

**A REVISION OF *CERATOCARCINUS* WHITE, 1847, AND  
*HARROVIA* ADAMS & WHITE, 1849 (CRUSTACEA: DECAPODA:  
BRACHYURA: EUMEDONIDAE), TWO GENERA OF CRABS  
SYMBIOTIC WITH CRINOIDS**

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**ABSTRACT.** - The crabs of the genera *Ceratocarcinus* White, 1847, and *Harrovia* Adams & White, 1849, are revised. Members of both genera are obligate symbionts of crinoids. *Ceratocarcinus* White, 1847, now contains three species: *C. longimanus* White, 1847, *C. frontodentata* (Shen, Dai & Chen 1982), and *C. trilobatus* (Sakai, 1938). One species, *Ceratocarcinus spinosus* Miers, 1879, is referred to a new genus, *Tiaramedon*. *Harrovia* is redefined and now contains seven species: *H. albolineata* Adams & White, 1849, *H. cognata*, new species, *H. elegans* De Man, 1887, *H. japonica* Balss, 1921, *H. longipes* Lanchester, 1900, *H. ngi* Chen & Xu, 1992, and *H. tuberculata* Haswell, 1880. *Harrovia purpureus* Gordon, 1934, and *Harrovia egeriae* Gordon, 1947, are referred to two new genera, *Permanotus* and *Tauropus* respectively.

**KEYWORDS.** - Revision, Eumedonidae, crinoid symbionts, *Ceratocarcinus*, *Harrovia*, new genera, new species.

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**INTRODUCTION**

The family Eumedonidae Dana, 1853, consists a group of marine crabs, all of which are symbiotic with echinoderms. Four genera are known obligate symbionts of featherstars (crinoids), viz. *Ceratocarcinus* White, 1847, *Harrovia* Adams & White, 1849, and *Rhabdonotus* A. Milne Edwards, 1879. Ng & Chia (1995) revised the genus *Rhabdonotus* and added two new species to the previously monotypic genus. Serène et al. (1958) had briefly discussed the taxonomy of some species of *Ceratocarcinus* and *Harrovia* but left many questions (especially the definition and composition of the two genera) open. More recently, Chia et al. (1993) dealt with the taxonomy of *Harrovia longipes* and *H. albolineata*, while Castro et al. (1995) clarified the identity of *Ceratocarcinus longimanus*.

The present paper revises the taxonomy of *Ceratocarcinus* and *Harrovia*. As a result, three species of *Ceratocarcinus* are now regarded as valid, viz. *C. longimanus* White, 1847, *C. frontodentata* (Shen, Dai & Chen 1982), and *C. trilobatus* (Sakai, 1938). One species, *Ceratocarcinus spinosus* Miers, 1879, is also transferred to a new genus, *Tiaramedon*. Seven species of *Harrovia* are here recognised, viz. *H. albolineata* Adams & White, 1849, *H. cognata*, new species, *H. elegans* De Man, 1887, *H. japonica* Balss, 1921, *H. longipes* Lanchester, 1900, *H. ngi* Chen & Xu, 1992, and *H. tuberculata* Haswell, 1880. *Harrovia japonica* had previously been regarded as a junior synonym of *H. elegans*. Two species previously assigned to *Harrovia* are transferred to new genera. *Harrovia purpureus* Gordon, 1934, is transferred to *Permanotus*, new genus, while *Harrovia egeriae* Gordon, 1947, is referred to *Tauropus*, new genus.

The term inner supraorbital tooth is equivalent to the lateral rostral lobule used by some workers. The abbreviations G1 and G2 are for the first and second male pleopods respectively. Measurements provided are of the carapace length and width respectively. carapace length (cl) was measured from the tip of the rostrum to the posterior margin of the carapace; carapace width (cb) from one antero-posterior angle to the other. A full description is only provided for the type species of each genus. Diagnoses are provided for the other species. The type species of each genus is discussed first and rest are treated alphabetically.

Specimens examined are deposited in: AM - Australian Museum, Sydney, Australia; BMNH - Natural History Museum (former British Museum (Natural History)), London, United Kingdom; BPBM - Bernice P. Bishop Museum, Honolulu, Hawaii, U.S.A.; IOAS - Institute of Oceanology, Academia Sinica, Qingdao, China; MNHN - Muséum National d'Histoire Naturelle, Paris, France; NMW - Naturhistorisches Museum, Vienna, Austria; NRS - Naturhistoriska Riksmuseet, Stockholm, Sweden; QM - Queensland Museum, Brisbane, Australia; IRSNB - Institut Royal des Sciences Naturelles de Belgique/Koninklijk Belgisch Instituut voor Natuurwetenschappen, Brussels, Belgium; RMNH - Nationaal Natuurhistorisches Museum (former Rijksmuseum van Natuurlijke Historie), Leiden, Netherlands; SMF - Natur-Museum und Forschungs-Institut Senckenberg, Frankfurt-am-Main, Germany; TMCD - Taiwan Museum (Crustacea Department), Taipei, Taiwan; USNM - United States National Museum of Natural History, Smithsonian Institution, Washington D.C., U.S.A.; WAM - Western Australian Museum, Perth, Australia; ZMUC - Zoological Museum, University of Copenhagen, Denmark; ZRC - Zoological Reference Collection, Department of Biological Sciences, National University of Singapore.

## DESCRIPTIVE PART

### GENUS *CERATOCARCINUS* WHITE, 1847

*Ceratocarcinus* White, 1847a: 125 [nomen nudum].

*Ceratocarcinus* White, 1847b: 57; White, 1847c: 61 [text identical to White, 1847b]; Adams & White, 1848-1849: 33; Neumann, 1878: 17; Miers, 1879a: 670; Miers, 1886: 104; Alcock, 1895: 286 [in key], 288; Flipse, 1930: 18, 20 [in key]; Gordon, 1934: 65, 67; Balss, 1957: 1631; Serène et al., 1958: 137, 168, 175, 231, 233; Sakai, 1976: 294 [in key], 300 [English text], 181 [Japanese text]; Takeda, 1979a: 69, 71; Wu, 1983: 65 [name in Chinese]; Stevcic et al., 1988: 1308, 1318; Dai et al., 1986: 162 [key only] [Chinese text], Dai & Yang, 1991: 179 [key only] [English text].

*Harrovia* - Stimpson, 1858: 221 (part); 1907: 32 (part); Balss, 1922: 136 (part); Sakai, 1938b: 329 [in key], 350 (part) [not *Harrovia* Adams & White, 1849].

**Type species.** - *Ceratocarcinus longimanus* White, 1847, by monotypy.

**Etymology.** - The name was derived from the Greek 'keratos' and 'carcinus' for 'horned crab'. Gender masculine.

**Diagnosis.** - Carapace pentagonal to quadrate, dorsal surfaces not distinctly convex; regions well defined; inner supraorbital teeth well developed, protruding well beyond frontal margin. Anterolateral and posterolateral margins clearly demarcated by angle; anterolateral margin usually lamelliform, with four teeth (including external orbital angle), first three teeth truncate, separated by deep, broad or narrow fissures or clefts, sometimes tightly adjoining each other and appearing fused, last anterolateral tooth always strong. Infraorbital and subhepatic teeth well developed. Antennules folding obliquely at about 45° from the horizontal. Second antennal segment elongate, length to width ratio of second antennal segment 4.2-5.7. Chelipeds granular to rugose; carpus usually with spine or distinct tubercle on inner angle; chelae elongated, length ca. 4 times length of fingers, height 4-5 times height of fingers; fingers not carinate, pollex not distinctly bent downwards. Dactylus of first ambulatory leg elongated, other segments subcylindrical, not cristate.

**Remarks.** - Stimpson (1858, 1907) synonymised *Harrovia* under *Ceratocarcinus*, noting that there were no clear characters separating them. This was followed by many subsequent workers like Balss (1922) and Sakai (1938) who followed Stimpson (1858, 1907). Serène et al. (1958) recognised both genera, distinguishing them almost entirely by the length of the inner supraorbital teeth, which in *Ceratocarcinus*, are very long, while in *Harrovia*, they are relatively short. Their decision was followed by workers such as Sakai (1976), Dai et al. (1986) and Dai & Yang (1991). Stevcic et al. (1988) recognised six species in the genus, viz. *C. dilatatus* A. Milne Edwards, 1872, *C. intermedius* Zehntner, 1894, *C. longimanus* White, 1847, *C. speciosus* Dana, 1851, *C. spinosus* Miers, 1879, and *C. trilobatus* Sakai, 1938.

