

**KRAUSSIINAE, A NEW SUBFAMILY FOR THE GENERA
KRAUSSIA DANA, 1852, PALAPEDIA, NEW GENUS,
AND GARTHASIA, NEW GENUS (CRUSTACEA:
DECAPODA: BRACHYURA: XANTHIDAE), WITH
DESCRIPTIONS OF TWO NEW SPECIES FROM
SINGAPORE AND THE PHILIPPINES**

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ABSTRACT.- The taxonomy of the Brachyuran genus *Kraussia* Dana, 1852, is revised and three genera are recognised - *Kraussia* s. str. (monotypic), *Palapedia*, new genus (13 species) and *Garthasia*, new genus (monotypic). A new subfamily, Kraussiinae, family Xanthidae MacLeay, 1838 sensu Guinot, 1978, is also established for these three genera. *Kraussia* and its allies were previously classified in the Atelecyclidae Ortmann, 1893, and Xanthinae MacLeay, 1838. The Kraussiinae is distinguished from other xanthid subfamilies predominantly by its distinctive carapace form, structure of the sternum and ambulatory legs, and larval features. Two new species of *Palapedia* are described - *Palapedia valentini*, from littoral coral reefs in Singapore, and *Palapedia serenei* from Mindoro Island in the Philippines. *Palapedia valentini* is allied to *P. nitida* (Stimpson, 1858), but can be distinguished by numerous carapace, cheliped and leg characters. *Palapedia serenei* resembles *P. marquesa* (Serène, 1972), with which the species has previously been confused, but differs markedly in the form of the frontal margin, carapace proportions and structure of the male first pleopod. *Kraussia truncatifrons* Sakai, 1974, is shown to be a junior synonym of *Palapedia bongensis* (Serène, 1972).

INTRODUCTION

The genus *Kraussia* Dana, 1852, contains at present, 13 recognised species, one of which is American. Serène (1972) last studied the Indo-Pacific members of the genus, describing five new species. Two others have since been added (Sakai, 1974; Dai *et al.*, 1986).

The taxonomic position of the genus *Kraussia* however, has been uncertain. For most of its history, it has been placed close to *Thia* Leach, 1814, in the subfamily Thiinae Dana, 1852, family Atelecyclidae Ortmann, 1893, presumably because of their very similar external fea-

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tures (see Alcock, 1899; Balss, 1957). Serène (1972) was the first to comment on the close affinity of *Kraussia* with the Xanthidae MacLeay, 1838, when he compared *Kraussia* with genera like *Guinotellus* Serène, 1971, and *Euxanthus* Dana, 1851. Guinot (1977, 1979) commented that *Kraussia* and *Thia* differed significantly in many aspects, and she was more inclined to ally *Kraussia* with crabs in the family Xanthidae s. str. than the Thiidae or Atelecyclidae. In her revised classification, Guinot (1978) reorganised the Atelecyclidae, restricted the Thiidae (as a family) for only one genus, *Thia*, and removed *Kraussia* from both families. Guinot (1978) transferred *Kraussia* to the Xanthidae s. str. in the subfamily Xanthinae. The present study confirms Guinot's action that *Kraussia* (and the two new genera described below) should be referred to the family Xanthidae. *Kraussia* and its allies however, have so many unusual features that a new subfamily, Kraussiinae, is proposed here to accommodate them.

With regards to the genus *Kraussia*, a re-appraisal of the characters used thus far as well as additional ones not used by earlier authors, shows that it can be split into three genera. *Kraussia* s. str. is restricted for only *Kraussia rugulosa* (Krauss, 1843), the sole American species is transferred to a new monotypic genus (*Garthasia*) whilst the other species previously referred to *Kraussia* are referred to a third genus (*Palapedia*, new genus).

Serène (1972) was uncertain about the identity of a specimen collected from an island off Singapore which he referred to "*Kraussia* aff. *nitida*". He noted that in the specimen, "... the frontal margin with round lobes differs strongly from that of *nitida* illustrated by Sakai (1939) for a specimen of nearly the same size ... " (Serène, 1972: 52). In 1987, I collected two more specimens from near Singapore which were clearly conspecific with Serène's specimen of "*Kraussia* aff. *nitida*". An ovigerous specimen was subsequently collected from Singapore in 1992. The species is here regarded as a new species of *Palapedia*, *P. valentini*. A specimen from the Philippines identified by Serène (1972) with doubt as *Kraussia marquesa* Serène, 1972, is also shown to be an undescribed species of *Palapedia*.

The present paper serves to diagnose the new subfamily, two new genera and two new species, and discuss their affinities. The first zoea of one of the new species (*Palapedia valentini*) is also described, the first known for the group. Studies of some recent material from Okinawa, Japan, also show that *Kraussia truncatifrons* Sakai, 1974, is a junior synonym of *K. bongensis* Serène, 1972 (= present *Palapedia*).

MATERIALS AND METHODS

The abbreviations G1 and G2 are used for the male first and second pleopods respectively. Measurements, in millimetres, are of the carapace width and length respectively.

The first zoea was obtained from one of the paratype females of *Palapedia valentini* (ZRC 1993.4066, 9.8 by 9.2 mm) (Singapore). Free-swimming zoeae were preserved in buffered formalin and later transferred to 70% alcohol.

Specimens are deposited in the Zoological Reference Collection (ZRC), Department of Zoology, National University of Singapore (former collection of the Raffles Museum and National Museum of Singapore); and the Allan Hancock Foundation (AHF), University of Southern California, U. S. A.

SYSTEMATICS

FAMILY XANTHIDAE MACLEAY, 1838

Kraussiinae, new subfamily

Type genus. - *Kraussia* Dana, 1852, designated herein.

Diagnosis. - Carapace dorsal surfaces evenly and gently convex longitudinally and laterally, anterior regions poorly defined, those on other parts of carapace very indistinct or absent; frontal margin strongly to weakly quadrilobate (sometimes appearing bilobed); anterolateral margin strongly arcuate, serrated, lined with sharp granules or spines; posterolateral margin converging; antennules folding obliquely; sternum elongated to very elongated, sternal sutures 2/3 and 3/4 shallow but complete, inner margins of male episternite 7 may be lamelliform, forming episternal bracket for margins of fused male abdominal segments 3-5; ambulatory legs short, laterally compressed, especially distal segments; dactyli of all four pairs of legs strongly flattened laterally, spade-like, sickle-shaped, curving upwards; G1 long, slender, distal part with long hairs; G2 short, with distinct distal and basal segments.

Remarks. - Guinot (1977, 1979), in her reappraisal of Brachyuran higher classification, noted that the genus *Kraussia* Dana, 1852, hitherto classified together with *Thia* in the subfamily Thiinae of the Atelecyclidae, probably did not belong there. She cited their very different sterna and male pleopods as evidence. In redefining the Thiidae (as a family), she specifically excluded *Kraussia*, noting that the Thiidae was a monogeneric family and *Kraussia* was probably closer to the Xanthidae MacLeay, 1838 s. str. In her proposed new classification, Guinot (1978) referred *Kraussia* to the family Xanthidae s. str. Guinot (1977, 1978, 1979) also indicated that *Paraxanthus* H. Milne Edwards & Lucas, 1844, was closely related to *Kraussia* (both genera resemble each other externally and have similar sternal structures), as was *Cycloxanthops* Rathbun, 1897. She (1978) suggested that *Kraussia* be classified in the subfamily Xanthinae s. str. with *Paraxanthus* and *Cycloxanthops*. Guinot (1978: 272) noted that "... *Kraussia* et *Paraxanthus* sont les plus primitifs, les autres genres appartiennent à la partie anagénétique de la sous-famille". Serène (1984), who expanded on Guinot's (1978) treatment of the Xanthoidea and redefined many of the subfamilies within the Xanthidae s. str., however, could not decide on the classification of *Kraussia* and excluded treating or discussing the genus.

The present study of specimens of *Kraussia* and *Palapedia*, new genus, confirm many of Guinot's observations. The external similarities between *Kraussia* and *Thia* are superficial, the result of convergent evolution and not phylogenetic in origin. Although I agree with Guinot (1979) that *Kraussia* (and *Palapedia*) has many typical xanthid features (viz. structure of the sternum, male first pleopods, male second pleopods), the genus also possesses several apomorphic characters which suggest that it should be placed in its own subfamily grouping within the Xanthidae.

I have obtained the first zoea of a species of *Palapedia* (*P. valentini*, new species), and its features support the removal of the genus from the Atelecyclidae or Thiidae. While the first zoea has many xanthid features (see Rice, 1980; Martin, 1984), supporting Guinot's conten-

tion that *Kraussia* belongs in the Xanthidae, it also differs from all known xanthid zoeae in several key characters.

The external features of *Kraussia*, *Palapedia*, new genus, and *Garthasia*, new genus, however, are so different from known xanthids, that the classification of the genus in the Xanthinae would be less than satisfactory. The smooth carapace, elongate sternum and sternal features, and the highly specialised legs necessitate the establishment of a separate new subfamily, Kraussiinae, for the genera *Kraussia*, *Palapedia* and *Garthasia*. Another feature of the subfamily is that in males, the inner margins of episternite 7 are sometimes lamelliform, forming a "catch" or "bracket" for the margins of the fused male abdominal segments 3-5. The strength of this lamelliform bracket varies between species. It is absent in *Garthasia americana* (Garth, 1939), low in *K. rugulosa* (Krauss, 1843), *P. bongensis* (Serène, 1972), *P. rastripes* (Müller, 1887) and *P. valentini*, new species, but is very strong and well developed in *P. serenei*, new species.

