Taiwan, China and Japan.

Key to species of *Petalomera*

1. Carapace margin behind lateral rostral teeth distinctly eave-like, merus of P3 petaloid 2
 - Carapace margin behind lateral rostral teeth not eave-like, merus of P3 flattened but not petaloid 3
2. Carapace surface sparsely granulate; eave-like carapace margin behind lateral rostral teeth distinctly not granulate; three distinct anterolateral teeth; length to width of ratio of propodus of P3 and P4 less than 1.0, dactyli strongly hooked but not opposable to the small propodal spines *Petalomera pulchra* Miers, 1884
 - Carapace covered in small rounded granules; carapace margin behind rostral teeth weakly eave-like granulate; three broad, granulated anterolateral teeth (less clear because of granules); length to width of ratio of propodus of P3 and P4 more than 1.0, dactyli curved and opposable to large propodal spines *Petalomera longipes* Ihle, 1913
3. Carapace highly domed, surface covered with large blunt granules (may be areolate) especially on anterior half; carapace regions not marked by deep grooves; no distinct anterolateral teeth; dactyli of P4 and P5 opposable to propodal spines *Petalomera granulata* Stimpson, 1858
 - Carapace not highly domed, surface covered with unevenly distributed vesiculose granules; carapace regions marked by deep grooves; variable number of small granular anterolateral teeth; dactyli of P4 and P5 not opposable to propodal spines.. *Petalomera indica* Alcock, 1900

Petalomera granulata Stimpson, 1858 (Figs. 1–3)

Petalomera granulata Stimpson, 1858: 240; 1907: 179, Pl. 21, Fig. 4; Alcock, 1901: 55 (list); Ihle, 1913: 48, 91 (key & list); Gordon, 1931a: 526 (list); Sakai, 1935: 33, Pl. 1, Fig. 2; 1936: 37, Pl. 2,

Fig. 3, text Fig. 10; 1965: 10, Pl. 5, Fig. 1; 1976: 25, Pl. 4, Fig. 4; Suzuki & Kurata, 1967: 95 (list); Yamaguchi et al., 1987: 7, Pl. 1, Fig. 5; Dai & Yang, 1991: 25, Pl. 2, 3, Fig. 7, 1–3; McLay, 1993: 165 (key); Ng et al., 2000: 162, Fig. 3A; Ng et al., 2001: 6; McLay et al., 2001: 965.

Not *Petalomera granulata* Shen, 1932: 3, Pl. 1, Figs. 9, 10, text Figs. 1–3 [= *Paradromia japonica* (Henderson, 1888)].

Material examined. – **Japan:** MORTENSEN EXPEDITION, Misaki, near Osaka, ~34°30'N 135°10'E, 46 m, 9 Jun.1914: 1 female 19.7 x 20.6 mm (coll. T. Mortensen) (ZMC); Sagami Bay, ~35°30'N 139°20'E, 40–50 m: 1 female 29.2 x 29.7 mm (coll. T. Sakai) (Neotype); Tosa Bay, 33°10'N 133°30'E, ?250 m, Apr.1968: 1 male 26.0 x 26.4 mm (coll. K. Sakai) (SMF); Osezaki, Suruga Bay, Izu Peninsula, 10 m, 3 Jun.1994: 1 male 36.1 x 36.8 mm (NSMT-Cr 11639). **Taiwan:** near Keelung, ~25°N 122°E, Oct.1999: 1 male 36.2 x 37.2 mm, 1 female 26.0 x 26.4 mm (ASIZ72378); South Taiwan, Singkang Port, ~24°N 121°30'E, 8 Aug.1985: 1 female 20.7 x 20.6 mm (ZRC 1993.7195). **China:** Spratly Islands, 8°38'N 111°55'E, 60 m, 30 Apr.1993: 1 female 25.7 x 25.9 mm (ZRC 1999.001); Nansha Islands, ~11°N 116°E, 28 Sep.1994: 1 male 7.9 x 8.4 mm (coll. H. Chen).

Type specimens. – Stimpson (1858) gave the size of the type male as 8.4 x 9.1 mm and noted that it was obtained from “Kagoshima (~34°N 131°E), “fundo conchose, prof. 20 org - 37 m” in Japan. This specimen was housed in the Chicago Academy of Sciences, but was almost certainly destroyed by a fire in 1871 (Stimpson, 1907; Evan, 1967; Deiss & Manning, 1981). Since the type is not extant we designate the following specimen as the neotype of *P. granulata*: a female, 29.2 x 29.7 mm, Sagami Bay, 40–50 m, SMF. This we believe is necessary to stabilise the taxonomy of the genus as most of the members are superficially similar to each other and *P. granulata* is the type species of the genus.

Description. – Carapace as long as or longer than wide, strongly convex, covered in large, blunt granules, especially on anterior half of carapace. A coating of short setae, with scattered longer examples, covers spaces between granules; such setae also present on all pereopods. Frontal groove well marked, cervical groove distinct, branchial groove only faintly marked. Crescent shaped branchiocardiac grooves, with a central pit, well marked, joined by a shallow groove across mid-line. Rostrum tridentate, median tooth deflexed, set on a lower level, lateral teeth, separated by a V-shaped sinus, horizontal, directed anteriorly. Median tooth shorter than lateral teeth in dorsal view. All teeth serrated.

Supraorbital margin concave from lateral rostral tooth, edge armed with 4 or 5 sharp granules increasing in size towards well developed supraorbital tooth, this tooth projects strongly from orbital margin, directed anterolaterally; after supraorbital tooth, orbital margin continues as a concave line to the postorbital corner, bearing 7 or 8 sharp granules, with a short orbital fissure. Postorbital corner not produced; straight line connecting tip of lateral rostral tooth and postorbital corner, running along anterior carapace margin. Suborbital margin armed with several sharp granules and a suborbital tooth that is visible dorsally. Hepatic area, between postorbital corner and beginning of anterolateral margin, evenly covered with large granules. Below level of postorbital corner, granules form a tubercle that is visible dorsally. Anterolateral margin granulate, begins at level of postorbital corner, with a

granulated swelling, with another similar swelling after cervical groove. No posterolateral tooth present. Posterior carapace margin slightly concave with a row of granules along edge.

Suborbital area convex densely granulated. Epistome triangular, concave, interantennular septum thick, margins bearing 2 or 3 blunt granules. Posterior margin of epistome bears a row of granules; corner of buccal frame with exhalant channels formed by epistome corner and carapace margin; channels lie immediately below base of antennae; adjacent to this opening is a distinct granulated buccal tooth. Epimeral suture distinct. Inhalant channels at base of chelipeds densely setose. Rest of branchiostegal margin fits tightly around bases of pereopods.

First article of antennule longer than wide, sub-rectangular, second article inserted at disto-medial corner, folded laterally across distal end; this article fits tightly against rostral extension that joins interantennular septum. Third article longer than wide, folds posteriorly and along with flagellum, is concealed beneath supraorbital edge. First article of antenna

(urinal article) wider than long, beak-shaped medially, not gaping. Second article much longer than wide, distal border bears several small granules and a well developed bilobed exopod. Disto-medial corner produced as a curved, blunt lobe on which third article is inserted at an angle. Fourth article, like third article, as long as wide. All antennal articles freely moveable.

Third maxillipeds operculiform with scattered large blunt granules on outer surface, palp exposed, crista dentata with 10 well developed blunt teeth and 7 or 8 calcareous teeth on outer margin of basis.