The length of the inner supraorbital teeth, frontal lobes, as well as the shape of the carapace and structure of the anterolateral teeth, however, while sometimes useful in separating species, do not reliably distinguish the two genera. In fact, the carapace and rostral features of some species (e.g. *H. cognata*, new species, and *H. ngi*) are intermediate.

Serène et al. (1958) discussed the possible value of the length of the basal and second antennal segments in separating *Harrovia* and *Ceratocarcinus*, but did not use this character eventually. In *Harrovia*, the second antennal segment is always short (length to width ratio of second antennal segment 2.0-3.4, see Table 1) whereas in almost all *Ceratocarcinus* species, the second antennal segment is distinctly elongate and proportionately longer (length to width ratio of second antennal segment 4.2-5.7). Serène et al. (1958) commented, that while *C. spinosus* Miers, 1879, has a short second antennal segment (like *Harrovia*), its long inner supraorbital teeth and carapace features were clearly those of *Ceratocarcinus*. Serène et al. (1958) also felt that *Harrovia purpurea* Gordon, 1934, was clearly a species of *Harrovia* with an unusually short second antennal segment. This apparent inconsistency made Serène et al. (1958) decide against using this character.

The excellent series of specimens of *Ceratocarcinus* and *Harrovia* species examined in this study, however, show that the relative length of the second antennal segments is a reliable generic character that can be used to distinguish the two genera. With the present transfer of *Ceratocarcinus spinosus* and *Harrovia purpurea* to their own respective genera, the range of the length of second antennal segment does not overlap for all adult specimens of

Table 1. Ratio of length over breadth of second antennal segment of species of *Ceratocarcinus* White, 1847, *Harrovia* Adams & White, 1849, *Permanotus*, new genus, *Tauropus*, new genus, and *Tiaramedon*, new genus.

Species	Adults		Juveniles
	Range (n = sample size)	Mean	Range (n = sample size)
<i>Ceratocarcinus longimanus</i>	4.5-5.7 (n = 10)	4.9	3.5, 4.1 (n = 2)
<i>Ceratocarcinus frontodentata</i>	4.2-4.6 (n = 3)	4.3	—
<i>Ceratocarcinus trilobatus</i>	4.4-4.7 (n = 3)	4.6	3.4 (n = 1)
<i>Harrovia albolineata</i>	2.4-3.2 (n = 10)	3.0	2.2, 2.7 (n = 2)
<i>Harrovia cognata</i>	2.2-3.4 (n = 10)	2.6	2.3 (n = 1)
<i>Harrovia elegans</i>	2.3-3.1 (n = 10)	2.4	2.1 (n = 1)
<i>Harrovia japonica</i>	2.3-3.1 (n = 10)	2.6	2.0, 3.0 (n = 2)
<i>Harrovia longipes</i>	2.3-3.0 (n = 20)	2.7	1.9-2.6 (n = 5)
<i>Harrovia ngi</i>	2.0 (n = 1)	2.0	—
<i>Harrovia tuberculata</i>	2.7 (n = 1)	2.7	—
<i>Permanotus purpureus</i>	1.4-2.0 (n = 10)	1.7	1.9 (n = 1)
<i>Tauropus egeriae</i>	1.4 (n = 1)	1.4	—
<i>Tiaramedon spinosum</i>	1.3-2.0 (n = 10)	1.5	1.5 (n = 1)

*Ceratocarcinus* s. str. and *Harrovia* s. str. examined (Table 1). *Harrovia frontodentata* Shen, Dai & Chen, 1982, is not a *Harrovia* species as presently defined, and should be referred to as *Ceratocarcinus* instead (see below). Juveniles of *Ceratocarcinus* and *Harrovia* species do have slightly proportionately shorter second antennal segments although this is not always the case (Table 1). The character is certainly reliable for adults.

*Ceratocarcinus spinosus*, with a length to width ratio of the second antennal segment at 1.3-2.0 and its many other peculiar features, should not be included in either *Ceratocarcinus* or *Harrovia*. It is here transferred to a new genus, *Tiaramedon* (see Remarks for *Tiaramedon*). *Harrovia purpurea*, with its folded frontal margin and inner supraorbital teeth, fused anterolateral lobes, almost straight G1 and short second antennal segment (length to width ratio 1.4-2.0) is also transferred to a new genus, *Permanotus* (see Remarks for *Permanotus*).

Using the character of the second antennal segment, some species, namely *H. ngi* Chen & Xu, 1992, and *H. cognata*, new species, although having carapace shapes similar to those of *Ceratocarcinus* species, are now placed in *Harrovia*. Similarly, we refer *Harrovia frontodentata* to *Ceratocarcinus*. This species has a carapace which resembles those of typical *Harrovia* species but the structure of its antennal segment argues for its inclusion in *Ceratocarcinus* instead. The present revision restricts *Ceratocarcinus* to only three species, *C. longimanus* White, 1847, *C. frontodentata* (Shen, Dai & Chen, 1982), and *C. trilobatus* Sakai, 1938. *Ceratocarcinus dilatatus*, *C. intermedius* and *C. speciosus* have been shown to be junior synonyms of *C. longimanus* (see Castro et al., 1995).

#### KEY TO THE SPECIES OF *CERATOCARCINUS*

1. Inner supraorbital teeth broader than long; anterolateral lobes not fused or callositised; no large tubercles on protogastric, metagastric, branchial and cardiac regions of carapace .....  
..... *C. frontodentata* (Shen, Dai & Chen, 1982), new combination

- Inner supraorbital teeth as long as broad or longer than broad; anterolateral lobes might be fused, tuberculated or callose; very large tubercles on protogastric, metagastric, branchial and cardiac regions of carapace ..... 2
- 2. Inner supraorbital teeth almost as long as broad; very large tubercles on protogastric, metagastric, branchial and cardiac regions of carapace; anterolateral lobe 1-3 truncate, lobe 1 free, 2 and 3 always fused and lightly callositised, lower part of lobe 3 laterally directed, lobe 4 very prominent, laterally directed, lower part expanded, abrupt, plate-like; distinct angle between anterolateral and posterolateral margins; all surfaces heavily tuberculated.....  
..... *C. trilobatus* (Sakai, 1938)
- Inner supraorbital teeth longer than broad; large tubercles on protogastric, metagastric, branchial and cardiac regions of carapace; anterolateral lobe 1-3 truncate, seldom fused with callosities, lower part of lobe three not often expanded to direct laterally except in very large specimens, lobe 4 very prominent, laterally directed; angle between anterolateral and posterolateral margins not as distinct; surfaces not as strongly tuberculated..... *C. longimanus* White, 1847

***Ceratocarcinus longimanus* White, 1847**

(Figs. 1, 2)

*Ceratocarcinus longimanus* White, 1847a: 125 [nomen nudum] (type locality 'Eastern Seas (Balambangan)' = Borneo: Sabah, Malaysia).

*Ceratocarcinus longimanus* White, 1847b: 57 (type locality 'northcoast of Borneo (Balambangan)' = Borneo: Sabah, Malaysia); White, 1847c: 62 (text identical to White, 1847b); Adams & White, 1848-1849: 34, pl. 6: Figs. 6, 6a [colour plate] (Sabah, Malaysia); Miers, 1886: 105 (Aru Islands, Indonesia); Alcock, 1895: 288 (Straits of Malacca); Balss, 1922: 136 (list only); Flipse, 1930: 76, 77, 80, 90 (list only); Roxas, 1930: 18 (Mindoro island, Philippines); Gordon, 1934: 69, Fig. 33a (Borneo, holotype re-examined; Banda Islands, Moluccas = Maluku Islands, Indonesia); Estampador, 1937: 559 (list only); Serène et al., 1958: 175 [in key], 184, 232 [as *G. longimanus*], 233, Figs. 4A, 4B, 6, pl. 4: Fig. B (on unidentified comatulid crinoid; Nhatrang, Vietnam); Estampador, 1959: 121 (list only); Serène & Romimohtarto, 1963: 5, Figs. 1B, 3 [male first pleopod]; pl. 1: Fig. C (Nusalenga, Moluccas = Maluku Islands, Indonesia); Serène, 1968: 63 (list only); Monod & Serène, 1976: 27 (on unidentified comatulid crinoids; list only); Serène et al., 1976: 16 (Moluccas = Maluku Islands, Indonesia); Yang, 1979: 11 (Mindoro island, Philippines); Stevcic et al. 1988: 1308 (on unidentified comatulid crinoid; Townsville, Queensland, Australia); Takeda, 1989: 150, Fig. 9B (on unidentified comatulid crinoid; Oshima Passage, Amami Islands, Nansei (Ryukyuu) islands, Japan); Fabricius & Dale, 1993: 43, 45 (on *Comanthus gisleni* Rowe et al., *C. parvicirrus* (Müller) & *Comatula purpurea* (Müller)), central Great Barrier Reef, Queensland, Australia); Castro et al., 1995: 239, Fig. 1 (India, Malaysia, Indonesia, Papua New Guinea, Australia, New Caledonia, Solomon Islands, Fiji, Palau, Philippines, Japan; on comatulids, zygometrids and himerometrids).

