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THE IDENTITIES OF TWO CRINOID SYMBIONTS,  
*HARROVIA ALBOLINEATA* ADAMS & WHITE, 1849,  
AND *H. LONGIPES* LANCHESTER, 1900  
(DECAPODA, BRACHYURA, EUMEDONIDAE)

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ABSTRACT

The identity of *Harrovia albolineata* Adams & White, 1849, the type species of the genus *Harrovia* Adams & White, 1849, is discussed. The confusion in the identities between *H. albolineata* and *H. longipes* Lanchester, 1900, is clarified. The two species are distinguished by numerous adult and larval characters. The range variation of the adult morphology within each species is discussed. The first zoea of *H. albolineata* s. str. is described for the first time.

RÉSUMÉ

L'identité de *Harrovia albolineata* Adams & White, 1849, espèce-type du genre *Harrovia* Adams & White, 1849, est discutée. La confusion entre *H. albolineata* et *H. longipes* Lanchester, 1900 est éclaircie. Les deux espèces se distinguent par de nombreux caractères larvaires et adultes. La variabilité de la morphologie de l'adulte est discutée pour chaque espèce. Le premier stade zoé de *H. albolineata* s. str. est décrit pour la première fois.

INTRODUCTION

The genus *Harrovia* Adams & White, 1849, is the largest and most frequently encountered genus in the family Eumedonidae Dana, 1852. The genus has also been the subject of many studies (e.g. Serène et al., 1958; Serène, 1968; Jones & Sankarankutty, 1961; Sankarankutty, 1966; Lim & Ng, 1988; Castro, 1989; Shen et al., 1982; Tirmizi & Kazmi, 1982; Števcíć et al., 1988; Chen & Xu, 1991). One of the more frequently reported species is *H. albolineata* Adams & White, 1849, the type species of the genus.

Serène et al. (1958) partially revised *Harrovia*, and presented their definition of *H. albolineata* on the basis of numerous specimens they had obtained from Vietnam. They synonymised *H. albolineata* var. *longipes* Lanchester, 1900, with *H. albolineata*, and suggested that *H. plana* Ward, 1936, might also be a junior synonym. Serène et al.'s (1958) definition of *H. albolineata* has been followed by all subsequent workers, including those describing new taxa (e.g. Shen et al., 1982; Chen & Xu, 1991).

Studies of recent collections from Singapore of numerous specimens of *Harrovia* from two different types of habitat and different crinoid host species have, however, indicated that there are some taxonomic problems with the identity of *H. albolineata* Adams & White, 1849, and doubts about Serène et al.'s (1958) definition of the species. Specimens dredged from muddy-gravelly substrates seemed to agree with the figure and description of *H. albolineata* in Adams & White (1849). Specimens from coral reefs however, are clearly referable to what Lanchester (1900) described as *H. albolineata* var. *longipes* from Singapore, and what Serène et al. (1958) (partim) have called *H. albolineata* (nec Adams & White, 1849) from Vietnam. The *Harrovia* specimens from the two habitats differed so substantially that it was obvious that they represented two distinct species.

Through the courtesy of Dr Paul Clark of the British Museum (Natural History), we managed to examine the types of both *H. albolineata* Adams & White, 1849, and *H. albolineata* var. *longipes* Lanchester, 1900. The study of these, as well as that of the recent specimens, showed that *H. albolineata* Adams & White, 1849 (pl. 1A) and *H. albolineata* var. *longipes* Lanchester, 1900 (pl. 1B) are valid taxa, and Lanchester's variety should be recognized as a distinct species. Some of the specimens referred to *H. albolineata* by Serène et al. (1958) are in fact, *H. longipes*. The first zoeae of *H. albolineata* and *H. longipes* were obtained and differences in their morphology support the contention that the two species are distinct.

In the present paper, the taxonomy of *Harrovia albolineata* and *H. longipes* is discussed and clarified. The first zoea of *H. albolineata* s. str. is also described for the first time. Zoeae previously referred to *H. albolineata* by Lim & Ng (1988) belong to *H. longipes* instead. A lectotype is designated for *H. albolineata*, and the host preference and habitat segregation of the two species are also discussed.