Chelipeds well developed, larger in males. Merus trigonal in cross-section, lower margin granulated, inner surface nacreous, expanded as petals, fitting closely against subhepatic areas of carapace. Outer surface of carpus convex, granulated, with 2 strong distal granules and inner margin of upper border with 4 or 5 granules. Outer face of propodus covered in large granules that tend to be arranged in longitudinal rows. Inner margin of upper border crest-like, granulated. Fingers short, down-curved, hollowed out internally, so that cutting teeth are on outer border. Edges of

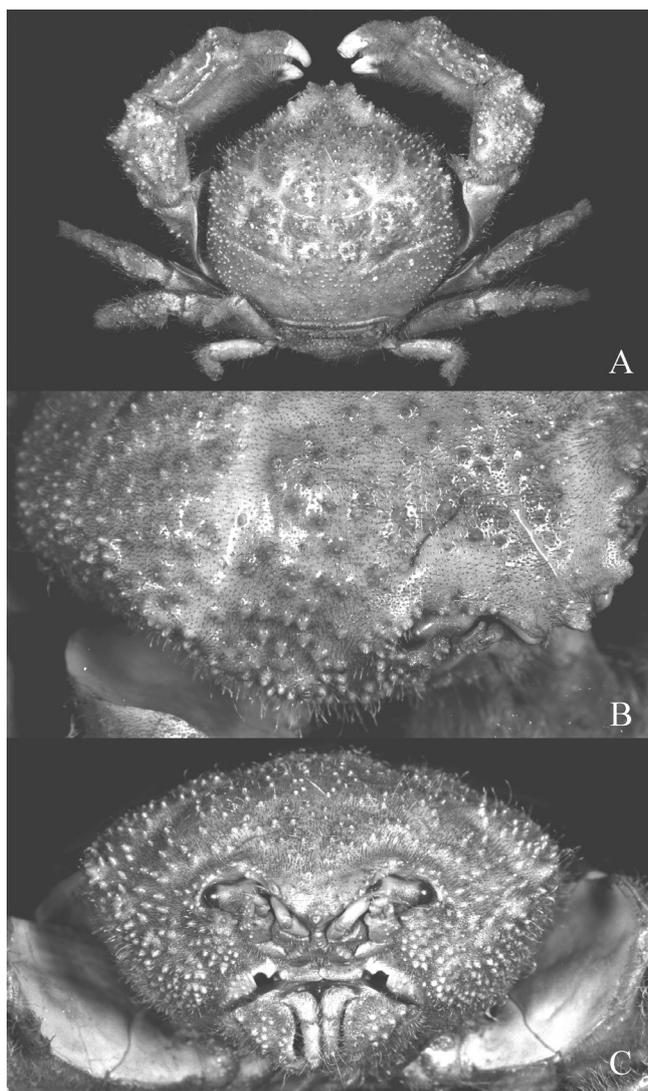


Fig. 1. *Petalomera granulata* Stimpson, 1858, male 36.2 x 37.2 mm (ASIZ 72378): A, overall dorsal view; B, right anterolateral margin showing tubercle arrangement; C, frontal view.

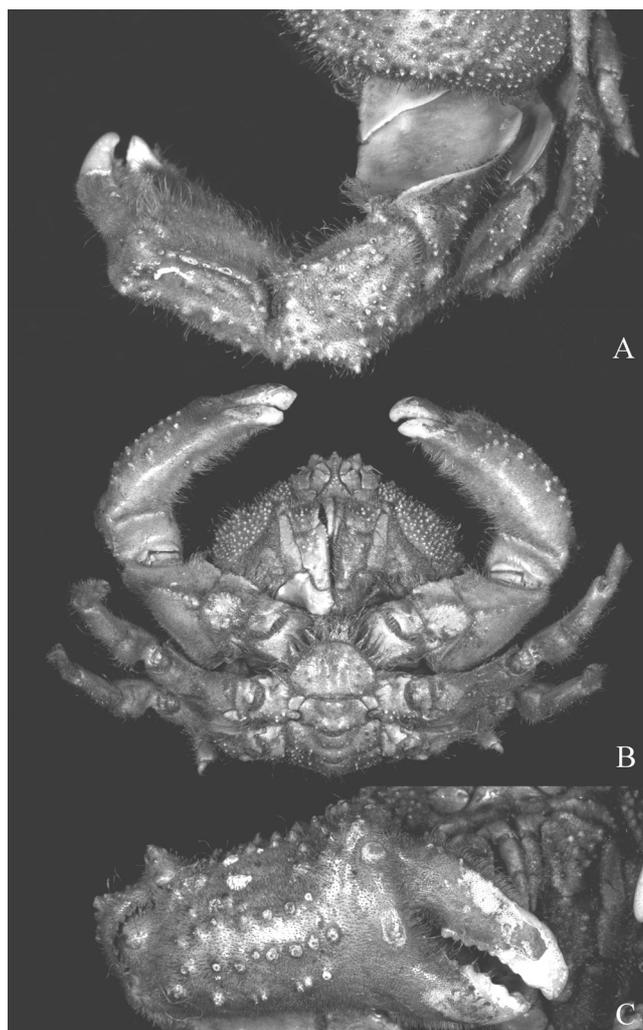


Fig. 2. *Petalomera granulata* Stimpson, 1858, male 36.2 x 37.2 mm (ASIZ 72378): A, left cheliped showing petaloid merus; B, ventral view of carapace; C, outer face of right chela.

