

REVISION OF THE GENUS *ZEBRIDA* WHITE, 1847 (CRUSTACEA:
DECAPODA: BRACHYURA: EUMEDONIDAE)

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ABSTRACT

The eumedonid genus *Zebrida* White, 1847, members of which are obligate symbionts of sea urchins, is revised. Three species are now recognized: *Z. adamsii* White, 1847 (type species), *Z. longispina* Haswell, 1880 and *Z. brevicarinata* new species.

Members of five genera of eumedonid crabs (*Echinoecus*, *Eumedonus*, *Gonatonotus*, *Zebridonus* and *Zebrida*) are known obligate symbionts on sea urchins. Of these, *Zebrida* White, 1847, has the most unusual appearance, with its long spines and distinctive coloration. The general consensus is that the genus is monotypic, being represented by only one species, *Z. adamsii* White, 1847, which has a wide Indo-West Pacific distribution (Suzuki and Takeda, 1974). The present study shows that three species of *Zebrida* can in fact be recognized: *Z. adamsii*; *Z. longispina* Haswell, 1880 and *Z. brevicarinata* new species.

METHODS AND MATERIALS

Measurements provided are of the carapace length and width. The length of the carapace (cl) was measured from the tip of the rostrum to the posterior margin of the carapace. The carapace width (cb) was taken across the widest part. The inner supraorbital tooth is used in lieu of the lateral rostral lobe of some workers. The abbreviations G1 and G2 are used for the male first and second pleopods, respectively.

Specimens examined are deposited in the following institutions: Australian Museum, Sydney (AM); Muséum National d'Histoire Naturelle, Paris (MNHN); Natural History Museum [ex British Museum (Natural History)], London (BMNH); National Museum of Victoria, Abbotsford, Australia (NMV); Northern Territory Museum of Arts and Sciences, Darwin (NTM); Queensland Museum, Brisbane (QM); Institut Royale des Sciences Naturelles de Belgique, Brussels (IRSNB); Nationaal Natuurhistorisches Museum (formerly Rijksmuseum van Natuurlijke Histoire), Leiden (RMNH); Forschungs-Institut Senckenberg, Frankfurt-am-Main (SMF); U.S. National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM); Western Australian Museum, Perth (WAM); Zoölogisch Museum, University of Amsterdam (ZMA); National Science Museum, Tokyo (NSMT); Chiba Museum of Natural History, Chiba (CBM); Zoological Reference Collection of the Raffles Museum, Department of Biological Sciences, National University of Singapore (ZRC).

TAXONOMY

Genus *Zebrida* White, 1847

Zebrida White, 1847a: 124 (nomen nudum).

Zebrida White, 1847b: 120.

Type species.—*Zebrida adamsii* White, 1847, by monotypy. Gender of genus feminine.

Diagnosis.—Carapace squarish; rostrum lamelliform, bilobed; without inner supraorbital teeth; dorsal surfaces relatively flat, smooth, glabrous. Anterolateral margin without

any teeth or lobes; lateral tooth lamelliform. Second antennal segment relatively long, length ca 2.2 times breadth. Surfaces of chelipeds smooth; dorsal margin with well developed crest; merus with 2 teeth, one distal in position along the inner margin and one on outer proximal margin; dorsal surface of carpus with 3 well developed lamelliform to sublamelliform spines; fingers of chela not crested. Anterior margins of merus, carpus and propodus of ambulatory legs cristate; propodus subfoliaceous, last dactylus and propodus forming subchelate structure.

Remarks.—The genus *Zebrida* is generally regarded as monotypic (Suzuki and Takeda, 1974), although Serène et al. (1958) and Serène (1968) recognized two species. Three species are recognized in the present study, viz. *Zebrida adamsii* White, 1847, *Z. longispina* Haswell, 1880, and *Z. brevicarinata* new species. As far as is known, all species are obligate symbionts on sea urchins.