Table 1. Differences between kraussiines and *Paraxanthus*

	Kraussiines	<i>Paraxanthus</i>
Carapace	regions not well defined, grooves very shallow indistinct; dorsal surfaces appear uniformly convex	regions well defined, grooves distinct; dorsal surfaces appear uneven and undulating
Sternum	relatively narrow; suture 3/4 shallow but complete	broader; suture 3/4 interrupted medially
Chelipeds	fingers usually short, never pigmented black throughout; surfaces adjacent to cutting edges with distinct tufts of stiff hair	fingers usually long, pigmented black throughout; surfaces adjacent to cutting edges glabrous, or if hairy, the hairs are scattered
Ambulatory legs	dactylus laterally flattened to different degrees, distinctly spade-like; stiff hairs present only on margins but never obscuring margin	dactylus subcylindrical, never distinctly laterally flattened or spade-like, short hairs gathered into dense pubescent areas which obscure margins of segment for first three pairs of legs.
Abdomen	first and second somites with distinct tufts of long, stiff hairs on posterolateral parts	first and second somites glabrous, or if hairy, hairs are scattered

Guinot (1977, 1979) commented that *Kraussia* (including *Palapedia*, new genus, and *Garthasia*, new genus) (here referred to as kraussiines) is closely allied to *Paraxanthus* H. Milne Edwards & Lucas, 1844, noting that their sternal structures were very similar. She (1978) classified kraussiines and *Paraxanthus* in the Xanthinae s. str. While their sternal structures are similar and both genera bear a superficial resemblance externally, I am not convinced that they are very closely related (Table 1). The sternum of *Paraxanthus* (fide Guinot, 1979: Fig. 22B) is relatively broader than that of kraussiines (cf. *Kraussia rugulosa*, fide Guinot, 1979: Fig. 22A, present data), with the suture between sternites 3 and 4 incomplete medially (less obvious in *Garthasia*). In kraussiines, the suture between sternites 3 and 4 is shallow but complete. Kraussiines and *Paraxanthus* also differ very markedly in the form of their carapace. The carapace surface of *Paraxanthus* is typical of a xanthine, the regions being well defined and the grooves separating them distinct. In kraussiines, the regions are very poorly defined (if at all), and the shallow grooves are very faint and present only in the anterior parts of the the carapace near the front. The carapace of kraussiines thus appear very even and evenly convex. Kraussiines and *Paraxanthus* also differ very significantly in the form of their ambulatory legs. The ambulatory legs of *Paraxanthus* are normal for xanthines, and the dactyli are not flattened and spade-like (see Rathbun, 1930). The chelipeds of kraussiines and *Paraxanthus* are also very different. That of kraussiines are usually gaping, with tufts of sensory hairs adjacent to the cutting edges of the fingers, and the pigmentation on both fingers are never completely black in colour. The chelae and fingers of *Paraxanthus* are of the typical xanthid form, the fingers being pigmented black. The condition of the episternites 7 of *Paraxanthus* are not known and cannot be compared with the kraussiines.

For these reasons, the American genus *Paraxanthus* is retained in the subfamily Xanthinae MacLeay, 1838, s. str. and not transferred to the subfamily Kraussiinae.

***Kraussia* Dana, 1852**

Type species. - *Platyonichus rugulosa* Krauss, 1843, by original designation.

Diagnosis. - Carapace rounded to slightly elongate, width to length ratio 1.1-1.2; anterolateral margin more than twice length of posterolateral margin, lined with four, well developed, slender sharp epibranchial spines; posterolateral margin short, distinctly concave. Third maxilliped very elongate, length to width ratio 3.1-3.2; merus slightly longer than broad, width to length ratio 0.92-0.93; carpus swollen, appearing bulbous. Sternum very elongate, suture between sternites 1 and 2 distinct, surfaces of sternites 1 and 2 gently convex. Tips of cheliped fingers deeply excavated, distinctly spoon-shaped. Merus of last ambulatory leg short, stout, length to width ratio ca. 1.6. Male abdomen second segment relatively long, width to length ratio ca. 1.6.

Remarks. - Serène (1972) commented that "... [*Kraussia*] *rugulosa* clearly seems to belong to a group quite separate from the other species " (p. 42). Several characters strongly suggest that it is generically distinct from the other species which have been assigned to *Kraussia*. Serène (1972) noted that the anterolateral margin of *K. rugulosa* has four distinct sharp epibranchial spines whereas that of all other *Kraussia* are only denticulate, sometimes appearing lobated but never with four spines. The tips of the cheliped fingers of *K. rugulosa* are deeply hollowed, spoon-shaped; with the proximal part of the closed fingers forming a broad and distinct gape (against sharp, rounded or slightly flattened but never deeply spoon-shaped in other species).

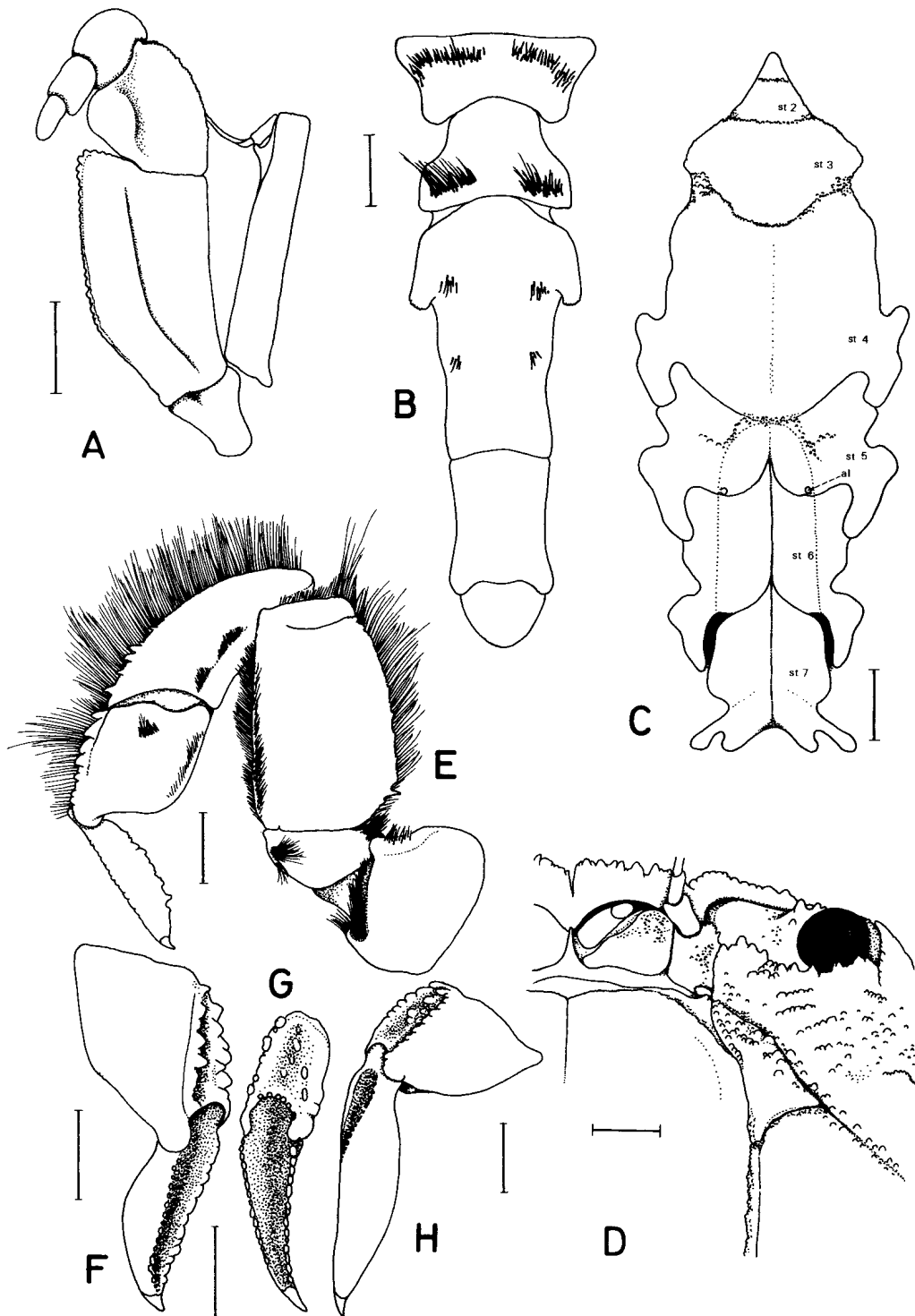


Fig. 1. *Kraussia rugosa* (Krauss, 1843). Male (11.4 by 10.0 mm) (ZRC 1965.10.10.2), Christmas Island. A, left third maxilliped (hairs denuded); B, abdomen; C, sternum (dotted lines indicate abdominal cavity; al = abdominal button lock; st = sternite); D, frontal view; E, left fourth ambulatory leg (lateral view); F, left fourth ambulatory dactylus and propodus (anterolateral view) (hairs denuded); G, left fourth ambulatory dactylus and propodus (anterior view) (hairs denuded); H, left third ambulatory dactylus and propodus (lateral view) (hairs denuded). Scales = 1.0 mm.

Serène (1972) also noted that the third maxilliped of *K. rugulosa* was distinctly longer than those of other species. The second male abdominal segment of *K. rugulosa* is also distinctly more elongate, with a much smaller width to length ratio (1.6 vs. 2.3) compared to the other *Kraussia* species. In view of these differences, I prefer to recognise two separate genera for the species known from the Indo-West Pacific. *Kraussia* s. str. is restricted for *K. rugulosa* (Krauss, 1843), whilst the other Indo-West Pacific species previously referred to *Kraussia* are transferred to a new genus, *Palapedia*. The sole American species, *K. americana* Garth, 1939, differs from both *Kraussia* and *Palapedia* in carapace shape and proportions, as well as in the structure of the sternum, third maxilliped and last ambulatory merus, and is transferred to a third genus, *Garthasia*, new genus. The differences between these three genera are detailed in Table 2.