#### MATERIALS AND METHODS

The abbreviations G1 and G2 are used for the male first and second pleopods respectively. The angle of bending of the distal part of G1 is measured from the vertical. The fourth anterolateral lobe or tooth/spine refers to the outermost one, at the junction of the anterolateral and posterolateral margins; the first being the one just behind the external orbital angle. Specimens examined are deposited in the Zoological Reference Collection (ZRC) of the Department of

Zoology, National University of Singapore, Singapore; the British Museum (Natural History) (BMNH), London, United Kingdom; and the Institute of Oceanology, Academia Sinica (IOAS), Qingdao, China.

The larvae were reared in the laboratory at a temperature of 28° C in a dish with fresh seawater supplied daily. After hatching, the larvae were preserved in Steedman's preservative (Griffiths et al., 1976) and drawings were made from these. Appendages were dissected in glycerin with entomological needles and drawn with the aid of a camera lucida. Structural details were based on at least five specimens.

The length of carapace was measured from the tip of the rostrum to the posterior margin of the carapace; the width from spine to spine. All measurements of the length and width are in millimeters.

#### TAXONOMY

### **Harrovia albolineata** Adams & White, 1849

(pl. 1A; text-figs. 1A, 2, 4A, C, 5A, B, E, F, 6A, C, 7A-J, 8B-K)

*Harrovia albolineata* Adams & White, 1849: 56, pl. 7 fig. 5 (Borneo and Philippines); Miers, 1879: 671, pl. 13 fig. 11; Lanchester, 1900: 728 (Singapore); Gee, 1925: 166 (Hong Kong); Flipse, 1930: 90 (list only); Gordon, 1934: 64, fig. 33c; Buitendijk, 1950: 70 (Straits of Malacca); Serène et al., 1958: 200 (part), fig. 7E (Vietnam); Serène, 1968: 63 (part) (list only); Serène et al., 1976: 16 (Ambon); Števičić et al., 1988: 1311 (part) (list only); Takeda, 1989: 151 (Ohshima, Japan).

*Harrovia tuberculata* - Lanchester, 1900: 729 (Singapore); Chen & Xu, 1991: 85, fig. 29 nos. 1-4 (Nansha = Spratly Islands, South China Sea) (nec Haswell, 1880).

*Harrovia* sp. - Buitendijk, 1950: 71 (Singapore); Johnson, 1962: 288 (part) (Singapore).

*Ceratocarcinus albolineatus* - Stimpson, 1858: 221 (Hong Kong); Stimpson, 1907: 33 (Hong Kong); Shen, 1940: 218 (list only).

*Ceratocarcinus* sp. - Johnson, 1962: 288 (part) (Singapore and Peninsular Malaysia).

Material examined. — Lectotype, male (7.0 × 8.9 mm), (BMNH 43.6), Philippine Islands, leg. H. Cuming, H. M. S. Samarang, 1843-1846. - Paralectotype, female (7.4 × 9.5 mm), (BMNH 43.6), same data as lectotype.