KEY TO SPECIES OF *ZEBRIDA*

- 1a. (In adults) absence of a lamelliform expansion on the anterior margin of eyestalk; rostral tip rounded and rostral length short; lateral carapace tooth short and flat; absence of spines on the anterior margins of carpus and merus of first to third ambulatory legs and posterior margin of merus of last ambulatory leg *Z. brevicarinata* new species
- 1b. (In adults) presence of a lamelliform expansion on the anterior margin of eyestalk; rostral tip sharp and rostral length long; lateral carapace tooth long and directed obliquely or upwards; presence of spines on the anterior margins of carpus and merus of first to third ambulatory legs; posterior margins of merus of all ambulatory legs expanded medially into cristiform or dentate structure 2
- 2a. Lamelliform expansion on the anterior margin of eyestalk small; tip of rostrum sharp and medium in length; lateral carapace tooth medium in length and directed obliquely; spines on the anterior margins of carpus and merus of first to fourth ambulatory legs medium in length; absence of spine on anterior margin of propodus of ambulatory legs *Z. adamsii* White, 1847
- 2b. Lamelliform expansion on the anterior margin of eyestalk large; tip of rostrum very sharp and long; lateral carapace tooth very long and directed upwards; spines on the anterior margins of carpus and merus of first to fourth ambulatory legs very long; presence of spine on the anterior margin of propodus of ambulatory legs *Z. longispina* Haswell, 1880

Zebrida adamsii White, 1847

(Figs. 1–3)

Zebrida Adamsii White, 1847a: 124 (nomen nudum) (Borneo).

Zebrida adamsii White, 1847b: 120 (Borneo); White, 1848: 223 (text identical to White, 1847b); Adams and White, 1848–1849: 24, pl. 7: fig. 1a–c (Borneo, Sulu Sea); Henderson, 1893: 335, 351 (India); Alcock, 1895: 287 (part) (India); Rathbun, 1910: 321 (Gulf of Thailand); Ozaki, 1964: 43 (Japan); McNeill, 1968: 9, 47 (part) (Australia); Doki, 1972: 25 (Japan); Suzuki and Takeda, 1974: 287, 288, figs. 1–4, pl. 1: fig. 1 (Japan); Daniel and Krishnan, 1979: 171, pl. 4 (India); Yanagisawa and Hamaishi, 1986: 153 (Japan); Yamaguchi et al., 1987: 17 (Japan); Mori et al., 1991: 292, figs. 1–7 (Japan); Anonymous, 1993: 8 (Japan); Takeda, 1994: 246 (Japan); Muraoka, 1998: 31 (Japan). *Zebrida adamsi* —Ortmann, 1893: 419, pl. 17: fig. 3 (Japan); Laurie, 1906: 393 (India); Urita, 1918: 163 (Japan); Urita, 1926a: 163 (Japan); Urita, 1926b: ii, 29 (Japan); Johnson, 1962: 288 (Singapore); Serène and Romimohartarto, 1963: 7, figs. 1d, 4, pl. 2: figs. d, e (Gulf of Thailand); Serène, 1968: 63 (list only); Utinomi, 1969: 37, fig. 1 (Japan); Lundoer, 1974: 5 (Andaman Sea); Sakai, 1976: 180, 298, pl. 99: fig. 1 (Japan); Shen et al., 1982: 145, fig. 48, pl. 2: Fig. 11 (South China Sea); Dai et al., 1986: 163, fig. 95, pl. 22: fig. 3 (South China Sea); Stevcic et al., 1988: 1313 (Philippines, Australia, New Caledonia); Dai and Yang, 1991: 181, fig. 95, pl. 22: fig. 3 (South China Sea).

Zebrida paucidentata Flipse, 1930: 73, fig. 44 (Makassar Strait).