*Ceratocarcinus speciosus* Dana, 1851: 274 (type locality 'Archipelago Vitiensis' = Viti Levu island, Fiji; on unidentified comatulid crinoid); Dana, 1852: 139, pl. 6: Fig. 8 (no new record); Miers, 1886: 105 (list only); Balss, 1922: 136 (list only); Flipse, 1930: 80, 90 (list only); Balss, 1938: 25 (Viti Levu island, Fiji); Serène et al., 1958: 175 [in key], 234, Fig. 4F (list only); Serène, 1968: 63 (list only); Stevcic et al., 1988: 1308 (list only).

*Ceratocarcinus dilatatus* A. Milne Edwards, 1872: 256, pl. 14: Figs. 2, 2a, 2b (type locality New Caledonia); Miers, 1886: 105 (list only); Walker, 1887: 109 (Singapore); De Man, 1887-1888: 230, 585 (Ambon, Moluccas = Maluku Islands, Indonesia); McCulloch, 1913: 338 (Murray Island, Torres Strait, Queensland, Australia); Rathbun, 1918: 29 (Double Island Point, Queensland, Australia); Hale, 1927: 143, Fig. 146 (Great Australian Bight, South Australia); Flipse, 1930: 71, 76, 77, 80, 90, Figs. 5, 6 (Postillon Island = Sabalana Island, Indonesia); Balss, 1957: Fig. 1189 (list only); Serène et al., 1958: 175 [in key], 233, Fig. 4C (list only); Griffin & Yaldwyn, 1968: 171 (list only); McNeill, 1968: 9, 49 (off Lookout Point, Queensland, Australia); Serène, 1968: 63 (list only); Stevcic et al., 1988: 1308 (on *Zygometa* sp., Roebuck Bay, Western Australia).

*Ceratocarcinus intermedius* Zehntner, 1894: 141, pl. 7: Figs. 1, 1a, 1b (type locality Ambon, Moluccas = Maluku Islands, Indonesia); Balss, 1922: 136 (list only); Flipse, 1930: 76, 77, 80, 90 (list only); Serène et al., 1958: 175 [in key], 233, Fig. 4D (list only); Serène, 1968: 63 (list only); Stevcic et al., 1988: 1308 (list only).

*Ceratocarcinus* sp. - Mather & Bennet, 1984: 66 (Heron Island, Queensland, Australia).

**Material examined.** - **Indonesia:** 1 female (20.0 by 14.3 mm) (MGE), Amboina, coll. Voyage Bedot Picket (holotype of *C. intermedius* Zehntner, 1894 ). **Vanuatu:** 1 female (MNHN B25594), Station CP1131, 15°38.41'S, 167°03.52'E, coll. MUSORSTOM 8, N/O 'Alis', 11 Oct. 1994. - 1 male (MNHN B25595), Station DW976, 19°25.22'S, 169°26.73'E, coll. MUSORSTOM 8, N/O 'Alis', 22 Sep. 1994. **Philippines:** 1 female (USNM 50879), station 5142, Jolo Island, vicinity of Jolo, 21 fms, coll. ALBATROSS Philippine Expedition, 15 Feb. 1908. - 1 male, 1 female (USNM 50880), Marengas Island, vicinity of Jolo, coll. ALBATROSS Philippine Expedition, 10 Feb. 1908. **Palau (= Belau):** 1 male, 1 female (USNM 134387), from green and yellow crinoid, Caroline Islands, coll. F. M. Bayer, 22 Oct. 1955. **Unknown locality:** 1 male (ZRC 1989.2050), from crinoid in aquarium at Singapore aquarium, possibly from Philippines, coll. P. K. L. Ng, May 1986. (For types of *C. longimanus* White, 1847, *C. speciosus* Dana, 1851, *C. dilatatus* A. Milne Edwards, 1872, and additional material from India, Singapore, Malaysia, Indonesia, Papua New Guinea, Australia, New Caledonia, Solomon Islands, Fiji, Palau, Philippines and Japan, see Castro et al., 1995).

**Description.** - Carapace quadrate, distinctly broader than long in all except juveniles; frontal margin short, distinctly deflexed downwards; inner supraorbital teeth well developed, longer than broad, produced well beyond edge of frontal margin; regions well defined, protogastric, metagastric, branchial and cardiac regions with well developed tubercles of varying degrees, more prominent in adults, tubercles covered with callosities in large individuals; surfaces of carapace relatively smooth, covered with scattered small granules coarser in larger adults; dorsal surface of carapace usually covered with very thin pubescence, with longer setae on protogastric tubercles. Anterolateral and posterolateral margins clearly demarcated; anterolateral margin lamelliform, with four lobes (including external orbital angle), first three lobes (especially the third) truncate, usually well defined, separated by narrow fissures, tightly adjoining each other, sometimes appearing fused, lower part of third lobe might be laterally directed, fourth lobe especially well developed, long, sharp, laterally directed. Antennules folding obliquely, ca. 45° from horizontal; antennular fossae oblique. Antenna free, does not fill orbital hiatus, reaching into orbit; antennal basal segment rectangular; length to width ratio of second antennal segment 4.5-5.7. Eyes well developed, filling orbit; cornea distinct, pigmented; infraorbital teeth very large. Anterior surface of epistome depressed; posterior margin appears entire because of 2 fused truncate median lobes. Pterygostomial, subhepatic, suborbital regions mildly granulated. Third maxilliped quadrate; ischium rectangular, median oblique sulcus shallow; merus squarish; exopod just reaches antero-external edge of merus. Sutures between thoracic sternite segments 1 and 2 indistinct, 2 and 3 distinct, shallow; between 3 and 4 interrupted medially; lateral clefts small. Abdomen 7 segmented, sutures for all segments visible. Chelipeds elongate, cylindrical; surfaces granular; carpus with sharp spine or low, rounded tubercle on inner distal angle; chelae elongated, length ca. 4 times length of fingers, height ca. 4-5 times of height of fingers; fingers not carinate, pollex does not bend downwards. Dactylus of first ambulatory leg elongated, other segments subcylindrical, not cristate; anterior margin of ambulatory meri sometimes tuberculated. G1 long, slender, distal part lined with short spines, tip bends at approximately 90°. G2 relatively short, distal segment short.