Table 2. Differences between *Kraussia* Dana, 1852, *Palapedia*, new genus, and *Garthasia*, new genus

	<i>Kraussia</i>	<i>Palapedia</i>	<i>Garthasia</i>
carapace	rounded, width to length ratio 1.11-1.15; anterolateral margin longer than posterolateral margin, with four distinct sharp epibranchial spines; posterolateral margin distinctly concave	rounded, width to length ratio 1.01-1.27; anterolateral margin longer than posterolateral margin, may be dentiform or uneven but never with sharp epibranchial spines; posterolateral margin distinctly concave	oval, broader than long, width to length ratio 1.33-1.35; anterolateral margin distinctly shorter than posterolateral margin, never with sharp epibranchial spines; posterolateral margin gently convex
third maxilliped	very elongate, length to width ratio 3.1-3.2; merus slightly longer than broad, width to length ratio 0.92-0.93; carpus swollen, appearing bulbous	elongate, length to width ratio 2.7-2.8; merus slightly longer than broad, width to length ratio 0.90-0.91; carpus swollen, appearing bulbous	short, length to width ratio ca. 2.4; merus much wider than long, width to length ratio ca. 2.2; carpus not swollen
chelipeds	tips of fingers deeply excavated, distinctly spoon-shaped	tips of fingers sharp or slightly flattened but never spoon-shaped	tips of fingers sharp not spoon-shaped
last ambulatory merus	short, stout, length to width ratio ca. 1.6	short, stout, length to width ratio 1.6-1.8	short, slender, length to width ratio ca. 2.7
sternum	very elongate, suture present between sternites 1 and 2, surfaces of sternites 1 and 2 gently convex	very elongate, suture present between sternites 1 and 2, surfaces of sternites 1 and 2 gently convex	less elongate, no suture present between sternites 1 and 2, surfaces of sternites 1 and 2 with longitudinal keel
male abdomen	second segment relatively long, width to length ratio ca. 1.6, segments 3-6 elongated	second segment much broader than long, width to length ratio 2.3, segments 3-6 elongated	second segment much broader than long, width to length ratio 3.0, segments 3-6 not elongated

***Kraussia rugulosa* (Krauss, 1843)**

(Fig. 1)

Platyonichus rugulosa Krauss, 1843: 26, pl. 1 fig. 5

Trichocera porcellana White, 1848: 59

Kraussia proporcillana Ward, 1934: 10, pl. 1 fig. 7 (for remainder of synonymy up to 1972, see Serène, 1972: 44)

Kraussia rugulosa - Sakai, 1976: 311, pl. 102 fig. 1; Dai *et al.*, 1986: 171, fig. 102(1), pl. 23(3); Dai & Yang, 1991: 190, fig. 102(1), pl. 23(3)

Material examined. - 1 female (6.8 by 6.4 mm) (ZRC 1993.4062), Horikawa reef flat, near Tamagusuka village, Okinawa, Ryukyus, Japan, coll. P. K. L. Ng, iv.1992. — 1 male (11.4 by 10.0 mm) (ZRC 1965.10.10.2), Christmas Island, coll. C. A. Gibson Hill, 1940. — 1 male (ZRC 1965.10.10.3), Christmas Island, coll. C. A. Gibson Hill, 1941. — 1 male (badly damaged) (ZRC 1965.10.10.1), Christmas Island, coll. M. Ward, 1934 [paratype of *K. proporcillana* Ward, 1934].

Remarks. - *Kraussia rugulosa* is the most widely distributed species in the genus, ranging from South Africa to Japan and Australia. Although Serène (1972) synonymised *K. porcellana* (White, 1848) (type locality Philippines), and *K. proporcillana* Ward, 1934 (type locality Christmas Island, Indian Ocean), under *K. rugulosa*, he hinted that there might be more than one species once specimens from throughout the species' range can be compared directly. The most obvious indication that a detailed restudy of all available specimens is necessary is suggested by the structure of the last ambulatory dactylus. In the South African and Australian specimens of *K. rugulosa*, the last ambulatory dactylus (fide Krauss, 1843: 26, pl. 1 fig. 5; Barnard, 1950: 195, fig. 36; Serène, 1972: 44, fig. 1B) is gently curved downwards, with the anterior (outer) margin straight or distinctly convex. In the "*K. rugulosa*" from Japan, China, Southeast Asia and Indian Ocean (present specimens; Sakai, 1976: 311, pl. 102, fig. 1; Dai & Yang, 1991: pl. 23(3)), the last ambulatory dactylus is distinctly recurved, sickle-shaped and curved upwards, with the anterior (outer) margin distinctly concave.

I have re-examined the specimens of *K. proporcillana* Ward, 1934, in the ZRC, including a paratype male, and they agree with Serène's (1972) general definition of *K. rugulosa*. For the moment, I follow Serène in synonymising *K. proporcillana* (and *K. porcellana*) with *K. rugulosa*.

***Palapedia*, new genus**

Type species. - *Palapedia valentini*, new species, by present designation.

Diagnosis. - Carapace rounded to slightly broader than long, width to length ratio 1.0-1.3; anterolateral margin longer than posterolateral margin, may be dentiform or lined with sharp granules but never with sharp epibranchial spines; posterolateral margin short, distinctly concave. Third maxilliped elongate, length to width ratio 2.7-2.8; merus slightly longer than broad, width to length ratio 0.90-0.91; carpus swollen, appearing bulbous. Sternum very elongate, suture present between sternites 1 and 2, surfaces of sternites 1 and 2 gently convex. Tips of cheliped fingers sharp, rounded or slightly flattened but never deeply excavated or spoon-shaped. Merus of last ambulatory leg short, stout, length to width ratio 1.6-1.8. Male abdomen second

segment much broader than long, width to length ratio 2.3.

Etymology. - The name is derived from the Latin "pala" for spade, and "pedis" for foot, alluding to the spade-like dactyli of the members in the group. Gender is feminine.

Remarks. - The differences between *Palapedia*, new genus, and its two allied genera, *Kraussia* and *Garthasia* have already been discussed earlier under *Kraussia*, and are summarised in Table 2.

The genus *Palapedia*, as defined here, contains 13 recognised species, all Indo-West Pacific in distribution: *P. bongensis* (Serène, 1972) (type locality: Philippines), *P. hendersoni* (Rathbun, 1902) (type locality: Australia), *P. integra* (De Haan, 1835) (type locality: Japan), *P. marquesa* (Serène, 1972) (type locality: Marquesas Islands), *P. nitida* (Stimpson, 1858) (type locality: Japan), *P. obliquefrons* (Dai, Yang, Song & Chen, 1986) (type locality: China) (see Ng, 1992 for comments on authorship of this species), *P. pelsartensis* (Serène, 1972) (type locality: Australia), *P. quadriceps* (Yokoya, 1936) (type locality: Japan), *P. rastripes* (Müller, 1887) (type locality: Sri Lanka), *P. roycei* (Serène, 1972) (type locality: Australia), *P. serenei*, new species (type locality: Philippines), *P. valentini*, new species (type locality: Singapore), and *P. wilsoni* (Serène, 1972) (type locality: Philippines).

Material examined of *Palapedia* species not discussed. - *Palapedia quadriceps*: 1 female (13.0 by 12.0 mm) (ZRC 1970.1.3.1), Colombo, Sri Lanka, coll. R. Serène, 1966. — *Palapedia rastripes*: 1 male (10.0 by 9.0 mm) (ZRC 1969.11.20.4), 2 females (larger 12.4 by 10.8 mm) (ZRC 1969.10.10.4-5), Cocos Keeling Islands, coll. C. A. Gibson Hill, 1941.

***Palapedia valentini*, new species**
(Figs. 3-5)

Kraussia aff. *nitida* - Serène, 1972: 51, figs. 12, 13, 23F (nec *Kraussia nitida* Stimpson, 1858)

Material examined. - Holotype, male (10.5 by 10.4 mm) (ZRC 1965.10.10.6), Pulau Pawai, Singapore, coll. M. W. F. Tweedie, xi.1933. Paratypes, 1 male (6.2 by 6.1 mm) (ZRC 1993.4064), 1 female (9.2 by 8.7 mm) (ZRC 1993.4065), under coral rock on coral sand substrate, Sentosa island, Singapore, coll. P. K. L. Ng & S. L. Tay, 21.xi.1987; 1 female (9.8 by 9.2 mm) (ex-ovigerous) (ZRC 1993.4066), under littoral coral rock, on coral sand substrate, Pulau Semakau, Singapore, coll. C. G. S. Tan, 27.x.1992. Others, 4 first zoeae (ZRC 1993.4067), from ovigerous paratype female (ZRC 1993.4066).

Diagnosis. - Carapace slightly broader than long, dorsal surfaces with weak but distinct transverse striae; frontal and lateral regions granulose to rugose; frontal regions with numerous long setae which project beyond the frontal margin. Frontal margin granulose, weakly quadrilobate, median cleft small, leading to deep fissure separating median lobes; lateral lobes separated by very shallow cleft or concavity. Supraorbital margin granulose, with deep median fissure, inner and outer orbital angles weakly produced; infraorbital margin granulose, with larger granules adjacent to the orbital angles. Anterolateral margin distinctly arcuate, lined with numerous blunt granules, epibranchial tooth very low, separated from rest of margin by broad, shallow dent. Posterolateral margin deeply concave.