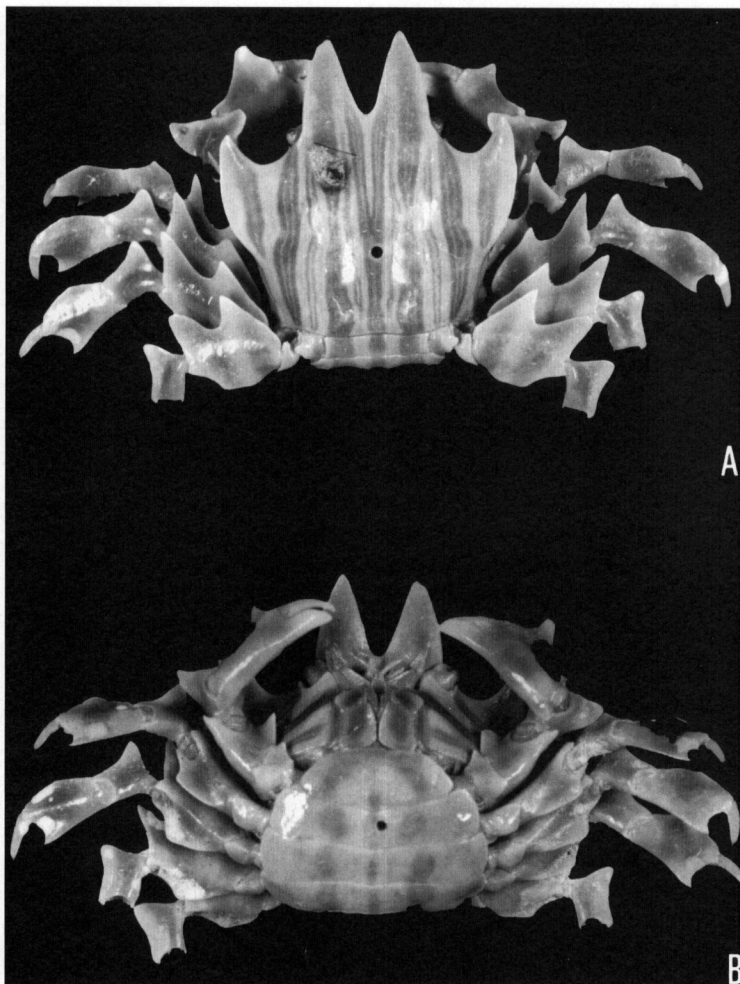


Figure 1. *Zebriada adamsii* White, 1847. Holotype female, 14.2 by 12.5 mm (BMNH 1939.9.20.6): A, dorsal view; B, ventral view.

Material Examined.—**HOLOTYPE:** female (14.2 by 12.5 mm) (BMNH 1939.9.20.6), Borneo, coll. Capt. Sir Edward Belcher.

OTHERS: **Sri Lanka:** 1 male (BMNH 1907.5.22.193), Gulf of Manaar, coll. Herdman, no other data. — 1 male, 2 females (ZRC 1997.209-311), coll. H. Müller, 1990s. — 1 female (AM P7699), coll. Colombo Museum. **Singapore:** 1 male (ZRC 1984.7860), Johore Shoals, coll. D.S. Johnson, 17 June 1954. **Indonesia:** 1 juvenile male (damaged, cb 2.5 mm) (ZMA De103.051, holotype of *Z. paucidentata*), Makassar Strait, coll. M. Weber, 10 May 1899. — 1 female (RMNH D41744), Kudinggareng Keke Isl., off Ujung Pandang, Sulawesi, coll. M. De Beer, 21 March 1989. **Thailand:** 1 male (USNM 39709), Koh Mesan, Gulf of Thailand, coll. Th. Mortensen, 5 February 1900. — 1 female (ovigerous) (USNM 39710), between Koh Mesan and Cap Liant, Gulf of Thailand, coll. Th. Mortenson, 4–7 February 1900. — 1 male (5.0 by 4.5.2 mm) (PMBC 2249), bottom trawl, off Phuket, coll. 22 November 1972. **New Caledonia:** 1 female (MNHN 24736), Ile de Pins, coll. R. Catala. — 1 female (MNHN AC135), Chalutage, coll. P. Laboute, 3 July 1986. — 1 male (9.2 by 8.5 mm) (MNHN AC136), Passe de la Sarcelle, coll. Tirard, 2 December 1987. **Philippines:** 1