Others. — 10 males, 6 females (ZRC 1992.9477-9492), Johore Shoal, Singapore, leg. P. K. L. Ng, 15.v.1992. - 1 male, 1 female (BMNH), Johore Shoal, Singapore, leg. P. K. L. Ng, 15.v.1992. - 2 males (BMNH 1900.10.22.40-41), Pasir Panjang, Singapore, leg. F. P. Bedford & W. F. Lanchester, 1899/1900. - 1 male, 2 females (BMNH 1900.10.22.43-45), Pasir Panjang, Singapore, leg. F. P. Bedford & W. F. Lanchester, 1899/1900. - 1 male (6.4 × 9.0 mm), (ZRC 1965.10.19.93), Singapore, no other data. - 2 males, 1 female (BMNH 1961.12.19.104-106), Singapore, leg. Singapore Fisheries Research Station, 27.vi.1956. - 4 males, 1 female (ZRC 1985.1435-1439), Singapore Straits, leg. Singapore Regional Fisheries Research Station, 6.i.1955. - 1 male (ZRC 1985.1432), south of Singapore, Station B73, 38-45 fms, clean rock substratum, leg. Singapore Regional Fisheries Research Station, 1955-1956. - 1 female (ZRC 1985.1433), South China Sea, leg. Singapore Regional Fisheries Research Station, 1955-1956. - 2 males (ZRC 1985.1420-1421), south of Bedok, station B64, 22 fms, station B60, 21-22 fms, Singapore, leg. Singapore Regional Fisheries Research Station, 1955-56. - 2 males, 1 female (ZRC 1985.1422-1424), south of Singapore, station B66, 24 fms, clean bottom, leg. Singapore Regional Fisheries Research Station, 1955-56. - 3 males (ZRC 1985.1417-1419), Raffles Lighthouse, station B28, 5-6 fms, shell substratum, leg. Singapore Regional Fisheries Research Station, 1955-56. - 1 female (ZRC 1985.1415), south of Singapore, station B59, 25-30 fms, clean bottom, leg. Singapore Regional Fisheries Research Station, 1955-56. - 1 male (ZRC 1985.1431), south of Singapore, station B59, 25-30 fms, clean bottom, leg. Singapore Regional Fisheries Research Station, 1955-56. - 1 female (ZRC 1985.1440), Bedok, Singapore, no other data. - 1 male, (ZRC 1992.9495), Outer Shoal,