**Sexual dimorphism.** - Males have disproportionately larger and stouter chelipeds when compared to females.

**Remarks.** - After examining a large series of specimens, Castro et al. (1995) showed that *C. dilatatus* A. Milne Edwards, 1872, *C. intermedius* Zehntner, 1894, and *C. speciosus* Dana, 1851, are junior synonyms of *C. longimanus* White, 1847. Castro et al. (1995) have already discussed in detail the synonymy and variation of the species. Castro et al. (1995) could not

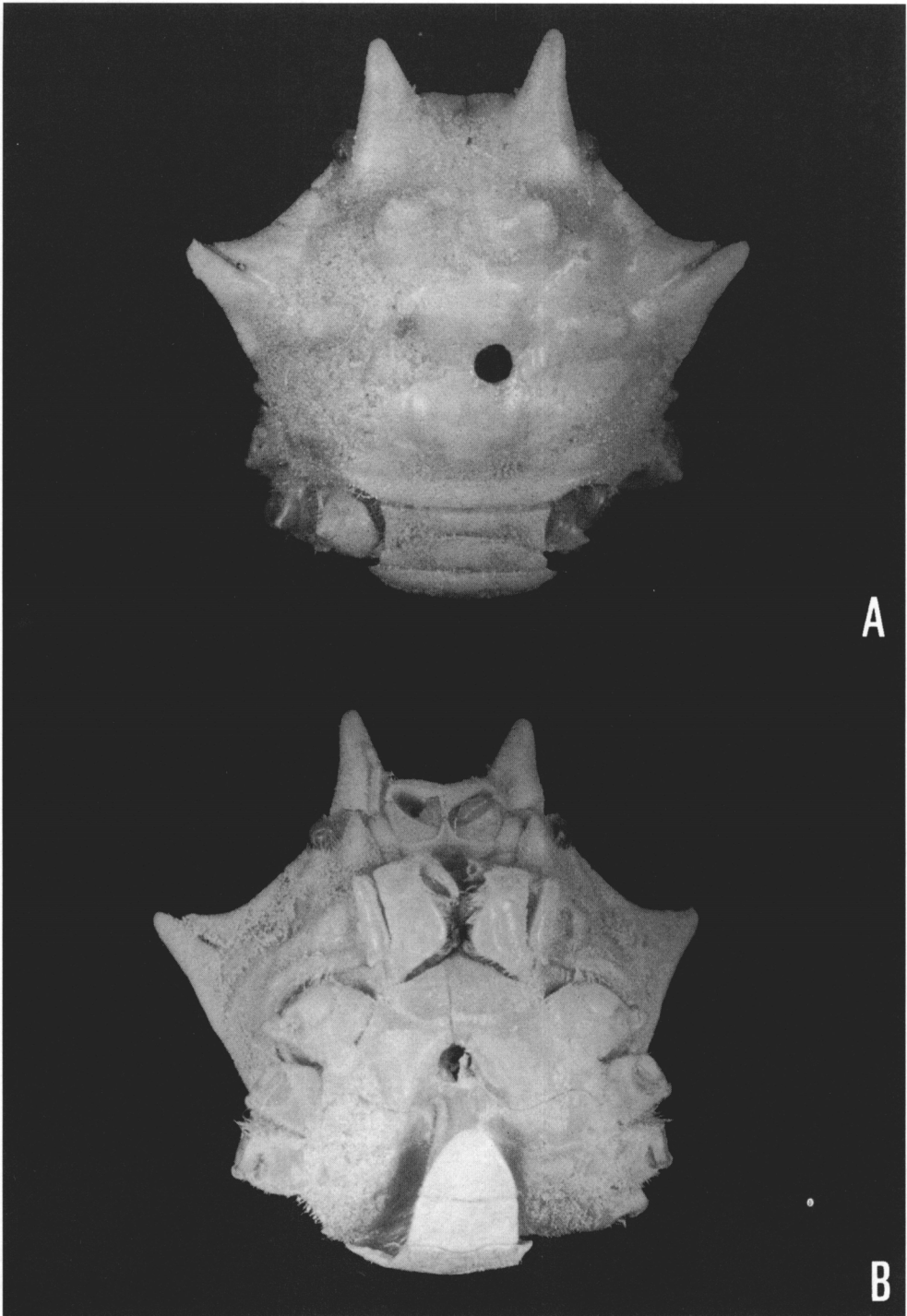


Fig. 1. *Ceratocarcinus longimanus* White, 1847. Holotype male, 8.0 by 6.6 mm (BMNH 1939.9.20.7). A, dorsal view; B, ventral view (circle indicate ex-position of pin).

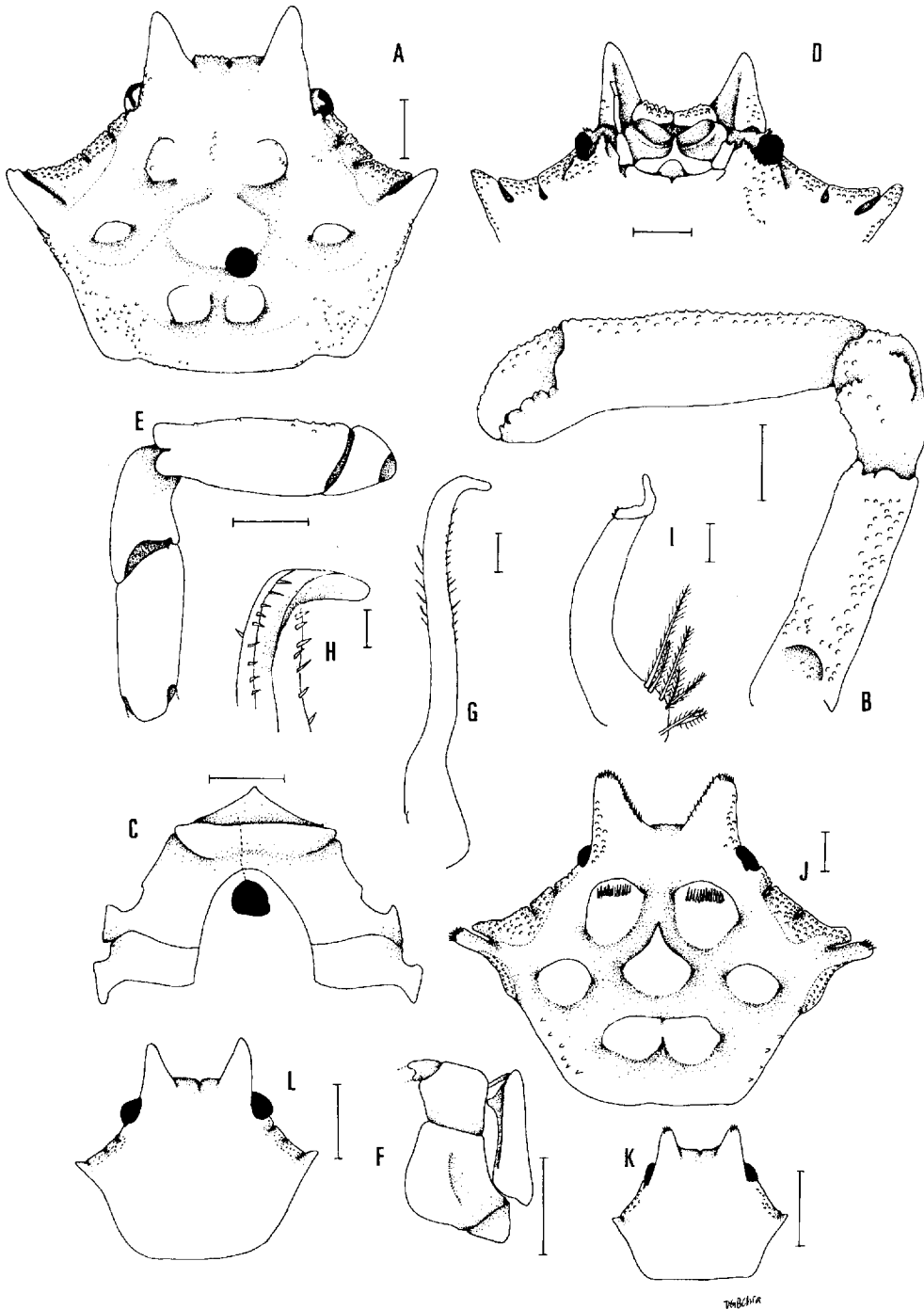


Fig. 2. *Ceratocarcinus longimanus* White, 1847. A-I, holotype male, 8.0 by 6.6 mm (BMNH 1939.9.20.7); J, female, 7.8 by 12.0 mm (MNHN B24738a); K, juvenile male, 2.0 by 2.5 mm, (MNHN B24738d); L, juvenile male, 3.4 by 3.6 mm (NRS 14396). A, dorsal view of carapace (solid circle indicates ex-position of pin); B, postero-dorsal view of right cheliped; C, thoracic sternum (solid circle indicates ex-position of pin; dotted line indicates a crack); D, face of carapace; E, fourth left ambulatory leg; F, left third maxilliped; G, left G1; H, distal tip of left G1; I, left G2. Scales: A-G, J-L = 1.0 mm; H-I = 0.1 mm (fide Castro et al., 1995)



examine the type of *C. intermedius* Zehntner, 1894, but argued that from the description and figures, it was clearly a synonym of *C. longimanus*. We have since managed to obtain the type on loan. The holotype is a large female 20.0 by 14.3 mm in excellent condition and agrees very well with the descriptions of *C. longimanus* by Castro et al. (1995). Most of the dorsal surface of the carapace of this specimen is distinctly pubescent except for the more glabrous anterolateral and highest parts of the regions. The swollen gastric regions have tufts of longer, coarser setae.