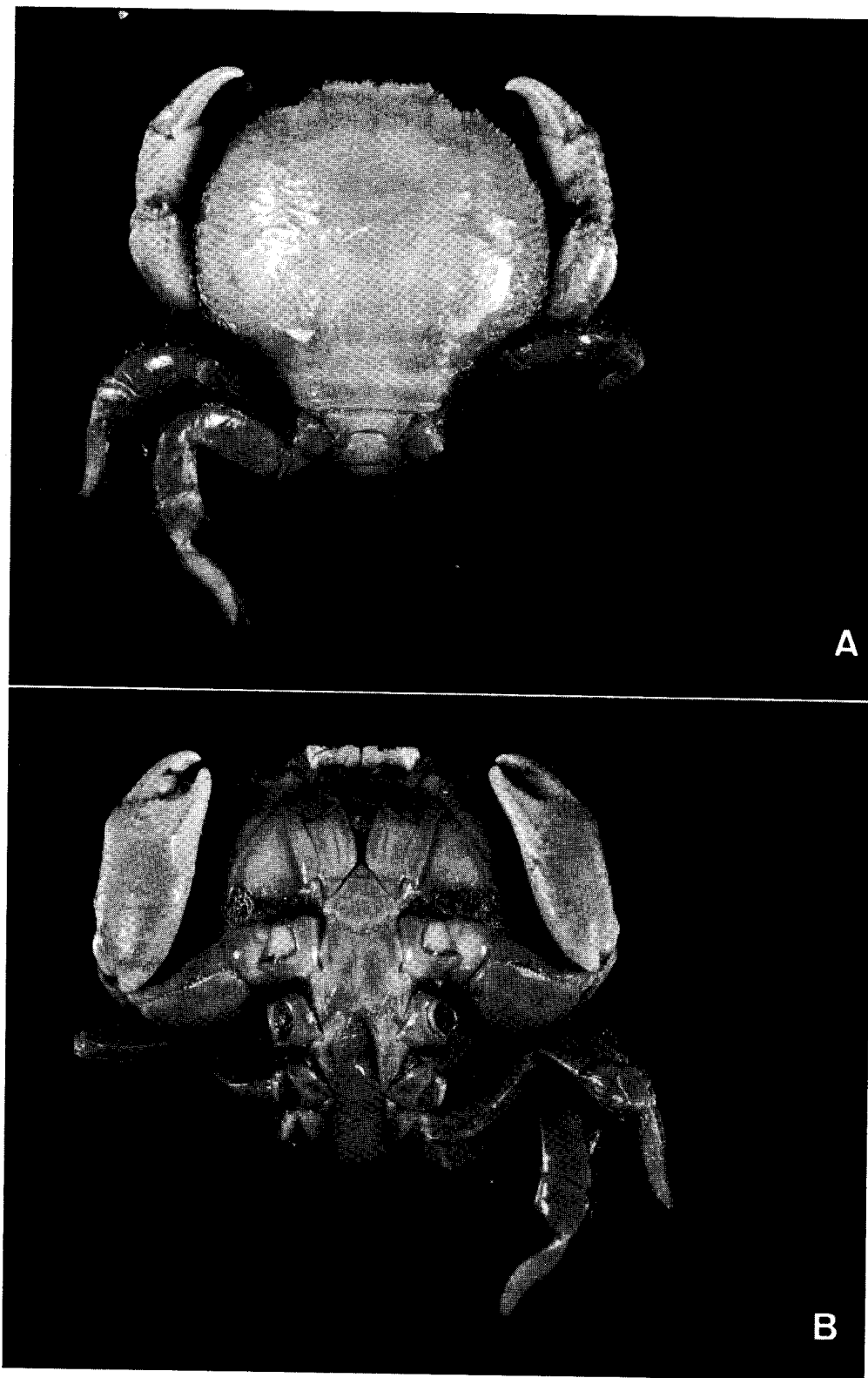


Fig. 2. *Palapedia valentini*, new species. Holotype male (10.5 by 10.4 mm) (ZRC 1965.10.10.6), Singapore. A, dorsal view; B, ventral view.

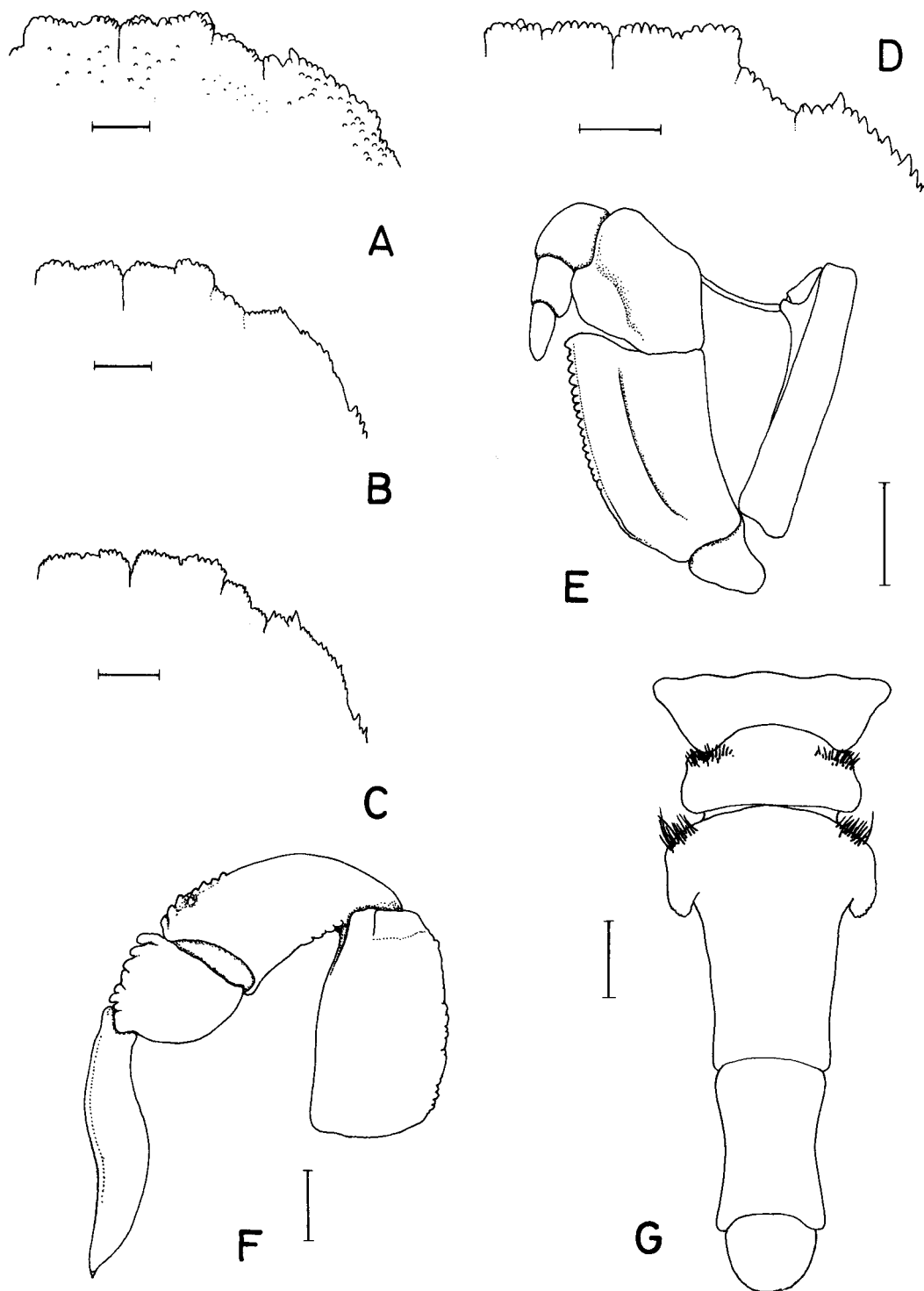


Fig. 3. *Palapedia valentini*, new species. A, E, F, holotype male (10.5 by 10.4 mm) (ZRC 1965.10.10.6), Singapore; B, male (6.2 by 6.1 mm) (ZRC 1992.4064), C, female (9.2 by 8.7 mm) (ZRC 1992.4065), Singapore; D, female (9.8 by 9.2 mm) (ZRC 1992.4066), Singapore. A-D, frontal margins; E, left third maxilliped (hairs denuded); F, left fourth ambulatory leg (hairs denuded); G, male abdomen. Scales = 1.0 mm.