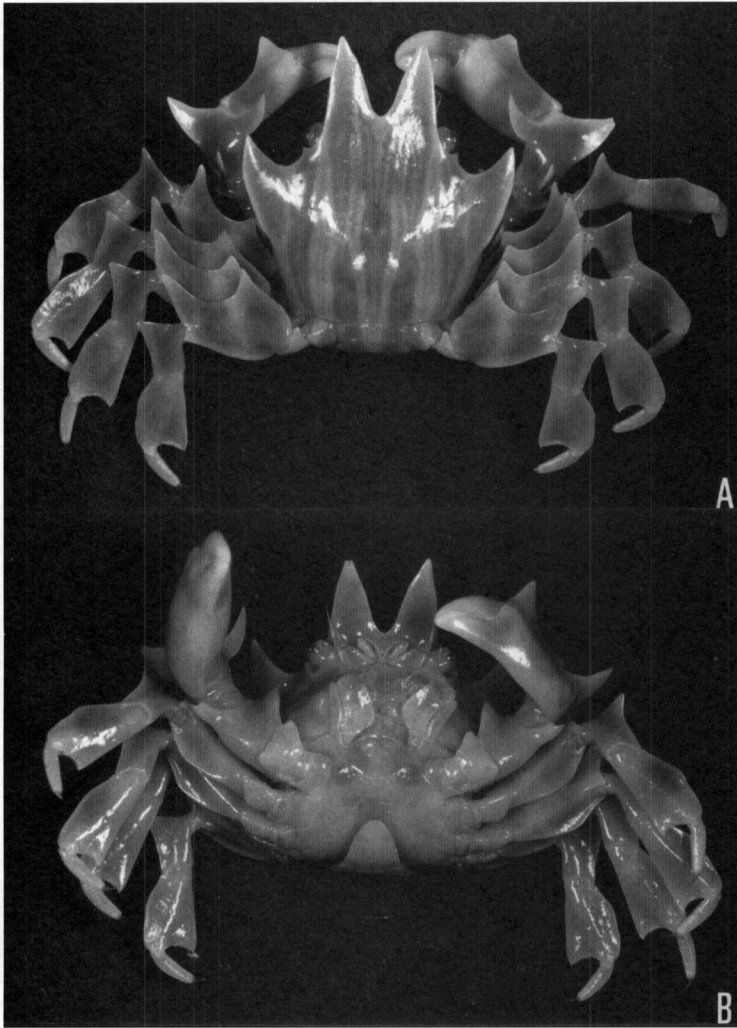


Figure 2. *Zebrida adamsii* White, 1847. Male, 12.7 by 12.3 mm (RMNH 32046): A, dorsal view; B, ventral view.

female (SMF ZMG 686), coll. C. Semper, 1859–64. — 1 female (WAM 143–67), Zal. Isl., Pearl Bank, Sulu Archipelago, coll. B.R. Wilson, R.V. PELE, 22 February 1964. 2 females (1 with bopyrid) (USNM 50882), Jolo Straits, vicinity of Jolo, coll. ALBATROSS, 1907–1910, 15 February 1908. — 1 male (USNM 50881), Jolo Island, vicinity of Jolo, coll. ALBATROSS, 1907–1910, 15 February 1908. — 1 female (USNM 50883), Sirun Island, Sulu Archipelago, vicinity of Siasi, coll. ALBATROSS, 1907–1910, 16 February 1908. — 2 males (1 with bopyrid), 1 female (USNM 50889), Sirun Island, Sulu Archipelago, vicinity of Siasi, coll. ALBATROSS, 1907–1910, 18 February 1908. — 1 male, 1 female (ovigerous) (USNM 50884), Observation Island, Sulu Archipelago, Tawi Tawi Group, 24 February 1908. — 1 male (USNM 159992), Recodo, near Philippines, Sulu Sea, coll. Balhani and sons, January 1941. **Vietnam (Gulf of Tonkin):** 1 male (MNHN 21546), coll. Zarenkov, 1963. **Japan:** 1 male (NSMT) Enashi, Suruga Bay, 20 m, coll. 3 March 1974. — 1 female (NSMT 74-004), Enashi, Suruga Bay, 5 m, from *Asthenosoma ijimai*, coll. 15 May 1974. — 1 female (NSMT 74-005), Enashi, Suruga Bay, 11 m, from *Toxopneustes pilosus*, coll. 13 May 1974. — 1 male