**Larvae.** - The first zoeae have been obtained by P. Castro (pers. comm.) and will be described at a later date.

**Host records.** - The ecology of this species has been reviewed by Castro et al. (1995).

**Distribution.** - *Ceratocarcinus longimanus* has been recorded from the Ryukyu Islands, southern Japan to as far west as the Nicobar Islands in the Andaman Sea and as far east as Fiji. Two specimens presumably from South Australia (Hale, 1927) represent the only record (indeed of any eumedonid) collected from outside the Indo-West Pacific region.

***Ceratocarcinus frontodentata* (Shen, Dai & Chen, 1982), new combination**

(Figs. 3, 4)

*Harrovia frontodentata* Shen, Dai & Chen, 1982: 146 [Chinese text], 149 [English text], Figs. 5-12 5-14, pl. 3: Fig. 13 [type locality Haimen, Guangdong Province, China]; Dai et al., 1986: 165, Fig. 97, pl. 22: Fig. 5 [list only]; Stevcic et al., 1988: 1312; Dai & Yang, 1991: 183, Fig. 97, pl. 22: Fig. 5 [list only].

**Material examined.** - Holotype: male (6.9 by 8.8 mm) (IOCAS C901), Haimen, Guangdong Province, coll. 7 May 1957.

Paratype: Male (6.0 by 7.1 mm) (IOCAS C902), same data as holotype.

Others: **China:** 1 female (7.7 by 9.4 mm) (BMNH), Foochow (= Fuzhou), coll. Ms. Clark, presented by Dr. Cheng, Fujian University.

**Diagnosis.** - Carapace quadrate, broader than long; rostrum short, slightly deflexed downwards; inner supraorbital teeth developed, broader than long, produced slightly beyond edge of frontal margin; regions well defined; surfaces of carapace relatively smooth, covered with scattered small granules; dorsal surface of carapace usually covered with very thin pubescence; protogastric, metagastric, branchial and cardiac regions mildly raised. Anterolateral and posterolateral margins clearly demarcated; anterolateral margin lamelliform, with four lobes (including external orbital angle), first three lobes truncate, separated by gaps, mildly tuberculated, fourth lobe conical; posterolateral margin lined with many minute spines. Pterygostomial region granulated, subhepatic and suborbital regions not as granulated. Chelipeds elongate; surfaces very granular; carpus without tubercle on inner distal angle; fingers not carinate, pollex does not bend downwards. G1 slender, long.

**Sexual dimorphism.** - Not known.

**Remarks.** - This is a poorly known species, known only from southern China. First described by Shen et al. (1982) on the basis of two males as a *Harrovia*, it is transferred to *Ceratocarcinus* in the present study on the basis of its long second antennal segment (Table

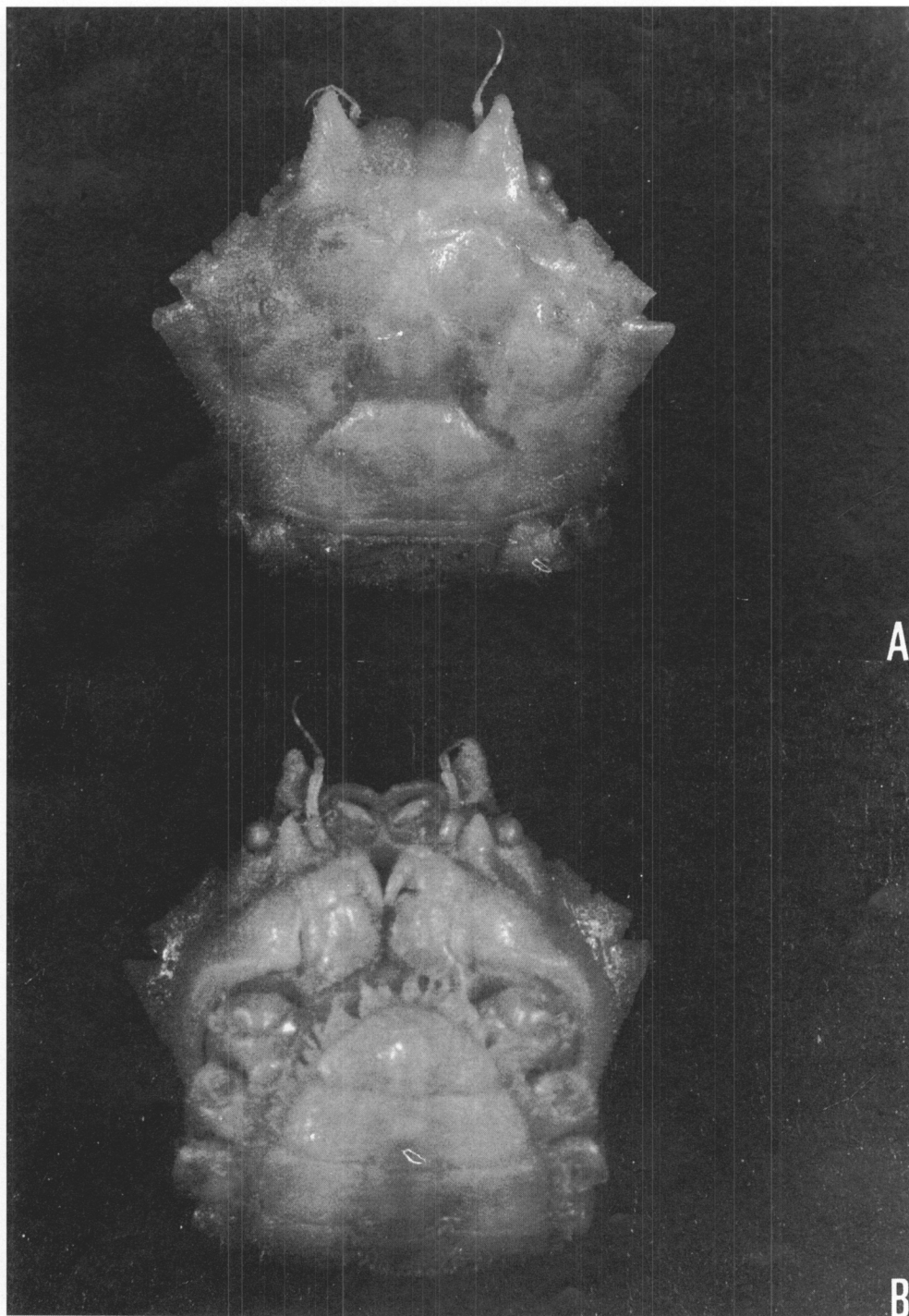


Fig. 3. *Ceratocarcinus frontodentata* (Shen, Dai & Chen, 1982), new combination. Female, 7.7 by 9.4 mm (BMNH): A, dorsal view; B, ventral view.