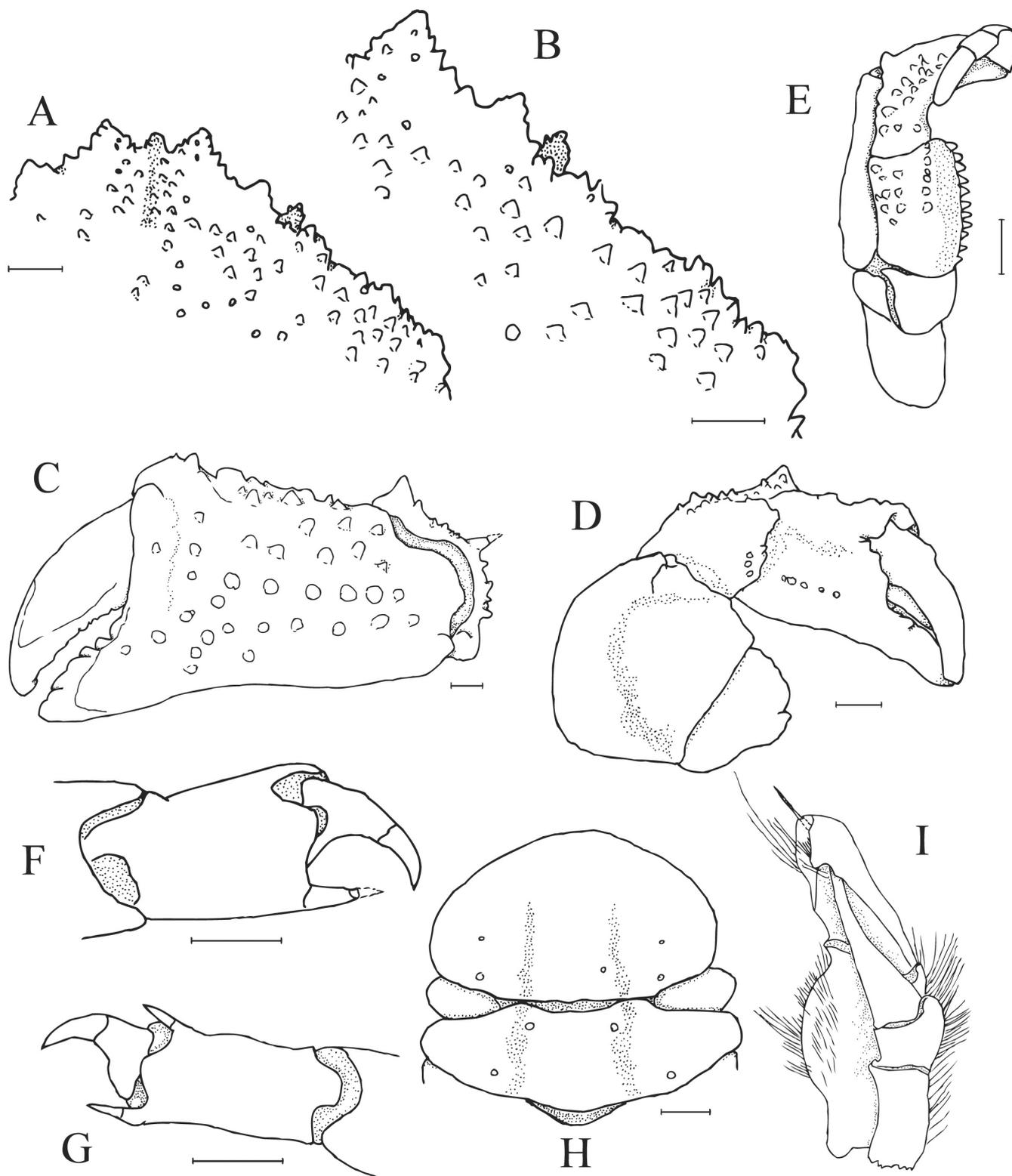


Fig. 3. *Petalomera granulata* Stimpson, 1858: A, B, dorsal views of right anterolateral areas; C, outer view of left chela; D, inner view of left cheliped showing flattened merus; E, right third maxilliped showing crista dentata; F, propodus and dactylus of right P4; G, propodus and dactylus of right P5; H, telson and sixth abdominal segment; I, left G1 and G2. A, B, D, F, neotype female 29.2 x 29.7 mm (SMF); C, E, I, male 36.2 x 37.2 mm (ASIZ 72378); G, H, female 26.0 x 26.4 mm (SMF). Scale bars: A–F = 2.0 mm, G–I = 1.0 mm.

fingers armed with 6 or 7 weakly developed teeth, all of which are touching when fingers are closed.

First 2 pairs of legs shorter than chelipeds, merus of first pair petaloid, merus of second pair, smooth, flattened, but not petaloid. Carpi tend to be flattened, fitting closely against preceding limbs, propodi sub-cylindrical. Outer surfaces of carpi and propodi sparsely granulated. Dactyli as long as propodi, tips curved, inner margins armed with 6 or 7 short spines, all of similar size.

Last 2 pairs of legs reduced, third pair smallest, only last pair truly subdorsal in position. Dactylus of third pair opposed by a single propodal spine about half length of dactylus. Dactylus of fourth pair also opposed by a similar single propodal spine, with another much shorter spine on outer propodal margin at base of dactylus. Ratio of length along dorsal margin (not including spine) to width of propodus for third and fourth legs 1.3 and 1.6, respectively.

Abdomen of 6 free segments, fourth or fifth segments widest in female, surface sparsely covered with granules. Last segment has many fewer granules than others. Uropod plates well developed, visible externally. Female telson much wider than long tip broadly rounded. All segments of male abdomen about same width, sparsely granulated, uropod plates large, visible externally, used to lock abdomen by fitting in front of prominent granulated flanges on coxae of first walking legs; such flanges present but not effective in mature females. Male telson wider than long, tip truncate.

Both male gonopods in situ reach just beyond sternal suture 4/5. First gonopod composed of 2 articles: first article concave ventrally, receiving long extension of vas deferens, second article concave medially, gradually forming a short tube ending in a chitinous tip. Margins of both articles and tip of second article densely setose. Marginal setae of second article increases effective length of tube in receiving second gonopod. Second gonopod with 3 articles: first short, cylindrical, second a shorter flattened and laterally expanded piece, and third is long terminal part that starts out wide, flattened, but quickly narrows to horny needle-like part, without microscopic structures on needle. Female spermathecal openings are at ends of sternal sutures 7/8 which lie between bases of first walking legs; openings on elevations lying close to gonopores on coxae of second walking legs; their diameter about half that of gonopores but not wide enough to receive tip of first male gonopod; only tip of second gonopod narrow enough to enter spermathecal opening.

Remarks. – This is the best known species in the genus and is often encountered in East Asia. See discussion for other species for comparisons with congeners.

Size. – Stimpson (1858) gave the size of the original male type as 8.4 x 9.1 mm. Dai & Yang (1991) had a male 35.2 x 35.6 mm. The largest *P. granulata* specimen recorded is a male from Suruga Bay, Japan and measured 36.1 x 36.8 mm. The largest known female is the neotype from Sagami Bay,

which measures 29.2 x 29.7 mm. Females and males probably grow to about the same size. *Petalomera granulata* is the largest of the four known species. The only known ovigerous female (carapace width 22.3 mm) was collected by Yamaguchi et al. (1987) in July from the Amakusa Islands, Japan, but the egg size and number was not reported.

Depth. – Stimpson (1858) gave the depth of the type locality of *P. granulata*, in Kagoshima Bay, as 37m. The depth range given by Sakai (1965) for Sagami Bay is 30-85 m. All other records fall within this range except for one specimen collected by K. Sakai from Tosa Bay that apparently came from 250 m. This outlier needs to be confirmed by further collections.

Camouflage. – No specimens carrying pieces of camouflage have been collected.

Distribution. – Taiwan, Hong Kong, North China and Japan.

Petalomera indica Alcock, 1900
(Fig. 4)

Petalomera granulata var. *indica* Alcock, 1900: 148.

Petalomera indica – Alcock, 1901: 55, Pl. 3, Figs. 14, 14a; Ihle, 1913: 48, 91 (key & list).

Not *Petalomera granulata* var. *indica* Urita, 1926: 1 [= *Petalomera granulata* Stimpson, 1858].

Material examined. – None.

Type specimens. – Alcock indicated that the “types” of *P. indica* in the Indian Museum came from Port Blair, Andamans, were collected by Wood-Mason and were recorded under the reference number 713. He did not indicate how many “types” there were or their sex and dimensions. When these syntypes are located a lectotype specimen should be selected.

Description. – Carapace sparsely setose, legs densely setose. Carapace slightly longer than wide, convex in both directions, with numerous unevenly distributed vesiculous granules. All regions distinct, but not equally well defined. Cervical, branchial and branchio-cardiac grooves well marked.

Rostrum dorsally grooved in mid-line, cut into 3 serrulate teeth, lateral rostral teeth large, triangular, median tooth small and on a lower level. Upper border of orbit serrulate, with a tooth sub-medially. Outer orbital angle pronounced but not dentiform. A straight line connects tip of lateral rostral tooth and postorbital corner, running along anterior carapace margin. Suborbital margin with a granular denticle.

Anterolateral carapace border cut into 3 blunt granular teeth, the first being subhepatic. Number of teeth variable (see below).

Chelipeds more massive than walking legs, these and first pair of walking legs with petaloid meri. Merus of second walking legs not petaloid, although upper border sharp. Inner

border of carpus and upper border of propodus prominent, granular, like upper and outer surfaces of these joints; 2 sharp tubercles present on distal end of outer surface of carpus. First 3 pairs of walking legs with few small granules on some joints.