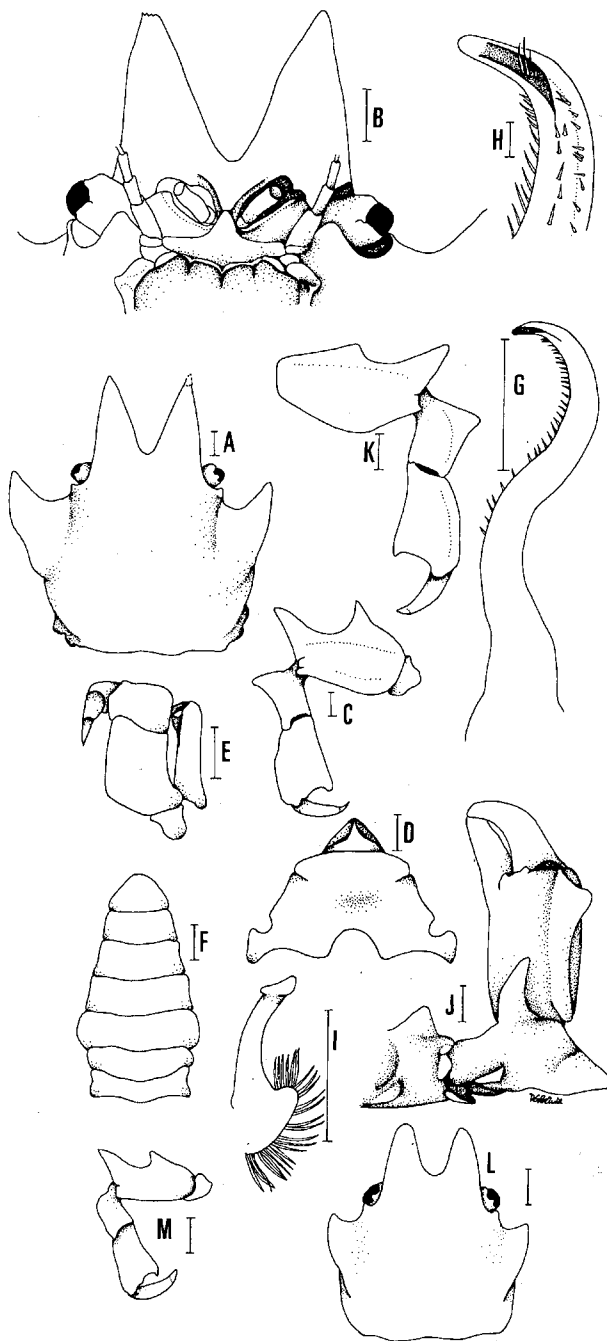


Figure 3. *Zebrida adamsii* White, 1847. Male, 12.7 by 12.3 mm (RMNH 32046): A, dorsal view of carapace; B, face of carapace; C, fourth left ambulatory leg; D, sternum; E, left third maxilliped; F, abdomen; G, right G1; H, distal tip of right G1; I, left G2; J, postero-dorsal view of right cheliped. K, male, 9.2 by 8.5 mm (MNHN AC136), third right ambulatory leg. L, M, male, 6.8 by 6.4 mm (ZRC 1984.7860), L, dorsal view of carapace; M, fourth left ambulatory leg. Scales for A-G, I-M = 1.0 mm; for H = 0.1 mm.

(CBM 4177), Oshima, Kushimoto, Kii Peninsula, 10 m, coll. S. Yamaguchi, 14 July 1978. — 1 male (CBM 4178), Izumo, Kushimoto, Kii Peninsula, coll. H. Misaki, December 1980. — 1 female (CBM 4180), Kushimoto, Kii Peninsula, coll. H. Misaki, 27 April 1978. — 1 male (CBM 4179), Izumo, Kushimoto, Kii Peninsula, coll. Igasaki, 26 October 1978. — 1 female (CBM 3660), off Minabe, Kii Peninsula, 30–40 m, coll. T. Komai, 28 March 1997. — 1 female (CBM 870), Minabe, Kii Peninsula, coll. T. Komai, 3 February 1995. — 1 male (12.7 by 12.3 mm), 1 female (RMNH 32046), Wagu, Kii Island, Mie Prefecture, coll. N. Yamashita, 1978–79. — 1 male (RMNH D39190), Wagu, Kii Island, Mie Prefecture, coll. N. Yamashita, 1978–79. — 1 male (SMF), no exact locality, coll. T. Sakai, no other data. — 2 males (SMF TS00068), no exact locality, coll. T. Sakai, no other data. — 1 male, 1 female (SMF 11067), Wagu, Mie Prefecture, 134°4'N, 136°51.3'E, coll. N. Yamashita. — 1 female (ZRC 1997.205), Kushimoto, coll. S. Nagai, March 1986. — 1 male (USNM 48458), Tara, Ibusuki, Satuma, Japan, coll. T. Urita, no date. **Australia:** 1 male (NTM Cr009508), Djungan Point, Croker Island, Northern Territory, 11°17'S, 132°37'E, coll. L. Vail, 26 September 1988. — 2 females (BMNH 1937.9.21.459-60), Great Barrier Reef, coll. British Great Barrier Reef Expedition, 1928–29. — 1 female (AMP12997), Hayman island, Cumberland Group, Queensland, 20°03'S, 148°53'E, 37m, coll. K. Dewitte. — 1 female (AM P13371), Chambers Bay, Northern Territory, 12°13'S, 131°35'E, coll. A. A. Racek, 7 November 1959. — 1 male, 1 female (IRSNB IG24.046), Great Palm island, Great Barrier Reef, coll. August 1967.