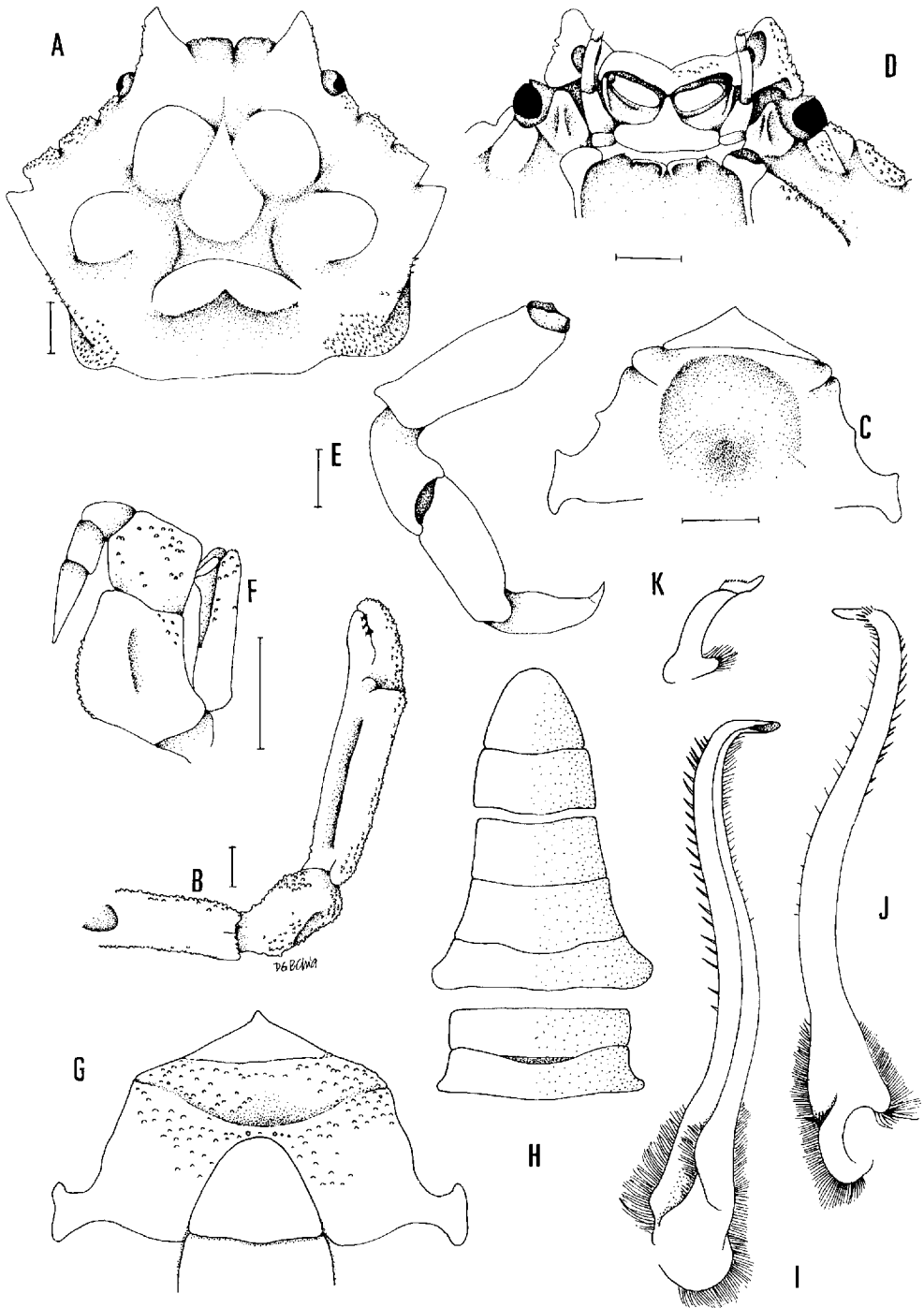


Fig. 4. *Ceratocarcinus frontodentata* (Shen, Dai & Chen, 1982), new combination. A-F, female, 7.7 by 9.4 mm (BMNH); G-J, holotype male, 6.9 by 8.8 mm (IOCAS C901): A, dorsal view of carapace; B, postero-dorsal view of right cheliped; C, thoracic sternum; D, face of carapace; E, only ambulatory leg (number cannot be determined); F, left third maxilliped; G, anterior thoracic sternites; H, abdomen; I, J, left G1. Scales = 1.0 mm.

1). The authorship for the species has been cited as Chen & Dai, in Shen, Dai & Chen, 1982, by some workers but the publication (Shen et al., 1982) was in actual fact a joint publication between Shen, Dai and Chen. The correct authorship for the species should thus be Shen, Dai & Chen (see Ng, 1994).

Although *C. frontodentata* has a relatively long second antennal segment, the carapace closely resembles those of *Harrovia* species with regards to the carapace proportions (almost as broad as long), broader than long inner supraorbital teeth and a less ornamented carapace.

The two type specimens agree with each other in all major aspects. The BMNH specimen is relatively soft and seems to have moulted just before it was collected. Therefore, some regions of the carapace which are not yet fully inflated (e.g. the left four anterolateral lobe and the sternum) which may be due to this. However, it agrees well with the types in almost all aspects.

**Distribution.** - Southern China only. Two species of *Ceratocarcinus* have been found so far in the southern waters of China, i.e. *C. trilobatus* and *C. frontodentata*.

### *Ceratocarcinus trilobatus* (Sakai, 1938)

(Figs. 5, 6)

*Harrovia trilobata* Sakai, 1938b: 351, 360, text-Fig. 55 [type locality Simoda (= Shimoda), Izu Peninsula, Honshu island, Japan]; Sakai, 1940: 56 [list only]; Sakai, 1956: 26 [appendix list; list only]; 1957: 698, Fig. 2018 [list only].

*Ceratocarcinus trilobata* - Serène et al., 1958: 172, 174, 175 [in key], 234; Sakai, 1965: 101, pl. 46: Fig. 1 [English text], 42 [Japanese text] [Honshu island, Japan].

*Ceratocarcinus trilobatus* - Serène, 1968: 63 [list only]; Nishimura & Suzuki, 1971: 112, pl. 39: Fig. 4 [list only]; Takeda, 1975: 130 [colour photograph, list only]; Sakai, 1976: 300 [in key], 301, text- Fig. 169 [English text], 181, 182 [Japanese text]; pl. 100: Fig. 2 [Honshu island, Japan]; Takeda, 1982: 137, Fig. 405 [list only]; Miyake, 1983: 212 [list only]; Wu, 1983: 65 [name in Chinese]; Dai et al., 1986: 164, Fig. 96, pl. 22: Fig. 4 [Fujian Province, southern China]; Masuda et al., 1986: 141 [colour photograph; list only]; Nishimura & Ito, 1987: 137 [colour photograph; list only]; Stevcic et al., 1988: 1309 [list only]; ?Morton, 1989: 20, 118, pl. 2 [Hong Kong]; Dai & Yang, 1991: 182, Fig. 96, pl. 22: Fig. 4 [list only].

**Material examined.** - **Japan:** 1 male (10.2 by 13.4 mm) (USNM 50888), Hirado, Hizen, coll. Y. Hirare. - 1 young female (ZRC 1997.150), Kushimoto, 10 m, with *Comanthus* sp., coll. S. Nagai, Feb. 1988. - 1 female (SMF TS00062), Nagai, Hayama, Kanagawa, coll. T. Sakai. - 1 male (7.9 by 9.7 mm) (SMF ZMGTS00405), Izu, Ohshima, Habu Minata, coll. T. Sakai.

**Diagnosis.** - Carapace quadrate, distinctly broader than long; rostrum short, distinctly deflexed downwards; inner supraorbital teeth developed, as long as broad, produced beyond edge of frontal margin; regions well defined; surfaces of carapace relatively smooth, covered with scattered small granules; dorsal surface of carapace usually covered with very thin pubescence; protogastric, metagastric, branchial and cardiac regions with well-developed tubercles of varying degree. Anterolateral and posterolateral margins clearly demarcated; anterolateral margin lamelliform, with four lobes (including external orbital angle), first three lobes truncate, lobe one and two separated by a gap, second and third lobes appearing fused and more tightly adjoined, lower part of third lobe elongated and laterally directed, fourth lobe especially well developed, long, sharp, laterally directed, lower part expanded, abrupt, plate-like; posterolateral margin lined with numerous small spines. Pterygostomial, subhepatic, suborbital regions highly granulated. Chelipeds elongate; surfaces very granular, rugose;



Fig. 5. *Ceratocarcinus trilobatus* (Sakai, 1938). Male, 10.2 by 13.4 mm (USNM 50888). A, dorsal view; B, ventral view.