Chelipeds slightly unequal, right larger. Outer surfaces of chela rugose to granulose, outer distal margin of chela (adjacent to base of dactylus) lined with large rounded granules; chela of major cheliped as long as but higher than that of minor chela. Fingers of major cheliped slightly shorter and stouter than that of minor cheliped; outer surface of dactylus with deep longitudinal median groove which is lined by low granules on each side; upper margin of dactylus with several large forward-directed granules on proximal part; cutting edge of pollex with one large, distinct broadly triangular tooth; inner and outer surfaces of tooth each with basal tuft of long

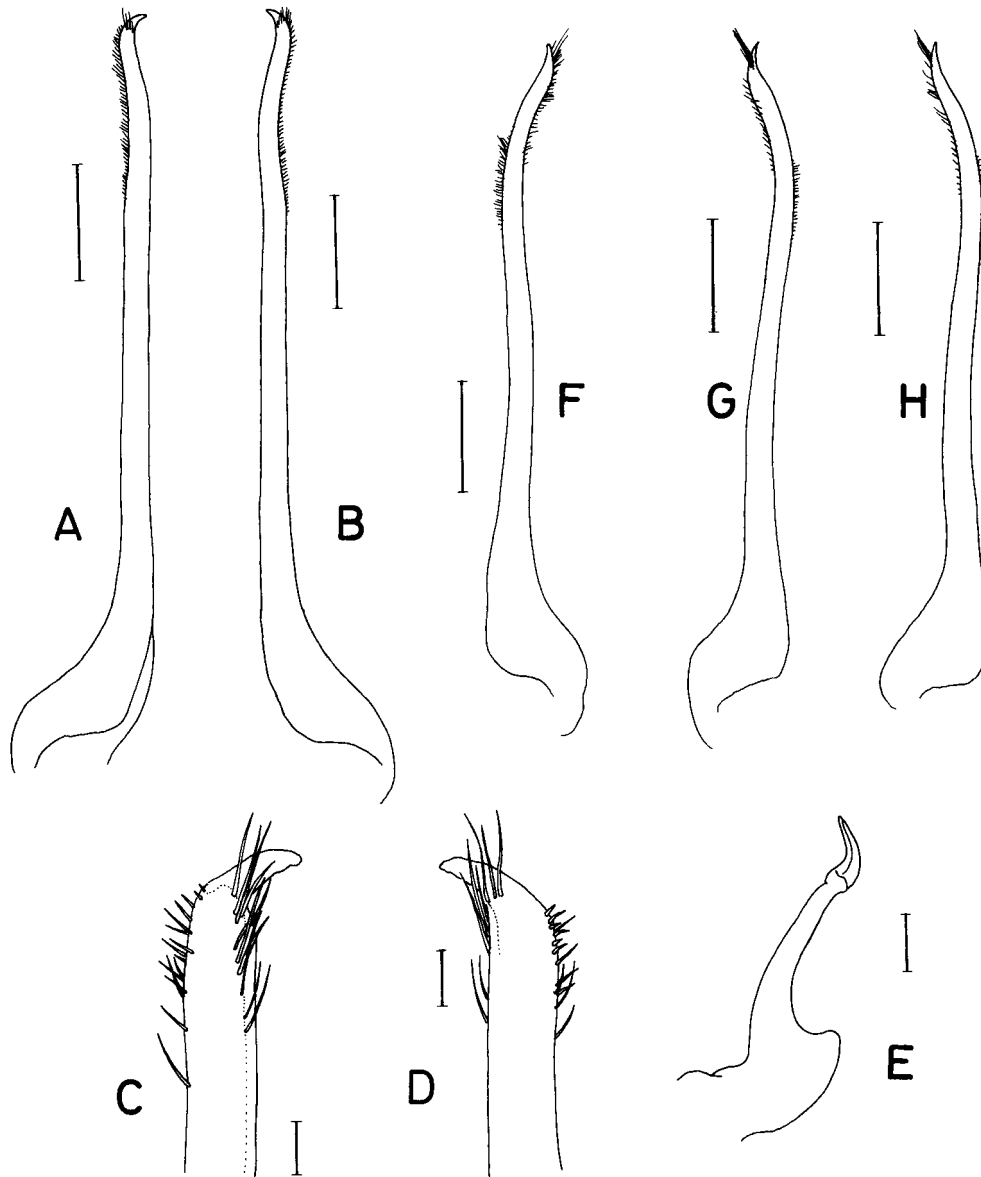


Fig. 4. *Palapedia valentini*, new species. Gonopods. A-D, E, Holotype male (10.5 by 10.4 mm) (ZRC 1965.10.10.6), Singapore; F-H, male (6.2 by 6.1 mm) (ZRC 1992.4064), Singapore. A-H, left G1s; C, D, distal part of G1; E, left G2. G, H, drawn from different angles. Scales: A, B, F-H = 1.0 mm; C, D, E = 0.1 mm.

hairs; cutting edge of dactylus with low and very broad tooth, less distinct in the minor cheliped, outer surface of median part of tooth with basal tuft of long hairs.

Ambulatory propodus short, outer margin with numerous small granules and long, stiff hairs. Dactylus of last leg sickle-shaped, laterally flattened, blade-like, curving upwards, outer margin lined with very small granules and row of short, stiff hairs.

G1 long, very slender, almost straight; distal part in adult sharply tapering to sharp point, distinctly curving outwards, subdistal area with numerous long hairs. G2 short, with distinct distal segment and well developed basal segment.

Paratypes. - The female paratypes agree very well with the holotype male in most of the non-sexual characters. The smaller female is already mature, as indicated by the form of its abdomen and setose, well developed pleopods. The differences between the G1s of the holotype male of *P. valentini* (ZRC 1965.10.10.6) and the paratype male (ZRC 1993.4064) are rather marked and require comment. Not only is the G1 of the paratype male proportionately shorter, its distal part is also only slightly curved outwards, and appears almost straight. This is in contrast to the hook-shaped distal G1 part of the holotype. The holotype male (10.5 by 10.4 mm) is however, much larger than the paratype male (6.2 by 6.1 mm), and the differences may be due to the age of the paratype, with its G1 not having reached its adult form. The G1 of the paratype male however, is already quite setose, with the subterminal hairs long and setose. Externally, the two males agree very well in all major aspects, although the granules lining the frontal and anterolateral margins are sharper and more distinct in the smaller paratype. There is thus no reason not to regard the two specimens as conspecific for the moment.

Etymology. - The species name honours an old friend and esteemed colleague, Zdravko Stevcic, who first got me interested in this genus. The species name is derived from the Latin transiteration of Zdravko, i.e. Valentinus.

Description of first zoea (based on 3 specimens, not preserved). - Carapace: length ca. 0.50 mm (excluding spines); with a long, recurved dorsal spine, a long rostral spine and 2 short lateral spines which are adjacent to lower margin of carapace; eyes large, sessile.

Antennule: Cone-shaped, with 2 long and 2 short aesthetascs.

Antenna: Protopod fused with endopodite, spinous process long, tip sharp, distal part with lateral spinules; exopod very short, bud-like, with 2 short distal stiff setae.

Mandibles: Asymmetrical, with several large sharp teeth and denticles; palp absent.

Maxillule: Endopod 2-segmented, proximal segment with 1 long seta, distal segment with 2 subterminal and 4 terminal long setae; coxal endite with 6 terminal and 1 subterminal stiff setae; basal endite with 3 uniserrate spines and 2 long, plumose setae.

Maxilla: Endopod, coxal and basal endites bilobed; endopod with 3 setae on proximal lobe and 5 setae on distal lobe; basal endite with 5 setae on proximal lobe and 4 setae on distal lobe;

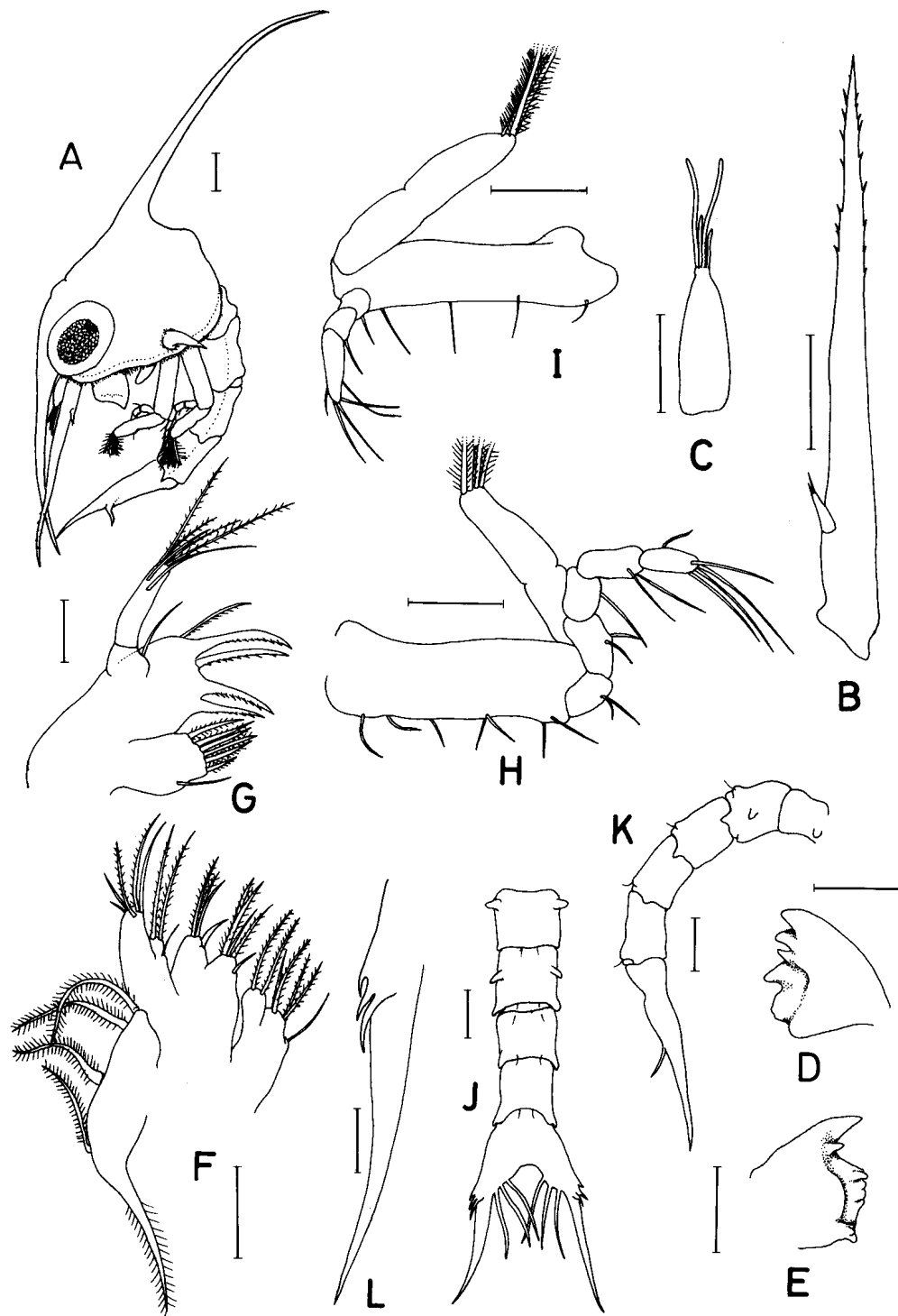


Fig. 5. *Palapedia valentini*, new species. First zoea. A, lateral view of whole zoea; B, antenna; C, antennule; D, E, mandibles; F, maxilla; G, maxillule; H, first maxilliped; I, second maxilliped; J, dorsal view of abdomen; K, lateral view of abdomen; L, left part of telson. Scales: A-C, H-K = 0.1 mm; D-G, L = 0.05 mm.

coxal endite with 4 setae on proximal lobe and 2 setae on distal lobe; scaphognathite with 1 long apical plumose setae and 4 stout marginal plumose setae.