Last 2 pairs of legs slender, ending in small claw-like dactylus opposable to strong propodal spines. Ratio of length along dorsal margin (not including spine) to width of propodus for third and fourth legs, 1.9 and 1.3, respectively. Last pair of legs slightly longer than penultimate pair.

Abdomen in both sexes with central convex ridge, second to fifth tergites with a few scattered granules. (After Alcock, 1900.)

Remarks. – Alcock's (1901: Fig 14; present Fig. 4) drawing shows a different number of teeth on the left and right sides for *P. indica*. On the left side, there appear to be two distinct teeth followed by one granular lobe, while on the right side, there are no distinct teeth matching those on the left. Behind the cervical groove, his figure shows two granular lobes on the right, but none on the left. Clearly, the arrangement and size of teeth on the anterolateral margins is variable.

Alcock (1900) stated that *P. indica* differed from *P. pulchra* in having a supraorbital tooth and differed from *P. granulata* in not having petaloid meri on the second pair of walking legs. However, it is clear from his fig. 14a (present Fig. 4A) that the merus is at least flattened if not petaloid.

Size. – Maximum size (sex unknown) given by Alcock (1901) was about 15.0 x 15.0 mm. Smaller specimens have a more elongate carapace than larger specimens.

Depth. – Specimens were collected off Sri Lanka between 51–62 m.

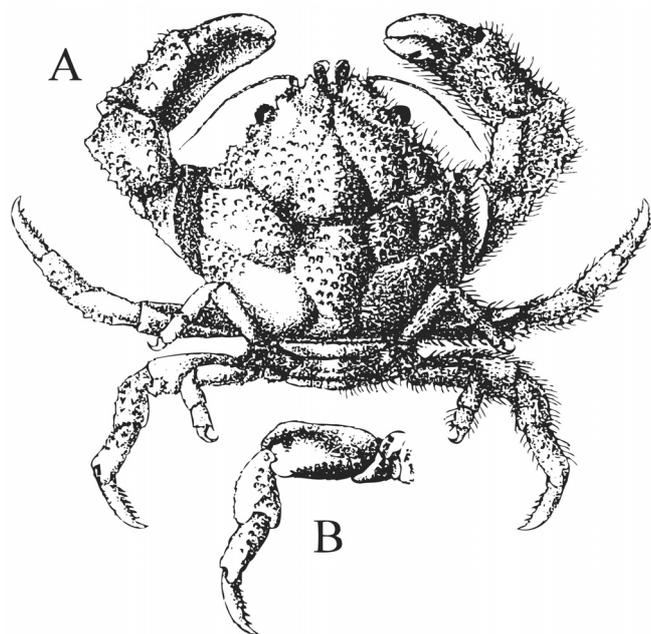


Fig. 4. *Petalomera indica* Alcock, 1900: A, overall view; B, posterior view of left first walking leg. (After Alcock, 1900: Fig 14, 14a).

Distribution. – Andamans and Sri Lanka (Ceylon).

Petalomera longipes Ihle, 1913
(Figs. 5–7)

Petalomera longipes Ihle, 1913: 49, Pl. 2, Fig. 12.

Petalomera pulchra – McLay, 1993: 166, Fig. 17a-b [not *Petalomera pulchra* Miers, 1884].

Material examined. – **Indonesia:** DUTCH EAST INDIES SIBOGA EXPEDITION 1899–1900, stn 301, Rotti Island, 10°38'S 123°25.2'E, 18–45 m, 30 Jan.1900: 1 male 8.1 x 8.7 mm (holotype) (coll. M. Weber, De.102.964) (ZMC). DANISH KEI ISLANDS EXPEDITION, 1922, stn 38, NE of Doe Roa, ~5°37'S 132°44'E, 35 m, 24 Apr.1922: 1 female (ovigerous), 12.9 x 14.4 mm (coll. T. Mortensen); Stn 67, Java Sea, 5°48'S 106°12'E, 38 m, 27 Jul.1922: 1 female (ovigerous) 10.1 x 10.4 mm (coll. T. Mortensen); Stn. 106, 5°50'S 106°16'E, 32 m, 5 Aug.1922: 1 female 10.5 x 10.4 mm (coll. T. Mortensen) (ZMC). **Philippines:** MORTENSEN EXPEDITION 1914, near Jolo, ~10°S 121°E, 46 m, 19.03.1914: 1 male 22.3 x 22.6 mm; Near Jolo, ~10°S 121°E, 37–55 m, 19 Mar.1914: 1 female 14.5 x 14.7 mm (coll. T. Mortensen) (ZMC). **Chesterfield Islands:** CHACAL 1: stn CP12, 20°35.30'S, 158°47.40'E, 67 m, 23 Jul.1984: 1 male 20.8 x 22.5 mm; Stn DC43, 20°41.50'S 158°38.40'E, 78 m, 23 Jul.1984: 1 female 16.6 x 17.4 mm. (MNHN).

Type specimens. – The holotype (ZMC De.102.964) is a male measuring 8.1 x 8.7 mm from Rotti Island, Indonesia.

Description. – Carapace long as or longer than wide, slightly convex, covered with small rounded granules, especially on anterior half of carapace, sparsely pubescent with a few longer setae fringing limbs. Frontal groove well marked, separating a pair of low rounded protuberances behind rostrum. Distinct crescent-shaped branchiocardiac grooves, with a central pit, joined by a shallow groove across mid-line. Cervical groove distinct, branchial groove less distinctly marked. Rostrum tridentate, all teeth serrated, horizontally directed, median tooth shorter, on a lower level, lateral teeth eave-like separated by U-shaped sinus.

Supraorbital margin concave behind lateral rostral tooth, entire edge granulate, interrupted by a distinct supraorbital tooth medially, followed by a notch, and margin ends at well marked orbital fissure beneath postorbital corner. A straight line connects tip of lateral rostral tooth and postorbital corner, running along anterior carapace margin. Suborbital margin convex, armed with a serrated tooth, visible dorsally. Hepatic area, between postorbital corner and beginning of anterolateral margin, has a few large granules, below level of suborbital margin with a granulated swelling, with a small tooth visible dorsally. Anterolateral margin begins at level of postorbital corner, armed with 2 granulated teeth: first is directed almost anteriorly, second behind cervical groove, directed more laterally. Behind both these teeth, carapace margin granulated; with 3 teeth (including small tooth below level of suborbital margin). Posterolateral tooth absent. Posterior carapace margin slightly convex, not granulated.

Suborbital area convex, granulated. Epistome triangular, flat, interantennular septum stout, margins granulated, interrupted

by a notch midway along each lateral margin, beside first article of antennule. Corner of buccal frame with exhalant channels formed by corner of epistome and carapace margin, positioned immediately below base of antennae, adjacent to channel opening is a distinct granulated buccal tooth. Epimeral suture distinct. Inhalant channels at base of chelipeds densely setose. Rest of branchiostegal margin fits tightly around bases of pereopods.

First article of antennule longer than wide, sub-rectangular, second article inserted at disto-medial corner and folded laterally across distal end, article fits tightly against rostral extension that joins interantennular septum. Third article longer than wide, folds posteriorly and along with flagellum concealed beneath supraorbital edge. First article of antenna (urinal article) wider than long, beak-shaped medially, not gaping. Second article much longer than wide, distal border bears well developed bilobed exopod. Disto-medial corner produced as a curved, blunt lobe on which third article is inserted at an angle. Fourth article, like the third, as long as wide. All antennal articles freely moveable.

Third maxillipeds operculiform, surface with scattered coarse granules, palp exposed, margins of basis cannot meet in mid-line, crista dentata with 9 well developed sub-acute teeth with 7 or 8 calcareous teeth on the outer margin of basis.