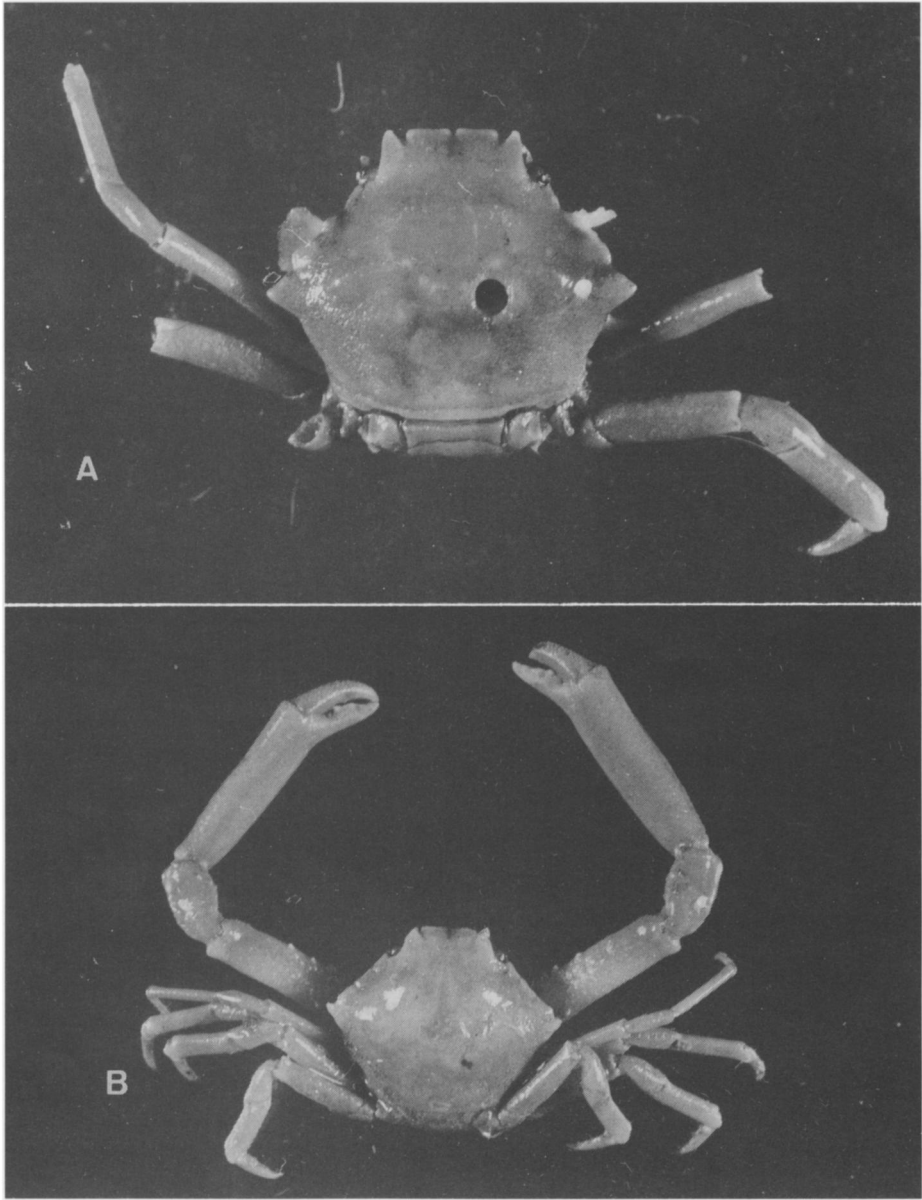


Plate 1. A, *Harrovia albolineata* Adams & White, 1849, lectotype, male, 7.0×8.9 mm (BMNH 43.6); B, *Harrovia longipes* Lanchester, 1900, holotype, male, 6.4×8.3 mm (BMNH 1900.10.22.42).

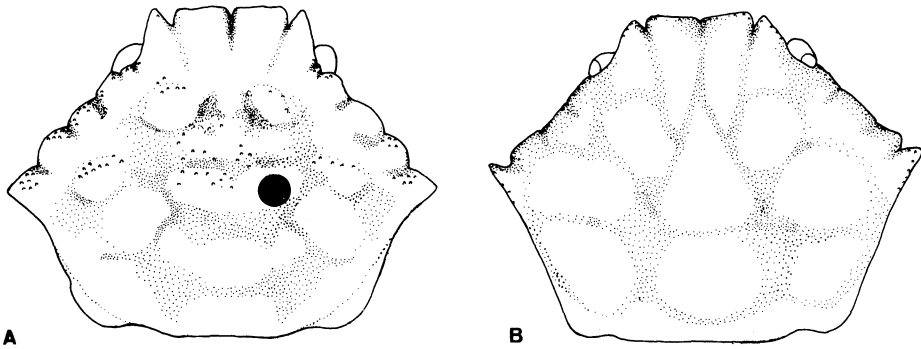


Fig. 1. Carapace denuded, dorsal view. A, *Harrovia albolineata* Adams & White, 1849, lectotype, male, 7.0×8.9 mm (BMNH 43.6) (solid circle indicates position of pin); B, *Harrovia longipes* Lanchester, 1900, holotype, male, 6.4×8.3 mm (BMNH 1900.10.22.42).

Singapore, no other data. - 1 male, 2 females (ZRC 1985.1412-1414), Johore Shoal, 10 fms, crinoid ground, leg. D. S. Johnson, 17.vi.1954. - 1 male (ZRC 1985.1411). Johore Shoal, 10 fms, crinoid ground, leg. D. S. Johnson, 17.vi.1954. - 1 female (ZRC 1985.1416) south of Singapore, station B58, 32 fms, sand, stone substratum, leg Singapore Regional Fisheries Research Station, 6.i.1955. - 4 males, 1 female (ZRC 1985.1435-1439), Singapore Straits, station B60, 21-22 fms, leg. Singapore Regional Fisheries Research Station, 6.i.1955. - 1 male (ZRC 1992.9493), Raffles Lighthouse, Singapore, leg. D. Vandenspiegel, viii.1992. - 2 males (ZRC 1985.1425-1426), Kuala Johore, 10 fms, mud, mussel bed, Peninsular Malaysia, leg. D. S. Johnson, 17.vi.1954. - 1 male, (ZRC 1992.9494), Singapore or Malaysia, no other data. - 1 male, 1 female (ZRC 1984.243-244), South China Sea, leg. Hee Huat, 28.viii.1983. - 1 male, 2 females (ZRC 1984.6373-6375), South China Sea, leg. Hee Huat, 16.ix.1983. - 1 male, 1 female (ZRC 1969.11.25), South China Sea, leg. Fisheries (United Nations Development Project), Vietnam, 25.xi.1969. - 1 male (6.2 × 8.1 mm), 1 female (5.8 × 7.2 mm) (IOAS X17B83), Beibu Gulf, South China Sea, leg. Zd., 21.iv.1962.