First maxilliped: Coxa without setae; basis with 1,1,1,2,2 setae (proximal to distal); endopod 5-segmented, with 2,2,1,2,5 setae (proximal to distal segments); exopod with 4 long, natatory setae.

Second maxilliped: Coxa without setae; basis with 1,1,1,1 setae (proximal to distal); endopod 3-segmented, with 1,1,5 setae (proximal to distal segments); exopod with 4 long, natatory setae.

Third maxilliped: Not discernible.

Pereiopods: Present as buds under carapace.

Abdomen: 5 somites, segment 6 fused to telson; somites 2-4 with posterolateral spines; somite 1 with pair of anterolateral blunt processes; somite 2 with pair of median lateral processes; somites 1-5 with 2,2,2,2 setae on posterior margins respectively.

Pleopods: Absent.

Telson: Bifurcate, each furca with 3 lateral, upwardly directed and inwardly pointing spines of spines of increasing size and strength; inner margin of fork with 3 pairs of plumose setae.

Remarks. - *Palapedia valentini*, new species, appears to be most closely related to *P. nitida* (Stimpson, 1858). The problem however, is that the identity of *P. nitida* has been less than clear, especially since Stimpson's type (as is most of his material) was lost in the great Chicago Fire. Serène (1972) reviewed the taxonomic problems associated with *P. nitida* (type locality Kagoshima, Japan, fide Stimpson, 1858). As Sakai (1939, 1965, 1976) also had a male specimen from Kagoshima, his definition and description (see also Stimpson, 1907) of the species must be regarded as the most accurate of *P. nitida*. It would seem appropriate that Sakai's male specimen from Kagoshima should be designated as the neotype when the specimen can be traced and re-examined at a later date.

Using Sakai's descriptions and figures of *P. nitida* as the basis for comparisons, *P. valentini* differs from *P. nitida* in the sculpture of the carapace, shape and form of the frontal margin, proportions of the two chelipeds, and form of the ambulatory propodi and dactyli (see Table 3). The shape of the front is a constant character. In *P. nitida*, the frontal margin is distinctly quadrilobed, with a deep V-shaped cleft separating the two pairs of lobes, and deep narrow fissures separating the two lateral lobes. In *P. valentini*, the front is only faintly quadrilobed, the median cleft been shallower. The structure of the frontal margin is very constant in *P. valentini*, even for the smaller male.

Table 3. Differences between *Palapedia valentini*, new species, and *Palapedia nitida* (Stimpson, 1858)

	<i>Palapedia valentini</i>	<i>Palapedia nitida</i>
Carapace surface	rugose, especially on frontal and antero-lateral regions	slightly rugose to almost smooth
Frontal region	with numerous long hairs which extend beyond the front	almost glabrous, with scattered hairs
Frontal margin	weakly quadrilobate, margin highly graulose, appears almost bilobed, with deep fissure separating median lobes, clefts (if present) separating lateral lobes shallow, indistinct	distinctly quadrilobate, with deep fissure separating median lobes, with deep V-shaped clefts separating lateral lobes
Supraorbital margin	relatively broad, 0.12-0.14 times carapace width	relatively narrow, ca. 0.1 times carapace width
Chelipeds	subequal, minor chela only slightly smaller than major chela, fingers of minor cheliped only slightly longer and more slender than that of major cheliped	unequal, minor chela distinctly smaller and more slender than major chela, fingers of minor cheliped longer and more slender than that of major cheliped
Ambulatory leg	dactylus proportionately longer, ratio of dactylus to propodus ca. 2.5; anterior margin distinctly concave, tip recurved; anterior margin of propodus and anterior distal margin of carpus with well developed, large granules, margins appearing distinctly serrated	dactylus proportionately shorter, ratio of dactylus to propodus ca. 2.2; anterior margin gently concave, tip straight; anterior margin of propodus and anterior distal margin of carpus with small granules, margins not appearing serrated

Dai *et al.* (1986: text fig. 102(2)) and Dai & Yang (1991: text fig. 102(2)) figured the G1 of a male *P. nitida* from China (as *Kraussia*), and it differs from that of *P. valentini* in having a shorter and sharper, strongly bent distal part (almost at right angles), appearing beak-like.

Rathbun (1902) named a new species, *Kraussia hendersoni*, based on a specimen from Australia reported by Henderson (1893) as *Kraussia nitida*. Serène (1972) questionably synonymised *K. hendersoni* with *K. nitida*. On the basis of Rathbun's (1902) and Henderson's

(1893) notes and figure, *K. hendersoni* is certainly a species of *Palapedia*, and very similar to Sakai's (1939, 1965, 1976) *P. nitida*, especially with regards to the form of the frontal margin. The identity of *P. hendersoni* and its relationship with *P. nitida* (if it is indeed a synonym) can only be resolved when the Japanese and Australian specimens are directly compared. *Palapedia hendersoni* is here tentatively regarded as a valid species.

The background colour of live *P. valentini* was dirty to creamy white, with mottled patches of reddish brown on the carapace and legs. The surfaces of the chela, especially the fingers, have reddish-brown rugae and granules.

Larval aspects. - The first zoea of *Palapedia valentini*, the first known for any kraussiine, has several very peculiar features which support the establishment of a separate subfamily. The basis of the first maxilliped of *Palapedia valentini* has a proximal to distal setal formula of 1,1,1,2,2 (total 7) whereas that of typical xanthids is 1,1,2,3,3 (total 10); and the first segment of the endopod only has 2 setae (3 in typical xanthids) (cf. Rice, 1980; Martin, 1984). This combination of larval characters is unique. Rice (1980) recognised four larval groups in the superfamily Xanthoidea, and the groups correspond approximately with the family groupings within the Xanthoidea proposed by Guinot (1978). Gore *et al.* (1981) and Andryszak & Gore (1981) proposed a fifth group for the American panopeids "*Micropanope*" *barbadensis* (Rathbun, 1921) and *Micropanope sculptipes* Stimpson, 1871, respectively, noting that their larvae had 3 distal setae on the exopod of its antenna and 2 setae on the the first segment of the first maxilliped endopod. The carapace, sternal and gonopod characters however, exclude the close relationship of *Micropanope* (family Panopeidae) with the Kraussiinae. A unique larval character possessed by *Palapedia valentini* is that the basis of the first maxilliped has only seven setae, against 10 in all other known xanthids. The larval characters of *Palapedia valentini* are very atypical for any xanthid subfamily (and xanthoid family for that matter), and support the recognition of a separate subfamily for the group.

Guinot (1978, 1979) had indicated that *Kraussia* was allied to more typical xanthine genera like *Cycloxanthops*, but their larval characters suggest against a close relationship. The zoeae of *Cycloxanthops truncatus* (de Haan, 1837) and *C. novemdentatus* (Lockington, 1877) have been described by Knudsen (1960), Hong (1977), Suzuki (1979) and Terada (1980), and they possess typical xanthine larval characters. Guinot noted that *Paraxanthus* was probably more closely related to kraussiines, but unfortunately, larvae from this genus is not known. The first zoeae of *Paraxanthus barbatus* (Poeppig, 1836) (the sole species in the genus), when it becomes available, should throw some light on how closely related it actually is to *Kraussia*, *Palapedia* and *Garthasia*.

Ecology and habits. - All the three recent specimens were sieved from fine coral sand under large pieces of coral rock in the littoral zone. They rapidly burrow backwards at an angle into the sand in aquaria using their upcurved ambulatory dactyli to push the sand forward and over the carapace.

With regards to the habitat, all known specimens of *P. valentini* (including an ovigerous female) were collected from shallow, littoral coral reef zones. The habitat of *P. nitida* has been described as "... bottoms of sand or broken shells, 30-55m. depth" (Sakai, 1976).

***Palapedia serenei*, new species**

(Figs. 6, 7)

Kraussia marquesa Serène, 1972: 53 (part), fig. 23H (nec *Kraussia marquesa* Serène, 1972, s. str.).

Material examined. - Holotype male (19.0 by 15.8 mm) (ZRC 1969.11.20.5), Puerto Galera, Mindoro island, Philippines, coll. University of the Philippines, no date.

Diagnosis (holotype). - Carapace rounded, broader than long, dorsal surfaces with weak but distinct transverse striae and flattened granules; frontal and lateral regions gently granulose; frontal regions with numerous hairs. Frontal margin quadrilobate, median cleft and fissure very deep; lateral lobes separated by distinct V-shaped cleft. Supraorbital margin granulose, without deep median fissure, infraorbital margin granulose. Anterolateral margin arcuate, lined with numerous small sharp tubercles and granules, some appearing spinulose, epibranchial tooth marked by sharp tubercle, separated from rest of margin by V-shaped cleft. Posterolateral margin short, gently concave.

Both chelipeds absent.