Diagnosis.—Small lamelliform expansion present on anterior margin of eyestalk; rostrum relatively long, tip usually sharp; lateral carapace tooth relatively long, directed obliquely laterally; anterior margins of carpus and merus of first to third ambulatory legs with distinct spines; anterior margin of propodus of ambulatory legs unarmed; posterior margins of merus of all ambulatory legs expanded medially into a flap-like structure.

Remarks.—*Zebrida adamsii* has been reported from a wide area across the Indian Ocean and West Pacific. Alcock (1895) synonymized *Zebrida longispina* Haswell, 1880, under *Z. adamsii*, but did not justify his action. Suzuki and Takeda (1974) subsequently argued that *Z. paucidentata* Flipse, 1930, is also a subjective junior synonym of *Z. adamsii*. The large series of specimens available to us, however, shows that three species can be recognized, viz *Z. adamsii* White, 1847, *Z. brevicarinata* new species, and *Z. longispina* Haswell, 1880.

The differences between the three species are in the structures of the eyestalk, rostrum, lateral carapace teeth and ambulatory legs (Table 1, Figs. 3,5,8). These differences work only when similarly sized specimens, particularly adults, are compared; with small juveniles posing problems for their positive identification. The teeth and spines on the carapace, chelipeds and legs are longest in *Z. longispina*, while these characters in *Z. brevicarinata* are the weakest. In *Z. adamsii* s. str., these spines are intermediate in strength. It is important to note here that all the specimens from southwestern Australia have very low spines, with no adult specimen having spines like those of *Z. adamsii* s. str. In addition, all adult populations of *Z. adamsii* we have examined from other areas are very consistent in the form of their spines, with none having spines like those specimens from western Australia. In addition, no southwestern Australian specimen has spines like those of *Z. adamsii* s. str. As such, it seems reasonable to recognize the southwestern Australian population as a distinct species (*Z. brevicarinata* new species). The specimens from northern Australia are more problematic. All the specimens presently referred to *Z. longispina* from here have very long spines and we have not found any adult specimen as yet which has spines intermediate in condition between *Z. longispina* and *Z. adamsii* s. str. In addition, one heterosexual pair (QM W18668), both with similar spine conditions, was collected together. It is also interesting to note that all the recent specimens of *Z. longispina*

Table 1. Differences between *Zebrida adamsii* White, 1847, *Z. brevicarinata* new species, and *Z. longispina* Haswell, 1880.

Species/Characters	<i>Z. adamsii</i>	<i>Z. brevicarinata</i>	<i>Z. longispina</i>
Lamelliform expansion	Small	Absent	Large at anterior margin of eyestalk
Tip and length of rostrum	Sharp; medium length	Rounded; short	Very sharp; very long
Lateral carapace tooth	Medium length; directed obliquely outwards	Short length; flat	Very long, thin, lamelliform in form; directed upwards
Anterior margins of first to third ambulatory legs	Merus with 2 sharp teeth; carpus with 1 sharp tooth; propodus unarmed	Margins of all merus, carpus and propodus unarmed	Merus with 2 long, sharp teeth; carpus with 1 long, sharp tooth; propodus with 1 long, sharp tooth
Posterior margin of merus of last ambulatory leg	Small tooth present	Unarmed	Large, sharp tooth present

were trawled from relatively deeper waters, suggesting a different habitat and possibly hosts as well from *Z. adamsii* s. str., with the species known only from northern Australia thus far. We have not examined any specimens even vaguely attributable to *Z. longispina* from outside northern Australia. As such, it seems best to recognise *Z. longispina* as a valid species for the time being at least.

Smaller and juvenile specimens of *Z. adamsii* generally have weaker spines and teeth (Figs. 3L,M), reminiscent of the condition in *Z. brevicarinata*, but *Z. brevicarinata* maintains these features even when it reaches adult sizes comparable in size to large adult *Z. adamsii*. Adult specimens of *Z. brevicarinata* can always be separated from *Z. adamsii* in that the anterior margin of the eyestalk is never expanded (Fig. 5B) (vs. short), the tip of the rostrum is always rounded and short (Figs. 4A,5A) (not relatively longer and often sharp), the carapace tooth is short and not directed upwards even slightly, thus appearing almost flat (Figs. 4A, 5A) (not relatively longer and directed slightly upwards), the anterior margins of the merus, carpus and propodus of the first to third ambulatory legs are unarmed (Fig. 5K) (not armed with well developed sharp teeth), and the posterior margins of the merus of the last ambulatory leg are not dentiform (Fig. 5C) (not distinctly dentiform).