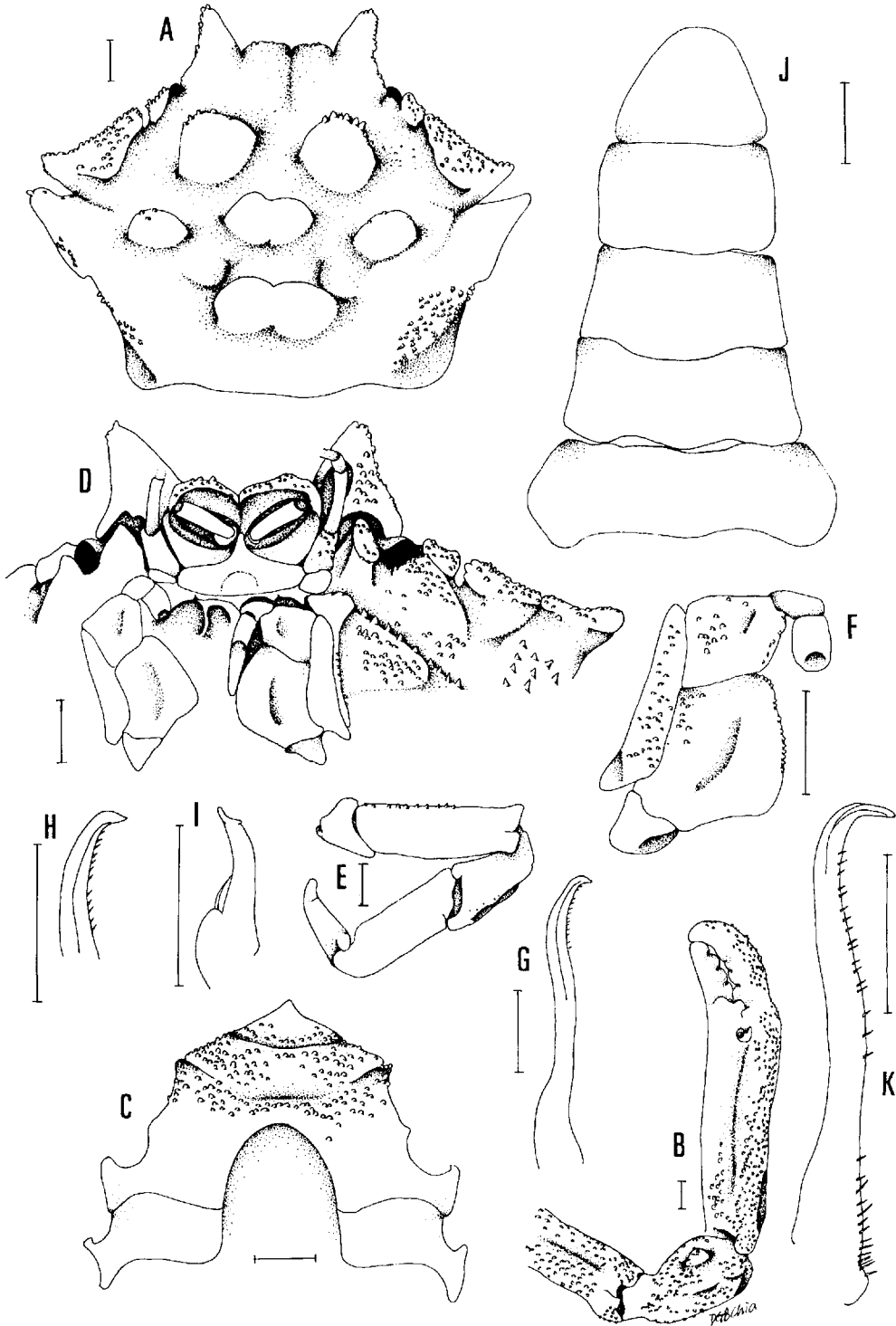


Fig. 6. *Ceratocarcinus trilobatus* (Sakai, 1938). A-J, Male, 10.2 by 13.4 mm (USNM 50888); K, male, 7.9 by 9.7 mm (SMF ZMGTS00405). A, dorsal view of carapace; B, postero-dorsal view of right cheliped; C, thoracic sternum; D, face of carapace; E, fourth right ambulatory leg; F, right third maxilliped; G, left G1; H, distal tip of left G1; I, left G2; J, abdomen (segment 3-7). Scales: A-G, I-K = 1.0 mm; H = 0.1 mm.

carpus with low, rounded tubercle on inner distal angle; fingers not carinate, pollex does not bend downwards. G1 long, slender.

**Sexual dimorphism.** - Males have disproportionately larger and stouter chelipeds as compared to females.

**Remarks.** - This is an uncommon species, known only from Japan and the southern coast of China. First described by Sakai (1938) in *Harrovia*, it was subsequently transferred to *Ceratocarcinus* by Serène et al. (1938: 172, 174-5) on the basis of its long inner supraorbital teeth and carapace proportions. Morton's (1989) figure is viewed with some doubt due to it being too schematic and having a seemingly highly inflated carapace. Thus its identity cannot be verified. With a record from Fujian, southern China (Dai et al., 1986), it is, however, not surprising that *C. trilobatus* can be found in Hong Kong as well.

The present study agrees with the prognosis of Serène et al. (1938: 172, 174-5) that this species belongs to *Ceratocarcinus* on the basis of its long second antennal segment and carapace proportions. *Ceratocarcinus trilobatus*, however, does closely resemble some larger specimens of *C. longimanus* (e.g. SMF ZMG685). However, in *C. trilobatus*, the inner supraorbital teeth are never as long as those of *C. longimanus*, its anterolateral lobes two and three are always fused even in juveniles and the lower part of lobe three is always laterally directed and reaching laterally as far as lobe four which is conical in shape.

**Host records.** - *Ceratocarcinus trilobatus* has always been collected from comasterids, although there is a questionable reference to its presence on *Dendronephthya*, a soft coral (Sakai, 1938; (Dai & Yang, 1991).

**Distribution.** - *Ceratocarcinus trilobatus* has only been recorded from Japan and southern China. There seems to be no overlap in the distribution of the *C. longimanus* and *C. trilobatus*. The former has never been reported from China and in Japan, being known only from the Ryukyu Islands (Takeda, 1989). As for *C. trilobatus*, it has been reported from China, southern Honshu and Kyushu (Japan) but not from the Ryukyus as yet.

### TIARAMEDON, NEW GENUS

*Ceratocarcinus* Miers, 1879a: 670; Miers, 1886: 104; Alcock, 1895: 286 [in key], 288; Flipse, 1930: 18, 20 [in key]; Gordon, 1934: 65, 67; Balss, 1957: 1631; Serène et al., 1958: 137, 168, 175, 231, 233; Sakai, 1976: 294 [in key], 300 [English text], 181 [Japanese text]; Takeda, 1979a: 69, 71; Wu, 1983: 65 [name in Chinese]; Stevcic et al., 1988: 1308, 1318; Dai et al., 1984: 162 [key only] [Chinese text]; Dai & Yang, 1991: 179 [English text] [not *Ceratocarcinus* White, 1847].

*Harrovia* - Stimpson, 1858: 221 (part); Stimpson, 1907: 32 (part); Balss, 1922: 136 (part); Sakai, 1938b: 329 [in key], 350 (part) [not *Harrovia* Adams & White, 1849].

**Type species.** - *Ceratocarcinus spinosus* Miers, 1879, by present designation. Gender of genus is masculine.

**Etymology.** - The name is derived from 'Eumedon', and alludes to the tiara-like appearance of the type species. Gender neuter.

**Diagnosis.** - Regions of carapace well defined, protogastric, metagastric, branchial and cardiac regions strongly produced into dorsally directed spines, length of spines varies, protogastric spines always longest. Frontal lobes triangular, very narrow, small, strongly deflexed, beak-

like from dorsal view, appearing fused at times with visible suture. Inner supraorbital teeth very well developed, produced well beyond frontal margin, almost 1.5 times longer than broad, obscuring most of frontal margin. Anterolateral and posterolateral margins clearly demarcated, anterolateral margin sublamelliform, entire, without trace of teeth or lobes; lateral carapace tooth strong, sharp and long. Antennules folding obliquely, ca. 45° from horizontal. Length to width ratio of second antennal segment 1.3-2.0. Chelipedal merus and basis-ischium unarmed; carpus with sharp spine on inner distal angle and distinct tooth on outer distal angle; distal dorsal margin of palm with distinct elongate tooth. Meri of all ambulatory legs with strong tooth on subdistal dorsal margin; merus of first ambulatory leg more slender than that of others, unarmed, not cristate; first ambulatory dactylus more elongate and slender, ca. 1.3 times that on other legs.

**Remarks.** - Serène et al. (1958), while noting that *C. spinosus* had an antenna very different from that of typical *Ceratocarcinus* species, commented that it was in all other respects, a species of *Ceratocarcinus*. In the long inner supraorbital teeth, well developed lateral tooth and ornamented carapace, *C. spinosus* indeed resembles *Ceratocarcinus*. But in the form of the antenna (with the very short second segment), extreme elongation of the protogastric teeth into long spines (vs. swollen tubercles, never spiniform in *Ceratocarcinus*), the triangular frontal lobes, shape of the male abdomen (proportionately broader) as well as the shorter, stouter and more sinuous G1, *C. spinosus* is clearly not congeneric with *C. longimanus*, the type species of *Ceratocarcinus*. A new genus, *Tiaramedon* has therefore been established for *C. spinosus* (Miers, 1879).