Ambulatory propodi short, outer margin with large granules and long, stiff hairs. Dactylus of last leg sickle-shaped, curving upwards, outer proximal margin flattened, lined with small granules and row of short, stiff hairs, distal two-thirds of outer margin flattened, blade-like.

G1 long, very slender, proximal three quarters almost straight, distal one quarter gently bent outwards, distalmost part gently sinuous, tip sharp. G2 short, with distinct distal segment and well developed basal segment.

Etymology. - The species name gives due recognition to the late Raoul Serène, whose contributions to Southeast Asian carcinology have been immense, and whose earlier revision of the genus *Kraussia* s. lato forms the foundation of the present study.

Remarks. - Serène (1972) referred the present Philippine specimen to "*Kraussia marquesa*" with reservation, commenting that it differed in many aspects in the form of the front as well as carapace proportions from the holotype male of *P. marquesa* from the Marquesas Islands. He figured the deeply clefted frontal margin of the Philippine specimen (Serène, 1972: Fig. 23H), which is the most obvious difference with the holotype male of *P. marquesa*. The Philippine specimen also has broader carapace (relative to the carapace length) and proportionately narrower front.

The deeply clefted frontal margin of the Philippine specimen resembles that figured by Henderson (1893) for *P. nitida*, which was subsequently referred to a new species, *Kraussia hendersoni* by Rathbun (1902). The present Philippine specimen however, differs from *P. hendersoni* in having the clefts even deeper, with all the four frontal lobes equal to subequal in size (the inner ones are distinctly smaller in *P. hendersoni*). More importantly, the anterior margin of the last ambulatory dactylus of *P. marquesa* is strongly granular, whereas in *P. hendersoni* and *P. nitida*, this margin is almost smooth. The chela of *P. marquesa*, in contrast to that of *P.*

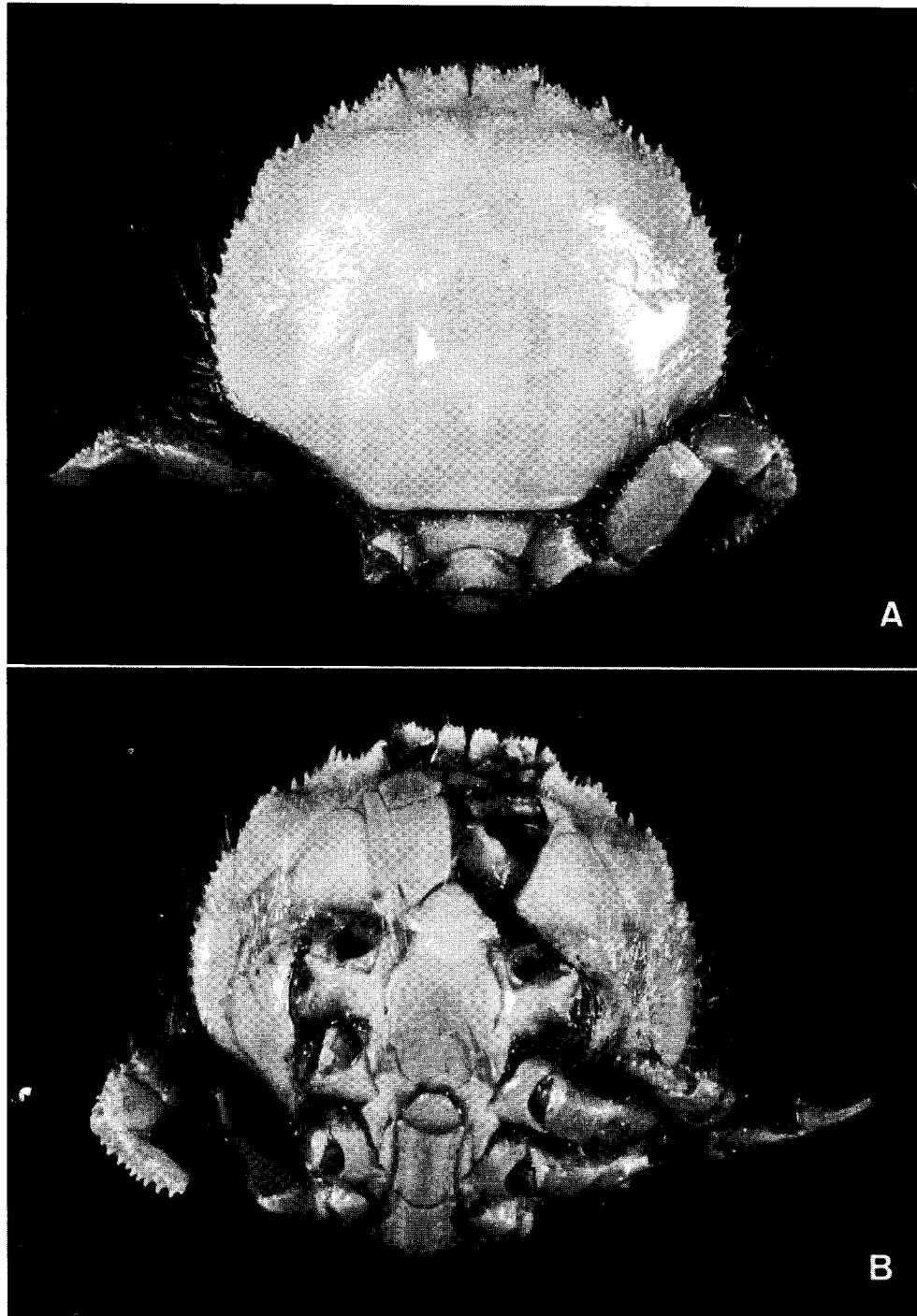


Fig. 6. *Palapedia serenei*, new species. Holotype male (19.0 by 15.8 mm) (ZRC 1969.11.20.5), Philippines. A, dorsal view; B, ventral view.

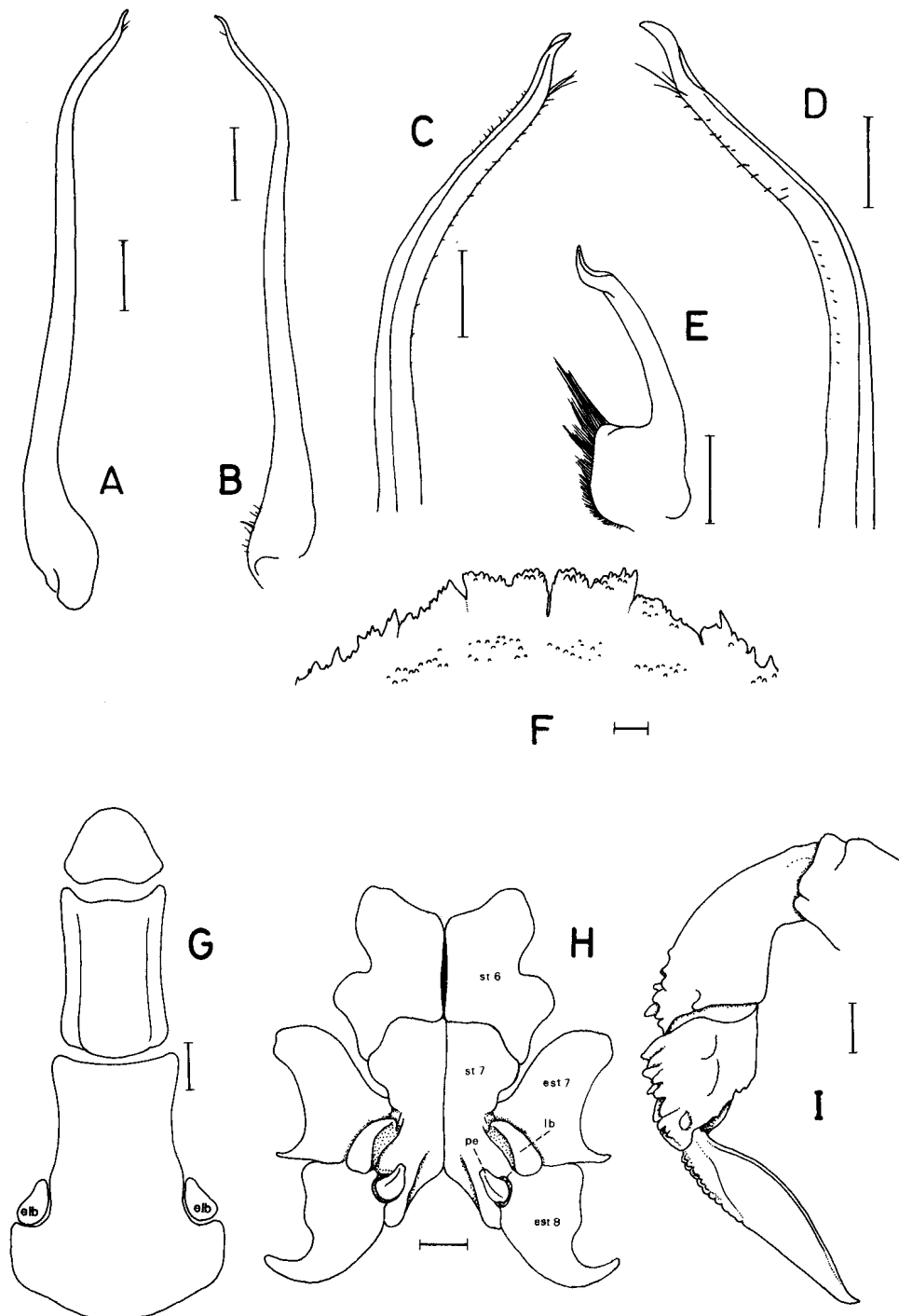


Fig. 7. *Palapedia serenei*, new species. Holotype male (19.0 by 15.8 mm) (ZRC 1969.11.20.5), Philippines. A-D, left G1; C, D, distal part of G1; E, left G2; F, frontal margin; G, male abdomen (segments 3-7) (hairs denuded); H, sternum (st = sternite, est = episternite, elb, lb = episternal lamelliform bracket, pe = penis) (hairs denuded); I, left last ambulatory leg (hairs denuded). Scales: A, B, F-I = 1.0 mm; C, D, E = 0.5 mm.

nitida and *P. hendersoni*, is shorter and stouter, the fingers being proportionately shorter and more curved.