The identity of *Z. paucidentata* Flipse, 1930, collected from the Makassar Strait, poses serious problems. The specimen is a very small juvenile male, the G1 being poorly developed, and half the carapace is missing. The anterior margins of the ambulatory meri are unarmed as in *Z. brevicarinata* but we believe that the type of *Z. paucidentata* is in fact a juvenile of *Z. adamsii*. Suzuki and Takeda (1974) had shown that juvenile *Z. adamsii* have generally weaker teeth on their legs and chelipeds, as on the type of *Z. paucidentata*, and they argued that both were synonyms. We observe this same trend. All adult *Z. adamsii*, however, have well developed spines and teeth. We have examined an adult specimen clearly referable to *Z. adamsii* (RMNH D41744) from near the type locality of *Z. paucidentata*. We thus believe that *Z. paucidentata* is no more than a juvenile and hence a junior synonym of *Z. adamsii*.

It is possible that the type of *Z. paucidentata* is actually conspecific with what is here recognized as *Z. brevicarinata*, especially since juveniles of *Z. adamsii* (including *Z.*

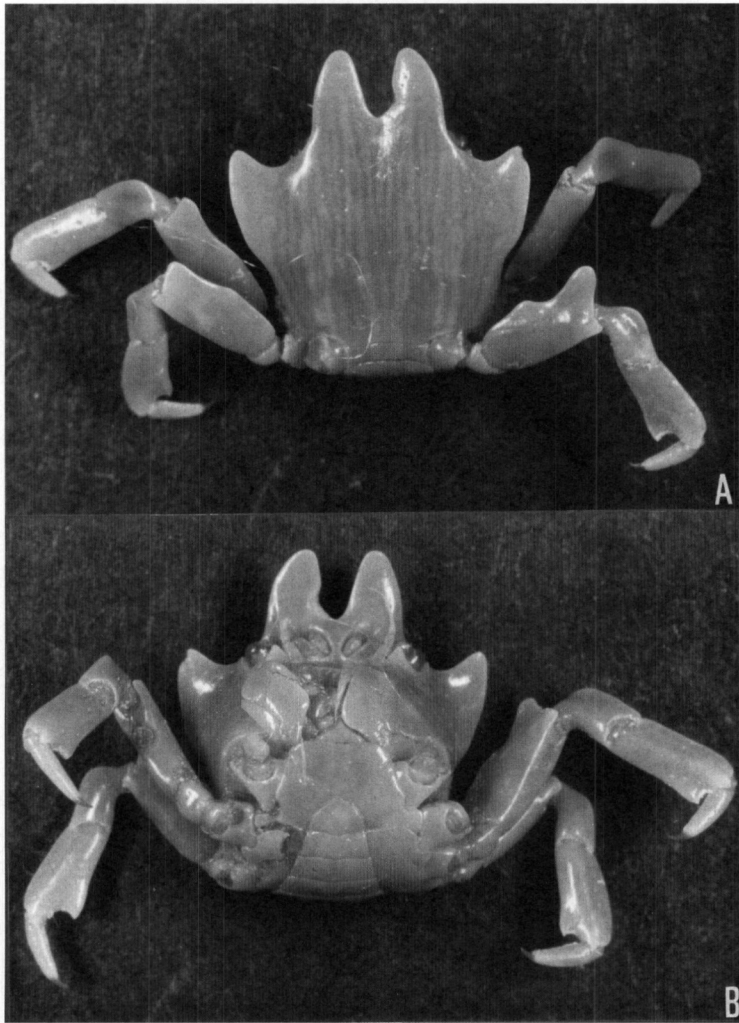


Figure 4. *Zebrida brevicarinata* new species. Holotype male, 7.5 by 8.0 mm (WAM 182-67): A, dorsal view; B, ventral view.

paucidentata) and *Z. brevicarinata* cannot be effectively separated. In view of the relatively longer rostral spines of the type of *Z. paucidentata* and its distribution, it seems more reasonable to refer *Z. paucidentata* to *Z. adamsii* rather than *Z. brevicarinata*.