Chelipeds well developed, larger in males. Merus trigonal in cross-section, lower margin granulated, inner surface petaloid, nacreous, fitting closely against subhepatic area of carapace. Outer surface of carpus convex, granulated, with 2 strong distal granules, inner margin of upper border with 5 or 6 granules. Outer face of propodus with granules that tend to be arranged in longitudinal rows. Inner margin of upper border crest-like, granulated. Fingers gaping, short, down-curved, hollowed out internally, so that teeth are on outer border. Edges of fingers armed with 7 or 8 well developed, distinct teeth, increasing in size distally, last 4 interlocking when fingers closed.

First 2 pairs of legs shorter than chelipeds, meri petaloid. Carpi tends to be flattened, fitting closely against preceding limbs, propodi sub-cylindrical. Dactyli as long as propodi, tips curved, inner margins armed with 4 or 5 short spines of similar sizes.

Last 2 pairs of legs reduced, third pair shortest, only last pair truly subdorsal in position. Dactylus of third pair opposed by

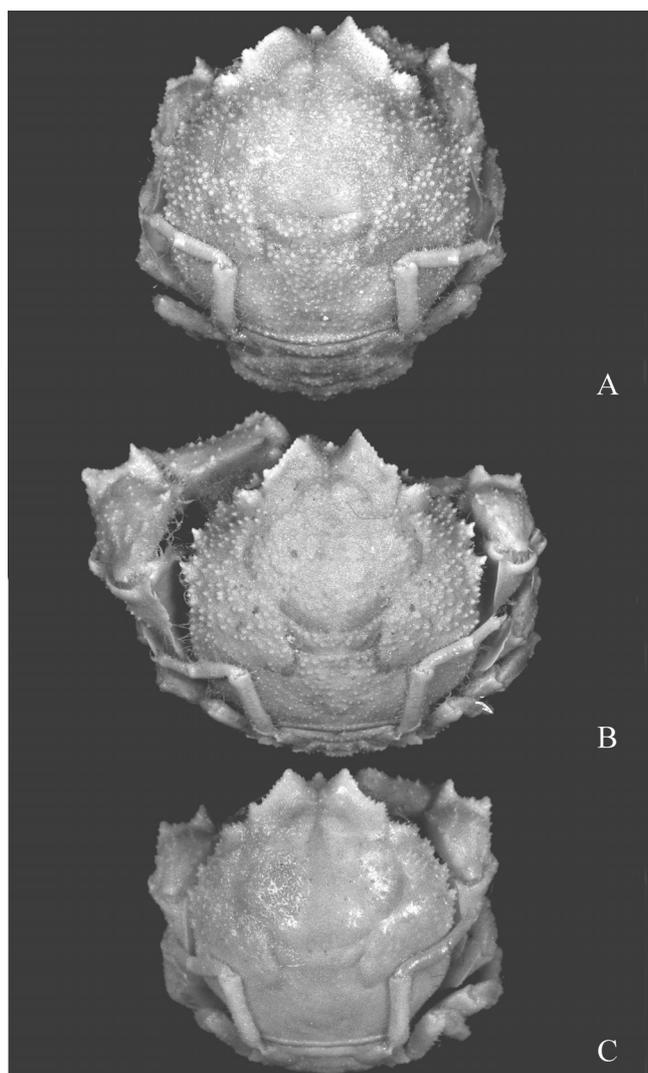


Fig. 5. *Petalomera longipes* Ihle, 1913, holotype male 8.1 x 8.7 mm (ZMC De.102.964): A, overall dorsal view; male 20.8 x 22.1 mm (CHALCAL 1, CP12); B, overall dorsal view; C, overall dorsal view, female 16.6 x 17.4, (CHALCAL 1, stn DC43).

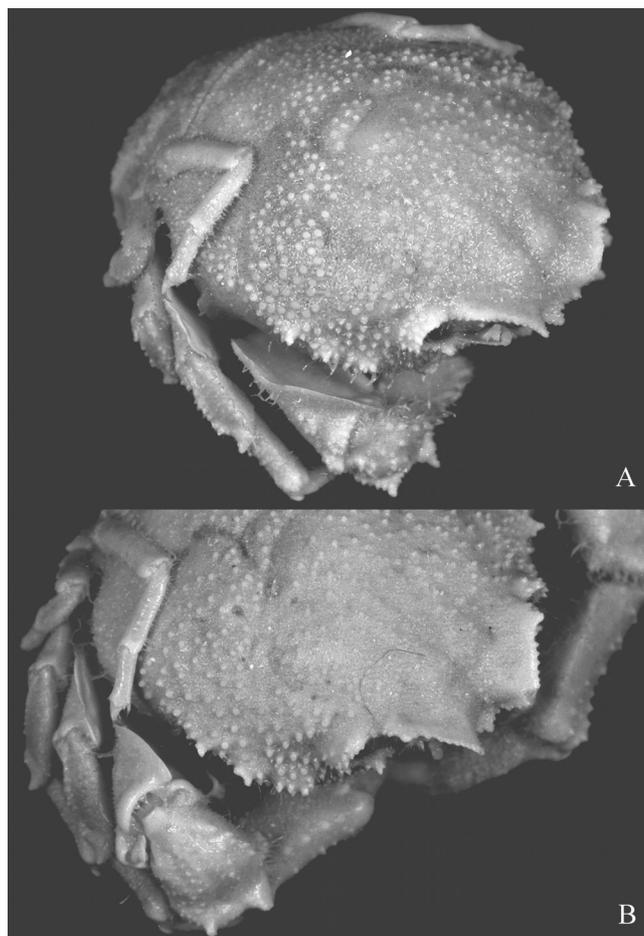


Fig. 6. *Petalomera longipes* Ihle, 1913, holotype male 8.1 x 8.7 mm (ZMC De.102.964): A, detail of carapace tubercles right anterolateral area; male 20.8 x 22.1 mm (CHALCAL 1, CP12); B, detail of carapace tubercles right anterolateral area.