Despite the external differences which clearly differentiate the Philippine specimen from any known species, Serène (1972) referred the specimen to *P. marquesa* because "... its male pleopod [G1] is so close to that of *marquesa* that at least provisionally it is considered as belonging to the same species" (p. 54). I have examined the G1 which was extracted by Serène. It is the right G1, and it indeed bears a striking resemblance to that figured by Serène for *P. marquesa* (Serène, 1972: Fig. 14). On closer examination however, it was found that the tip had been broken, the breakage point being very obvious under high magnification. The left G1 was examined, and fortunately, its distal part was intact. The intact left G1 is very different from that of *P. marquesa*, the distal part being very long and slender and distinctly bent obliquely. There can thus be no doubt now that the Philippine specimen represents a separate species, distinct from *P. marquesa*, *P. nitida* s. str. and *P. hendersoni*. The species is here named *Palapedia serenei*, new species.

Palapedia bongensis (Serène, 1972)

Kraussia bongensis Serène, 1972: 56, Figs. 19, 20, 23J, 24

Kraussia truncatifrons Sakai, 1974: 90; Sakai, 1976: 308, text fig. 172b, Pl. 101 fig. 4

Material examined. - 1 female (5.9 by 4.8 mm) (ZRC 1993.4063), Horikawa reef flat, near Tamagusuka village, Okinawa, Ryukyus, Japan, coll. P. K. L. Ng, iv.1992.

Remarks. - There are no substantial characters separating *P. bongensis* (Serène, 1972) and *Kraussia truncatifrons* Sakai, 1974. The form of the front and structure of the G1 agree very well in both species. Although Sakai (1974) did not illustrate the G1, he noted that "... the distal piece of the anterior pleopod of male is spatulate, a little broader than that of *integra*" (Sakai, 1976: 309). This description agrees very well with the figure of the G1 of *P. bongensis* by Serène (1972: Fig. 19). As such, I have little doubt that *Kraussia truncatifrons* Sakai, 1974, is a junior synonym of *P. bongensis* (Serène, 1972). Sakai (1974, 1976) in describing *Kraussia truncatifrons*, had apparently not been aware of Serène's (1972) earlier revision of the genus, and made no reference to it.

The distribution of *P. bongensis*, previously known from Tawitawi Bay in the Sulu Archipelago, Philippines, now includes Japan.

Garthasia, new genus

Type species. - *Kraussia americana* Garth, 1939, by present designation.

Diagnosis. - Carapace distinctly oval, much broader than long, width to length ratio 1.33 - 1.35; anterolateral margin distinctly shorter posterolateral margin, without sharp granules or epibranchial spines; posterolateral margin gently convex. Third maxilliped short, length to width ratio ca. 2.4; merus much wider than long, width to length ratio ca. 2.2; carpus not swollen. Sternum not greatly elongated, suture between sternites 1 and 2 absent, surfaces of sternites 1

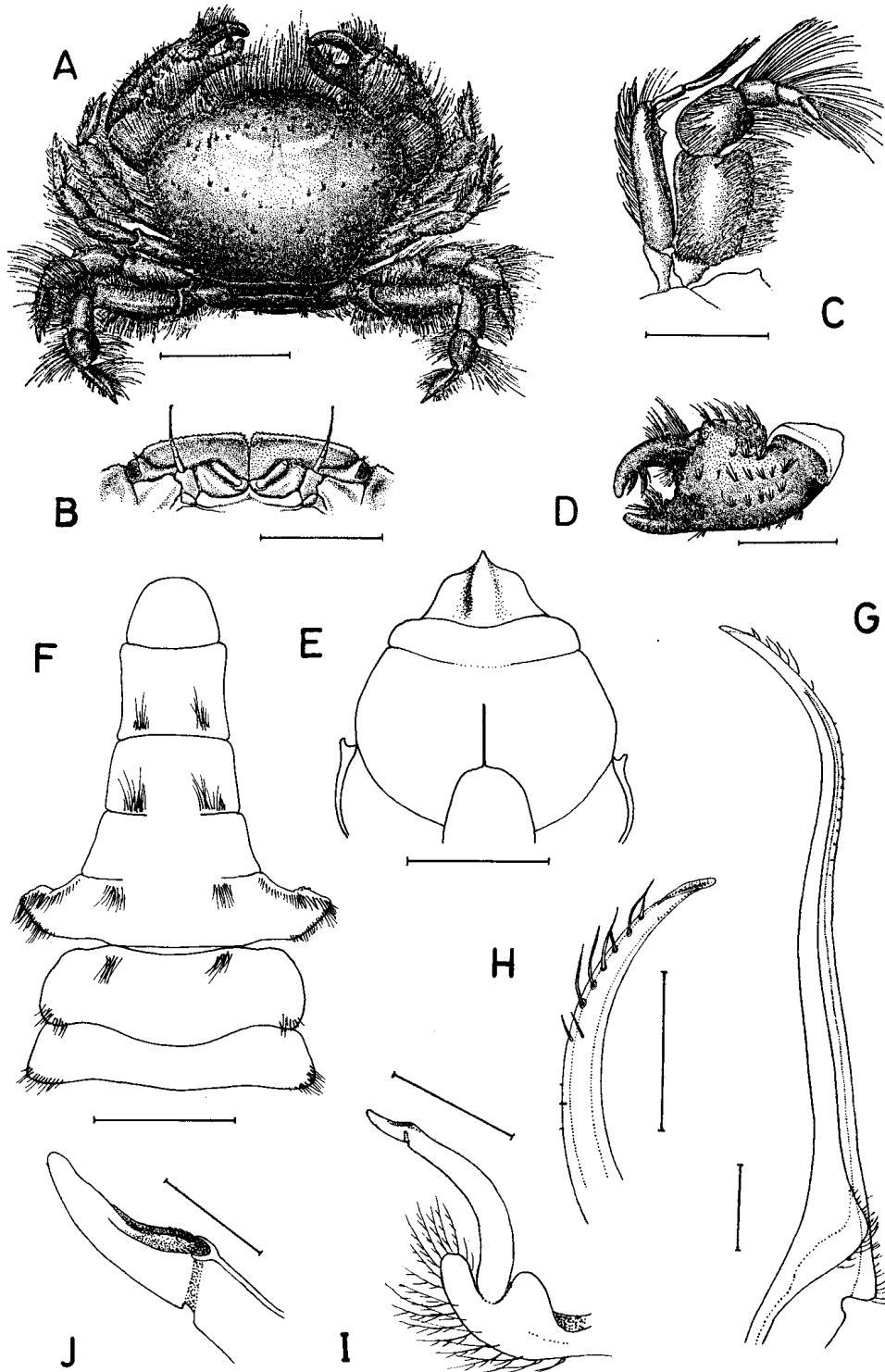


Fig. 8. *Garthasia americana* (Garth, 1939). A-D, G-J, holotype male, (14.7 by 10.9 mm) (AHF 371); A, dorsal view; B, antennules and front; C, right third maxilliped; D, left chela; E, anterior sternal segments; F, abdomen; G, right G1; H, distal part of G1; I, right G2; J, distal part of G2. Scales: A = 6.0 mm; B, D = 4.0 mm; C, E, F = 2.0 mm; G-I = 0.5 mm; J = 0.1 mm. (A-D after Garth, 1939; G-J, courtesy of J. Garth).

and 2 with distinct longitudinal keel. Tips of cheliped fingers sharp. Merus of last ambulatory leg short, slender, length to width ratio ca. 2.7. Male abdomen second segment much broader than long, width to length ratio ca. 3.0.

Etymology. - The new genus is named in honour of John Garth, who has contributed so much to carcinology over the years. Gender is feminine.

Remarks. - Garth's (1939) excellent description and figures of *Kraussia americana* leave little doubt that his species differs generically from other kraussiines described from the Indo-West Pacific. The other differences between these genera are summarised in Table 2. The sternum, male abdomen and third maxillipeds of *Garthasia* are less elongate and closer to typical xanthines than either *Kraussia* or *Palapedia*. The carapace of *Garthasia* is also distinctly broader than long. In all other aspects, it is closer to *Kraussia* and *Palapedia*, and must be placed in the Kraussiinae. *Garthasia* may be regarded as an intermediate form linking the Xanthinae to the Kraussiinae.

***Garthasia americana* (Garth, 1939)**

(Fig. 8)

Kraussia americana Garth, 1939: 19, Pl. 7 figs. 1-4.

Material examined. - 1 male (12.5 by 9.5 mm) (AHF 1758-49), three-quarter mile WSW of Perico Point, Carmen Island, Gulf of California, 15-18 fms. depth, coll. J. S. Garth, 21.iii.1949.

Remarks. - Garth (1939) described *Kraussia americana* from two male specimens from the California and Galapagos, and there is no need to elaborate on his excellent description here. The holotype male (AHF 371) was obtained from Puerto Refugio, Angel de la Guardia Island, Gulf of California, Mexico, from a depth of 8 to 10 fathoms. The present specimen (AHF 1758-49) agrees very well with Garth's (1939) descriptions and figures. The fingers of the chelipeds of the present specimen are partially pigmented black on its median parts.

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