The more recently collected specimens from northern Australia indicate that *Z. longispina* Haswell, 1880, is a valid species, and not a junior synonym of *Z. adamsii* as supposed by Alcock (1895). In *Z. longispina*, the anterior margin of eyestalk is expanded into a large lamelliform structure (Figs. 8B), the rostrum is very long, and the tip is very sharp (Fig. 7A), the lateral carapace tooth is distinctly directed upwards (Fig. 6A), the anterior margins of the merus, carpus and propodus of the first to third ambulatory legs are strongly dentiform (Fig. 8K), and the posterior margin of the merus of the last ambulatory legs are expanded medially into a large, lamelliform structure (Fig. 8C). In *Z. adamsii*, however, the anterior margin of the eyestalk has only a small tooth (Fig. 3B), the

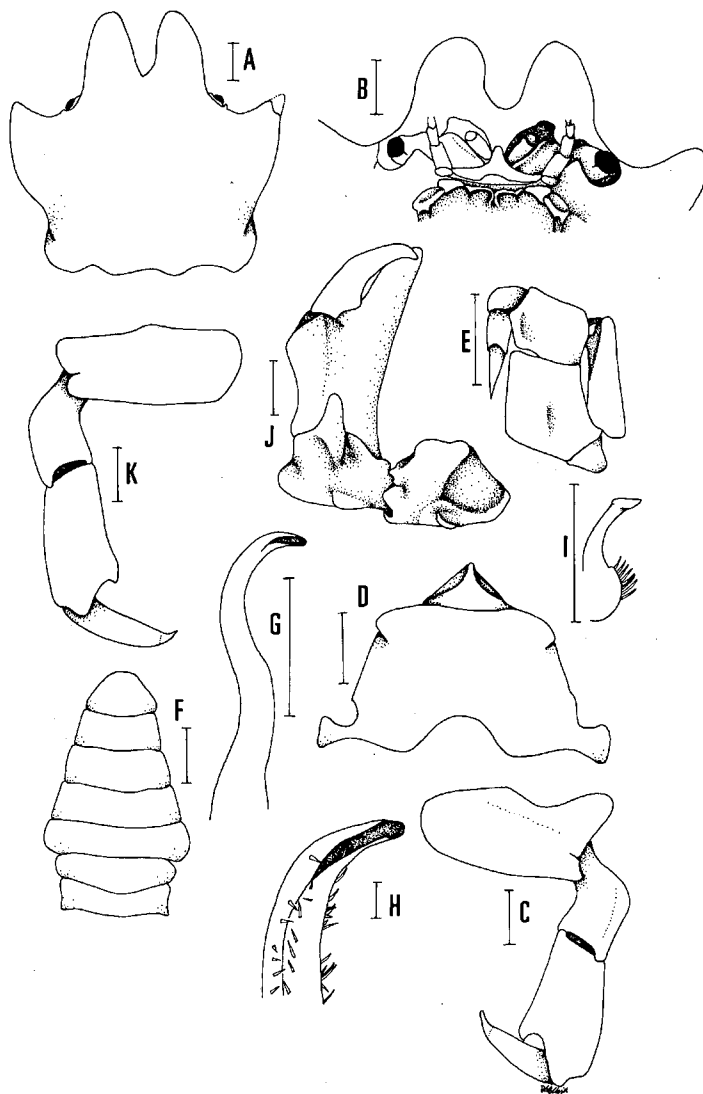


Figure 5. *Zebrida brevicarinata* new species. Holotype male, 7.5 by 8.0 mm (WAM 182-67): A, dorsal view of carapace; B, face of carapace; C, fourth right ambulatory leg; D, sternum; E, left third maxilliped; F, abdomen; G, left G1; H, distal tip of left G1; I, left G2; J, postero-dorsal view of left cheliped; K, third left ambulatory leg. Scales for A-G, I-K = 1.0 mm; for H = 0.1 mm.

rostrum is proportionately shorter and the tip blunter (Figs. 1A,2A), the lateral carapace tooth is directed only obliquely upwards (Figs. 1A,2A), the anterior margins of the merus and carpus of the first to third ambulatory legs are dentiform but the propodus is unarmed (Fig. 3K), and the posterior margin of the merus of the last ambulatory leg is expanded medially into small teeth (Fig. 1A).

McNeill (1968) reported a specimen from Queensland, Australia. From his description, his specimen is clearly *Z. adamsi*.