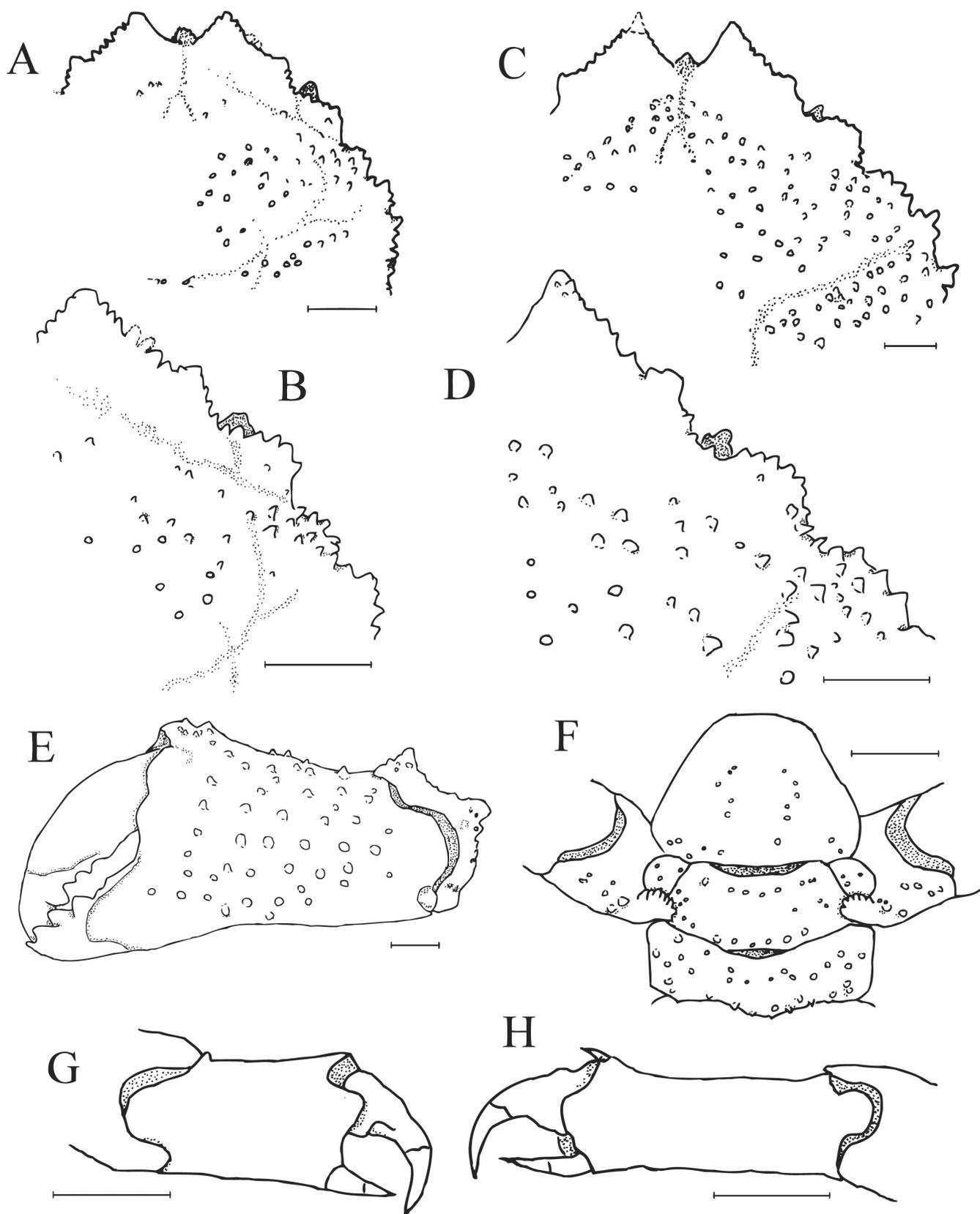


Fig. 7. *Petalomera longipes* Ihle, 1913: A–D, dorsal views of frontal and right anterolateral areas; E, outer view of left chela; F, ventral view of abdominal locking mechanism; G, propodus and dactyl right P4; H, propodus and dactyl right P5. A, B, holotype male 8.1 x 8.7 mm (ZMC De.102.964); C, D, male 20.8 x 22.1 mm (CHALCAL 1, CP12). Scale bars: A, B, G, H = 1 mm; C–F = 2 mm.

a single, strong propodal spine. Dactylus of fourth pair also opposed by a single similar propodal spine, with another small spine on outer propodal margin at base of dactylus. Ratio of length along dorsal margin (not including spine) to width of propodus for third and fourth legs, 1.2 and 2.2, respectively.

Abdomen of 6 free segments, fourth or fifth segments widest in female, surface sparsely granulate. Uropod plates well developed and visible externally. Female telson much wider than long tip broadly rounded. All segments of male abdomen about the same width, granulated, uropod plates large, visible externally and used to lock the abdomen by fitting in front of prominent granulated flanges on coxae of first walking legs; such flanges absent in mature females. Male telson wider than long, tip truncate.

Both male gonopods in situ reach just beyond sternal suture 4/5. First gonopod composed of 2 articles: first article concave ventrally, to receive long extension of vas deferens, second article concave medially, gradually forming a short tube ending in a chitinous tip. Margins of both articles, and tip of second article, densely setose. Marginal setae of second article increases effective length of tube receiving second gonopod. Second gonopod composed of 3 articles: first short, cylindrical, second a shorter flattened and laterally expanded piece, and third is a long terminal part that starts out wide and flattened but narrows to horny needle-like structure, without microscopic structures on surface. Female spermathecal openings are at ends of sternal sutures 7/8, between bases of first walking legs; openings on elevations anterior to gonopores on coxae of second walking legs

Remarks. – The name *Petalomera longipes* has been ignored and not used since it was established by Ihle (1913). However, it is now clear, after a re-examination of the type specimen and other material collected by the Mortensen Expedition that this taxon is valid.

Size. – McLay (1993) gave the size range of *P. longipes* (as *P. pulchra*) as 5.2–20.8 mm for males and 5.5–22.5 mm for females. The male specimen from the Philippines, 22.3 x 22.6 mm, increases the maximum size for males and makes the maximum size similar for both sexes.

The present material includes two ovigerous females from the Kei Islands and the Java Sea, near Jakarta: one female (12.9 x 14.4 mm) carried ~550 eggs (ED = 0.6 mm) while and another female (10.1 x 10.4 mm) had ~170 eggs (ED = 0.5 mm). McLay (1993) reported brood sizes for females CW 6.7–19.9 mm ranging from 120–1278 eggs, with a mean egg diameter of ~0.7 mm. The new material collected by Mortensen does not alter these values.

Depth. – McLay (1993) gave the range of specimens from New Caledonia and the Chesterfield Islands as 7–86 m. The depth of the present material does not extend the known depth range.

Camouflage. – A female (CW = 8.5 mm) from New Caledonia (CORAIL 2) (see McLay, 1993, as *P. pulchra*)

carried a small fragment of a compound ascidian that only covered the rear half of its carapace.

Distribution. – The male type came from Rotti Island, Indonesia, 10°38'S 123°25.2'E. The specimens reported here from the Philippine Islands, Jolo, ~10°S, 121°E, extend the known geographic range of *P. longipes* that now includes Indonesia, Philippine Islands and New Caledonia.

Petalomera pulchra Miers, 1884
(Figs. 8, 9)

Petalomera pulchra Miers, 1884: 260, Pl. 27, Fig. A; Ihle, 1913: 48.

Not *Petalomera pulchra* McLay, 1993: 166, Fig. 17a–b [= *Petalomera longipes* Ihle, 1913].

Material examined. – **Australia:** Torres Strait, Prince of Wales Channel, Queensland, ~9°S 142°E, 13–17 m: 2 females 17.8 x 17.7,