**Diagnosis.** — Carapace hexagonal, regions not well-defined, usually with two tubercles on epigastric and two tubercles on epibranchial regions, but sometimes absent; surface usually pubescent; anterolateral margins cut into four teeth, separated by shallow, narrow fissures, the first low, subtruncate, second low, blunt, third and fourth large, distinctly dentiform, strongly developed, third slightly smaller than fourth, rarely equal in size; frontal margin with small median fissure, not strongly deflexed, appearing straight in dorsal view; chelipeds cylindrical, one large tubercle or spine on distal inner margin of carpus, several tubercles on the inner and outer proximal margin of merus; ambulatory legs short and stout, ratio of length to width of fourth ambulatory merus 2.2-2.5, anterior margin of ambulatory merus smooth or lined with blunt and small tubercles; distal part of G1 bent at approximately right angles or at about 110°.

**Remarks.** — Adams & White (1849) in describing *H. albolineata*, did not indicate the number of specimens they had available. In the BMNH are two specimens which bear the labels of Adams & White indicating that they are types. Both specimens are thus syntypes as no holotype was designated. The male specimen (7.0 × 8.9 mm) (BMNH 43.6) is here designated the lectotype.

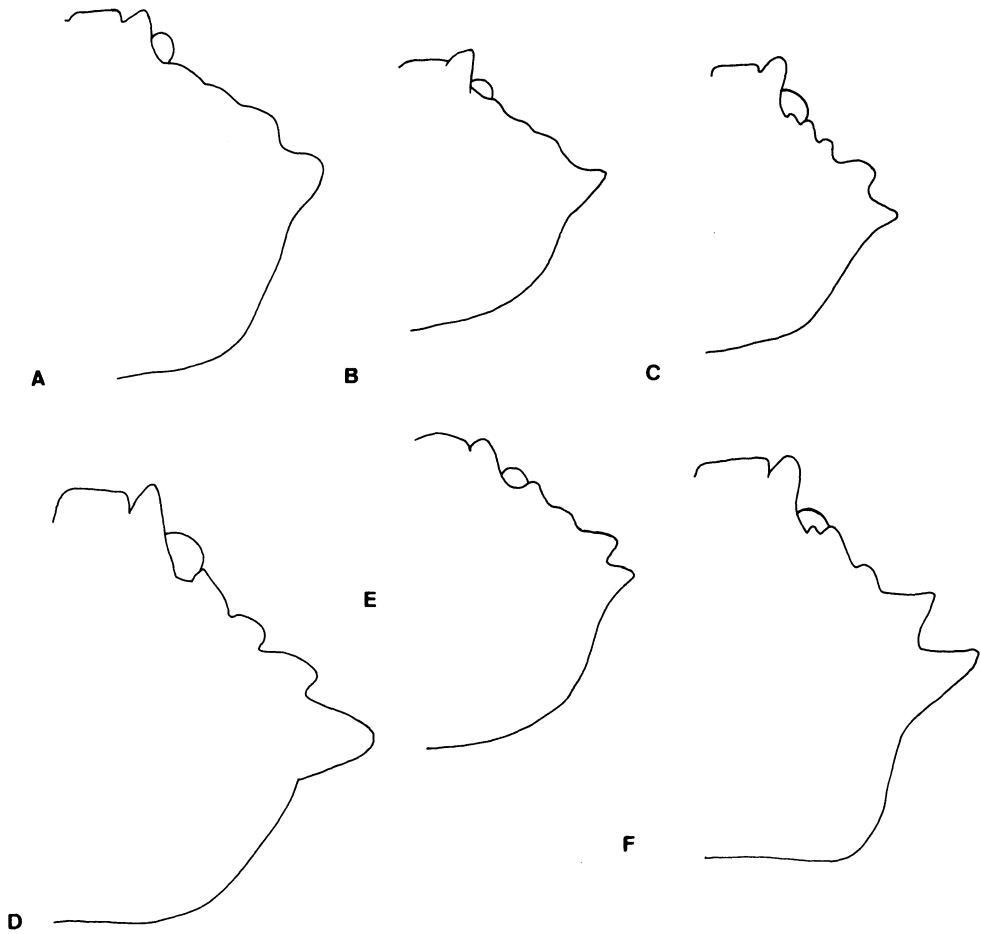