***Tiaramedon spinosum* (Miers, 1879), new combination**  
(Figs. 7, 8)

*Ceratocarcinus spinosus* Miers, 1879b: 2, 27, pl. 5: Fig. 11 [type locality 'Eastern Seas']; Balss, 1922: 136 [list only]; Balss, 1924: 2 [Red Sea]; Balss, 1929: 25 [list only]; Flipse, 1930: 72, 76, 77, 80, 90 [Paternoster = Sabalana Island, Flores Sea, Indonesia]; Gordon, 1934: 65, 66, Figs. 33b, b1 [holotype re-examined; Red Sea]; Sakai, 1938a: 54, Fig. 1 [Honshu island, Japan]; Balss, 1940: Fig. 42 [list only]; Sakai, 1953: 74 [Hachijo Island, Japan]; Sakai, 1956: 26 [appendix list], fig 68 [list only]; Serène et al., 1958: 175 [in key], 176, 234, Figs. 4E, 5, pl. 5 [Spratly Islands, South China Sea]; Guinot, 1966: 299, 312 [list only]; Suzuki & Kurata, 1967: 97, pl. 8: Fig. 4 [Oshima Island, Japan]; Serène, 1968: 63 [list only]; Fishelson, 1973: 467, Fig. 4b [Red Sea]; Fishelson, 1974: 188, Fig. 10 [specimens of Fishelson, 1973]; Sakai, 1976: 300 [in key], text-Fig. 168 [English text], 181 [Japanese text] [Honshu island, Japan]; Serène et al., 1976: 16 [Moluccas = Maluku Islands, Indonesia]; Monod & Serène, 1976: 27 [list only]; Hwang & Yu, 1980: 153, pl. 4: Fig. 3 [Taiwan]; Miyake, 1983: 56, 212, pl. 19: Fig. 6 [list only]; Wu, 1983: 65 [name in Chinese]; Stevcic et al., 1988: 1309 [list only].

**Material examined.** - Holotype: juvenile (3.6 by 4.0 mm) (BMNH 62.53), Australia sea, coll. H.M.S. Herald.

Others: **Red Sea:** 1 male (NMW 1820), Pola expedition, coll. Museum Vindobonensis. - 1 female (BMNH 1928.6.7.3), coll. Meinertzhagen. **Israel:** 2 juveniles (RMNH 26997), Eilat, Gulf of Akaba, coll. L. Fishelson, 20 Feb. 1966. - 1 male (RMNH 19938) (heavily damaged by fungus), Eilat, Gulf of Akaba, on *Lamprometra klunzingeri*, coll. L. Fishelson, 23 Mar. 1964. **Indian Ocean:** 1 male (AM P21801), Christmas Island, 10°30'S, 105°40'E, coll. Slack-Smith & Paterson, Sep. 1969. **East Malaysia:** 1 juvenile (ZRC 1997.202), Hanging Gardens, Sipadan, Sabah, on *Comanthus parvicirra*, coll. D. Lane, 25 May 1992. **Indonesia:** 1 juvenile male, 1 female (MNHN B24767), Siladen, Manado, Indonesia, 10-12 m, on crinoid, coll. P. Castro, 20 Sep. 1992. - 1 female (RMNH), lagoon, Bay of Sanggar, north of Sumbawa Island, Snellius II station 4.114, 8°19.2'S 118°14.4'E, scuba diving/snorkeling, side of barrier reef, 21/22 Sep. 1984. - 1 female (RMNH), NE Cape, Komodo Island, Snellius II station 4.096, 30 m, scuba diving/snorkeling, edge of narrow coastal reef, sloping down



to sandy bottom, 8°29'S 119°34.1'E, 19 Sep. 1984. **Papua New Guinea:** 1 male (ZRC 1997.203), Reef crest, Padoz Tinan Reef, Madang, 5°09.53'S, 145°48.88'E, on *Clarkcomanthus littoralis*, coll. P. Castro, 16 Dec. 1993. - 1 female (ZRC 1997.204), Reef crest, Padoz Tinan Reef, Madang, 5°09.53'S, 145°48.88'E, on *Comanthus suavia*, coll. P. Castro, 18 Dec. 1993. - 1 male (MNHN B24748), Wongad Island, Madang, 3-6 m, on *Clarkcomanthus littoralis*, coll. P. Castro, 16 Dec. 1993. **Australia:** 1 male (WAM 108-93), Sandy Island, East of Gun Island, Pelsart Gr., Abrolhos Islands, Western Australia, coll. L. Marsh, F. Wells & C. Bryce, 4 Apr. 1976. - 1 male (9.9 by 9.9 mm) (WAM 105-93), east of North Scott Reef, Western Australia, coll. L. Marsh, 14 Sep. 1984. - 1 male (8.0 by 8.6 mm) (WAM 98-93), west side of Clarke Reef, Rocky Shoals, Western Australia, on crinoid reef flat, coll. WAM Party, Jul. 1982. **New Caledonia:** 1 male (MNHN B25649), 23°24.86's, 168°05.72'E, SMIB8, DW186, 57 m, coll. MUSORSTOM, 31 Jan. 1993. **Niue:** 1 male (BPBM), site HNIUE-13, on crinoid. **Unknown locality:** 1 male, 1 female (USNM 359474), no other data.

**Description.** - Carapace squarish, slightly broader than long; regions well defined, protogastric, metagastric, branchial and cardiac regions strongly produced into dorsally directed spines, length of spines varies, protogastric spines always longest; surfaces of carapace smooth, densely covered with short, stiff setae in a systematic fashion. Frontal lobes, triangular, very short, narrow, strongly deflexed downwards, appears beak-like from dorsal view. Inner supraorbital teeth well developed, long, almost 1.5 times longer than broad, produced well beyond and obscuring most of frontal margin. Anterolateral and posterolateral margins clearly demarcated; anterolateral margin sublamelliform, entire, without trace of teeth or lobes; lateral carapace teeth strong, sharp. Antennules folding bilaterally, ca. 45° from horizontal, covered with setae; antennular fossae oblique. Surfaces of antenna covered with short stiff setae; antennal free, free, does not fill orbital hiatus, reaching into orbit; antennal basal segment rectangular; length to width ratio of second antennal segment 1.3-1.8. Eyes well developed, filling orbit; cornea distinct, pigmented; infraorbital tooth distinct, subhepatic tooth distinct. Anterior surface of epistome depressed; posterior margin appears entire because of 2 fused truncate median lobes. Pterygostomial, subhepatic, suborbital regions smooth with occasional scattered, minute granules beneath a dense layer of stiff short setae. Third maxilliped quadrate, surfaces covered with short, stiff setae; ischium rectangular, inner margin mildly granulated, median oblique sulcus shallow; merus squarish; exopod just reaches antero-external edge of merus. Thoracic sternum covered with setae; sutures between sternite segments 1 and 2, 2 and 3 distinct, shallow; between 3 and 4 interrupted medially; lateral clefts indistinct. Abdomen 7 segmented, sutures for all segments visible, all surfaces covered with setae. Chelipeds smooth, densely covered with short, stiff setae; merus and basis-ischium unarmed; carpus with sharp spine on inner distal angle and distinct tooth on outer distal angle; chela stout, length 3 times length of fingers, height ca. 2-3 times height of fingers, distal dorsal margin with distinct elongate tooth; fingers not carinate, pollex not bent downwards. Ambulatory legs unarmed, densely covered with short, stiff setae; meri of all ambulatory legs with strong tooth on subdistal dorsal margin; merus of first ambulatory leg more slender than that of others, unarmed, not cristate; first ambulatory dactylus more elongate and more slender, ca. 1.3 times that on other legs. G1 long, sinuous, tip bends at approximately 90°. G2 relatively short, distal segment short.

**Remarks.** - The label on the type specimen (BMNH 62.53) states that the collection site was in 'Australian seas', not 'Eastern seas' as originally reported by Miers (1879). Although the precise type locality is uncertain, *T. spinosum*, being a widely distributed species, is indeed present in Australia as well (Western Australia, present record). The distribution of this species also reaches the vicinity of northeastern Australia, i.e. Papua New Guinea and New Caledonia. Although the holotype is a juvenile and its exact type locality is uncertain, from the current range of specimens examined there is little doubt that all the present specimens belong to this species, with relatively limited variation. It is a very distinctive species