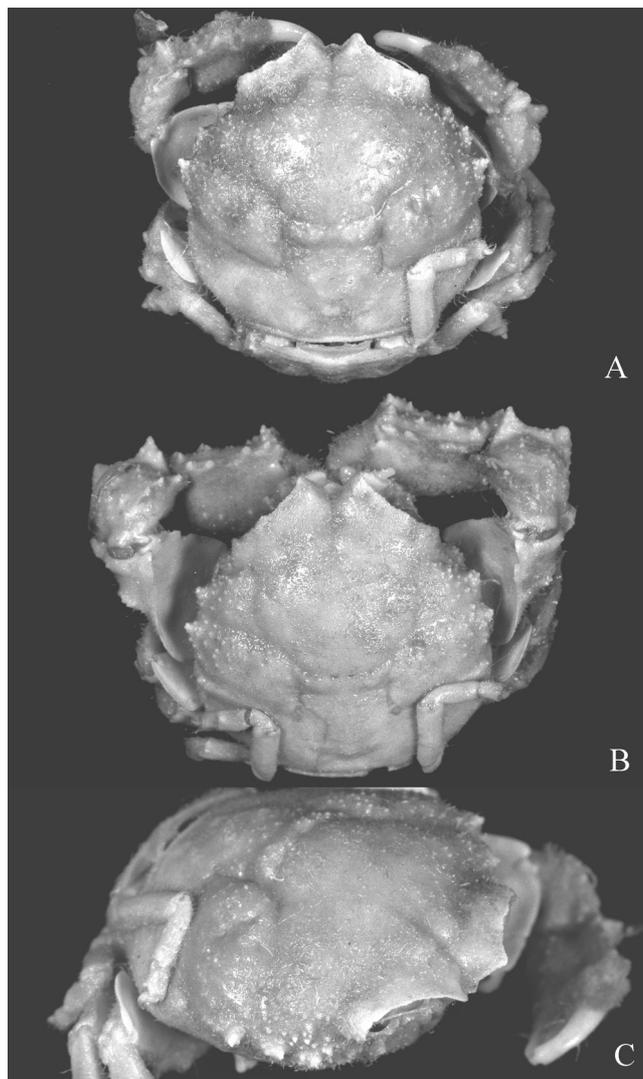


Fig. 8. *Petalomera pulchra* Miers, 1884 1913: A, B, dorsal views; C, detail of carapace tubercles on right anterolateral area. A, lectotype female 17.8 x 17.7 mm (NHM 1882.7); B, C, male 15.3 x 15.7 mm (AM P19529).

15.1 x 15.5 mm (larger female lectotype, here designated, NHM 1882.7); North end Albany Passage, North Queensland, Aug.–Sep.1928: 1 female 14.6 x 15.2 mm (AM-P19486) (coll. M. Ward); Black Is., North Langford Reef, Whitsunday Group, Queensland, ~20°30'S 149°30'E, Nov.1969: 1 male 15.3 x 15.7 mm, 1 female (ovigerous) 11.8 x 12.0 mm (AM-P19529); NE Montebello Islands, Western Australia, 20°08'S 115°57'E, 80 m, 2 Dec. 1979: 1 male 13.5 x 15.1 mm (WAM 109-83, "Soela"); ENE Montebello Islands, 20°18'S 116°01'E, 60–64 m, 2 Dec.1979: 1 female 23.1 x 23.3 mm (WAM 126-83, "Soela"); 53 km NE of Montebello, 80 m, 19°55'S 116°36'E, 58 m, no date: 1 male 11.6 x 12.2 mm (WAM 62-83); NW Shelf, 19° 04.4'S 118°07.3'E, 80 m, 28 Apr.1983: 7 males 3.9 x 4.0, 4.3 x 4.4, 5.3 x 5.5, 6.7 x 6.9, 6.7 x 7.0, 6.8 x 7.0, 7.3 x 7.5 mm, 1 female 4.3 x 4.4 mm, 2 females (ovigerous) 6.7 x 6.9 mm, 7.0 x 7.6 mm (NTM AS0283-133, "Soela").

Type specimens. – There are two female syntypes, measuring 17.8 x 17.7 mm and 15.1 x 15.5 mm (NHM 1882.7). We here designate the larger female as the lectotype and our description is based primarily on this specimen. Male characters were obtained from a male 15.3 x 15.7 mm (AM-P19529). In the container of Mier's types are two small vials, one containing gills and the other containing mouthparts and some gills. There is only one abdomen present and it consists of the first four segments only. This seems to belong to the larger lectotype female, 17.8 x 17.7 mm. The mouthparts and gills should thus belong to the other, smaller, female, 15.1 x 15.5 mm, as it has the carapace detached from the body.

Description. – Carapace about as long as wide, slightly convex, sparsely covered with blunt granules except on the hepatic and anterior branchial areas where granules are denser. Short setae cover the carapace surface with a few scattered longer setae which also fringe pereopods. Frontal and cervical grooves evident, branchial groove faintly marked. Crescent shaped branchiocardiac grooves evident, with a central pit, joined by a shallow groove across mid-line. Rostrum tridentate, median tooth deflexed, set on a lower level, much shorter than lateral teeth in dorsal view. Lateral teeth separated by a wide V-shaped sinus, horizontal, directed anteriorly. All teeth minutely serrated.

Supraorbital margin, eave-like, concave behind lateral rostral tooth, edge minutely granulated until slight convex projection halfway, thereafter margin without granules, ending at a well marked orbital fissure beneath post orbital corner. Entire orbital margin stands out from frontal margin so that postorbital corner projects prominently. A straight line connecting tip of lateral rostral tooth and edge of postorbital corner, and then extending laterally, is well in advance of first anterolateral tooth. Suborbital margin convex, unarmed, not visible dorsally. Hepatic area, between postorbital corner and beginning of anterolateral margin, with a few large granules, below level of suborbital margin with a well developed granulated, hepatic tubercle that is visible dorsally. Anterolateral margin begins at level of postorbital corner, armed with 2 granulated teeth: first is directed almost anteriorly and second, behind cervical groove, is directed more laterally; carapace margin granulated behind both these teeth. Posterolateral tooth absent. Posterior carapace margin slightly convex, not granulated.

Suborbital area convex, granulated. Epistome triangular, flat, interantennular septum stout, margins granulated, interrupted by a notch midway along each lateral margin, beside first article of antennule. At corner of buccal frame are exhalant channels formed by the epistome corner and carapace margin; channels lie immediately below base of antennae; adjacent to channel opening is a distinct granulated buccal tooth. Epimeral suture distinct. Inhalant channels at base of chelipeds densely setose. Rest of branchiostegal margin fits tightly around bases of pereopods.

First article of antennule longer than wide, sub-rectangular, second article inserted at disto-medial corner and folded laterally across distal end; this article fits tightly against rostral extension that joins interantennular septum. Third article longer than wide, folds posteriorly and along with the flagellum is concealed beneath supraorbital edge. First article

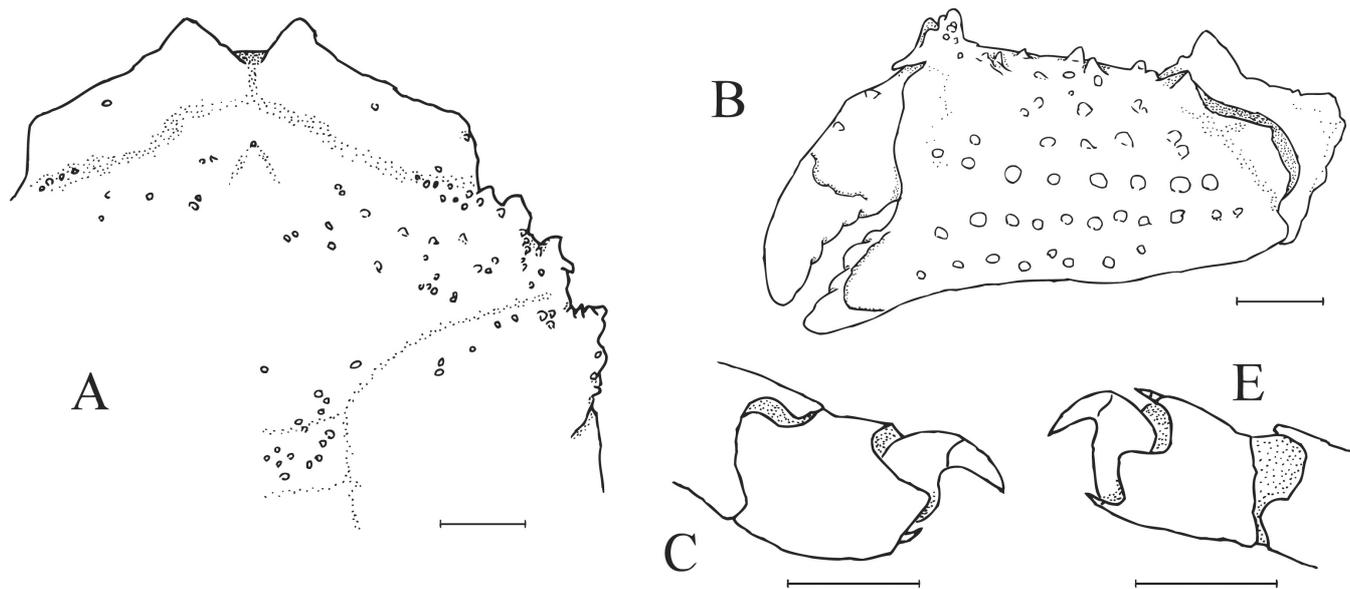


Fig. 9. *Petalomera pulchra* Miers, 1884: A, dorsal view of right anterolateral area; B, outer view of left chela; C, propodus and dactylus of right P4; D, propodus and dactylus of right P5. A, C, D, lectotype female 17.8 x 17.7 mm (NHM 1882.7); B, male 15.3 x 15.7 mm (AM P19529). Scale bars – A, B = 2.0 mm; C, D = 1.0 mm.

Table 2. Comparison of size range and depth range of *Petalomera* species.

Species	Minimum Mature female CW	Maximum female CW	Maximum male CW	Depth Range
<i>P. granulata</i>	?	29.2 mm	36.1 mm	30–85 m
<i>P. indica</i>	?	?15.0 mm	?15.0 mm	51–62 m
<i>P. longipes</i>	6.7 mm	22.5 mm	22.3 mm	7–86 m
<i>P. pulchra</i>	6.7 mm	23.1 mm	15.3 mm	15–80 m

of antenna (urinal article) wider than long, beak-shaped medially, not gaping. Second article much longer than wide, distal border bears well developed bilobed exopod. Disto-medial corner produced as a curved, blunt lobe on which third article is inserted at an angle. Fourth article, like the third, as long as wide. All antennal articles freely moveable.

Third maxillipeds operculiform, scattered coarse granules, palp exposed, margins of basis unable to meet medially, crista dentata with 10 well developed blunt teeth with 6 or 7 calcareous teeth on outer margin of basis.

Chelipeds well developed. Merus trigonal lower margin granulated, inner surface petaloid, nacreous, fitting closely against subhepatic area of carapace. Outer surface of carpus convex, granulated, 2 strong distal granules and inner margin of upper border with 4 or 5 granules. Outer face of propodus with granules that tend to be arranged in longitudinal rows. Inner margin of upper border crest-like, granulated. Fingers short, down-curved, hollowed out internally, so that teeth are on outer border. Edges of fingers armed with 7 or 8 well developed, last 4 distinct teeth interlocking when fingers are closed.

First 2 pairs of legs shorter than chelipeds, meri petaloid. Carpi tend to be flattened, fitting closely against preceding limbs, propodi sub-cylindrical. Dactyli as long as propodi, tips curved, inner margins armed with 4 or 5 short spines of similar sizes.

Last 2 pairs of legs reduced, third pair smallest, only last pair are truly subdorsal in position. Dactylus of third pair strongly hooked, opposed by a single, almost obsolete, propodal spine. Dactylus of fourth pair strongly hooked, opposed by a single small propodal spine, with another very small spine on outer propodal margin at base of dactylus. Ratio of length along dorsal margin (not including spine) to width of propodus for third and fourth legs, 0.5 and 0.8, respectively.

Abdomen of 6 free segments, fourth or fifth segments widest in female, surface mostly smooth. Uropod plates well developed, visible externally. Female telson much wider than long tip broadly rounded. All segments of male abdomen about same width, sparsely granulated, uropod plates large, visible externally, used to lock abdomen by fitting in front of prominent granulated flanges on coxae of first walking legs; such flanges absent in mature females. Male telson wider than long, tip truncate.

Both male gonopods in situ reach just beyond sternal suture 4/5. First gonopod composed of 2 articles: first article concave ventrally, to receive long extension of vas deferens, second article concave medially, gradually forming a short tube ending in a chitinous tip. Margins of both articles, and tip of second article, densely setose. Marginal setae of the second article increases effective length of tube receiving second gonopod. Second gonopod composed of 3 articles: first short, cylindrical, second a shorter flattened and laterally expanded piece, and third a long terminal part that starts out wide and flattened but narrows to horny needle-like part without microscopic structures on surface. Female spermathecal openings are at ends of sternal sutures 7/8 which lie between bases of first walking legs; openings borne on elevations anterior to gonopores on coxae of second walking legs.

Remarks. – All of the material reported by McLay (1993) as *Petalomera pulchra* should now be referred to *P. longipes*. The type specimen reported by Ihle (1913) was an ovigerous female measuring 12.5 x 11.5 mm.

The subchelate mechanism in *P. pulchra* is more poorly developed than in the other three species. The dactylus in *P. pulchra* is set at almost a right angles to the end of the propodus and even when moved towards the spine, it cannot reach as far as to allow the tip of the dactylus to get anywhere near the propodal spine. There is no propodal extension in congeners.

Size. – Miers (1884) gave the dimensions one of the females as 18 x 19 mm, but our measurements of the largest specimen shows it to be 17.8 x 17.7 mm. The maximum size for males is 15.3 x 15.7 mm and for females 23.1 x 23.3 mm. The smallest ovigerous female known is 6.7 x 6.9 mm. Egg numbers range from 48 (female CW = 6.7 mm) to ~200 (female CW = 11.8 mm) with the egg diameter varying from 0.68–0.74 mm, suggesting that *P. pulchra* probably has a planktotrophic larval stage.

Depth. – Only four depths have been recorded, giving a range of ~15–80 m.

Camouflage. – Not known.

Distribution. – Most specimens have come from northern Australia, as far as ~20°S on both east and west coasts. Ihle (1913) has reported the only specimen outside Australian waters, from Aru Island (5° 28.2'S 134° 53.9'W), Moluccas, Indonesia.

GENERAL DISCUSSION

It is not possible to discuss the life history features of *P. indica* because we have not examined any specimens, but the other three species of *Petalomera* seem to fall into two groups with respect to maximum size (Table 2). *Petalomera granulata* grows to a much larger size than the other species (maximum CW = 36.1 mm), while *P. longipes* (the best known species) and *P. pulchra* both grow up to CW = 23.0 mm, and as far as we know, *P. indica* is an even smaller species (maximum CW = 15.0 mm). Females of *P. longipes* and *P. pulchra* mature at a relatively smaller sizes (CW = 6.0–7.0 mm). Larval development of *Petalomera* is unknown, but given that their egg size ranges 0.6–0.8 mm in diameter, it is very likely that development is indirect and involves one or more larval stages. While *P. granulata*, *P. indica* and *P. pulchra* do not seem to be very common, *P. longipes* was the second most abundant dromiid in the New Caledonian fauna (McLay, 1993).

All the species of *Petalomera* come from relatively shallow water (7–86 m) so that if they occurred in the same area, their depth ranges would probably overlap. *Petalomera indica* is the only species in the Indian Ocean. *Petalomera pulchra*, previously known from northern Queensland, Australia, is newly reported from Western Australia, thus making it the only species of *Petalomera* that occurs in both the Pacific and Indian Oceans. *Petalomera granulata* is a north Pacific species while *P. longipes* is a south Pacific species. The distributions of these two species do not overlap as yet. Only *P. longipes* and *P. pulchra* occur in the same area.

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