Fig. 2. Carapace of *Harrovia albolineata* Adams & White, 1849 (schematic to show variation in the anterolateral teeth). A, female, 6.2×7.9 mm (ZRC 1992.9477); B, female, 5.3×7.0 mm (ZRC 1992.9478); C, female, 5.0×6.5 mm (ZRC 1992.9479); D, male, 6.2×8.5 mm (ZRC 1992.9480); E, male, 4.0×5.1 mm (ZRC 1992.9481); F, male, 6.4×9.0 mm (ZRC 1965.10.19.93).

The original description by Adams & White (1849) of *Harrovia albolineata* was brief, and their figure was rather too small to clearly discern many characters. Despite this, many workers have tended to identify specimens from several parts of east Asia as *H. albolineata* without hesitation. One of the most striking features in the original drawing by Adams & White (1849) of *H. albolineata* which may have led many workers astray in perceiving it as a useful character is the pattern of alternating maroon and white stripes on the carapace. Such a colour pattern however, is also found in many other *Harrovia* species (e.g. *H. purpurea* Gordon, 1934, *H. longipes* Lanchester, 1900) and it is a character which varies a great deal even within *H. albolineata* s. str. itself.



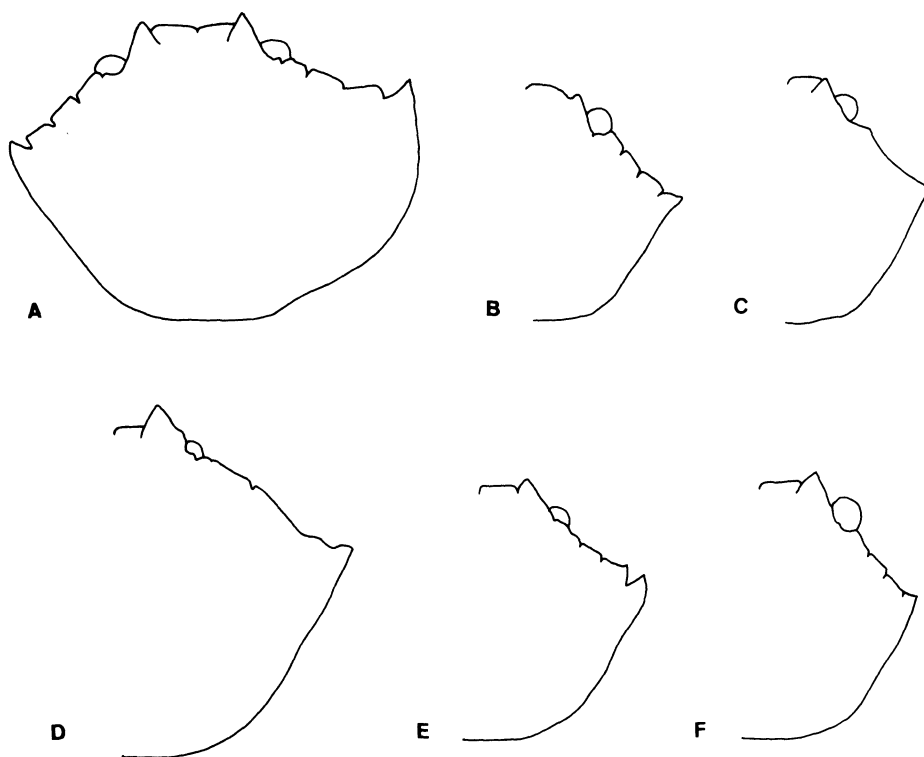


Fig. 3. Carapace of *Harrovia longipes* Lanchester, 1900 (schematic to show variation in the anterolateral teeth). A, female, 7.0×9.3 mm (ZRC 1992.9521); B, male, 5.8×7.3 mm (ZRC 1992.9517); C, female, 7.2×9.0 mm (ZRC 1992.9496); D, female, 10.5×13.8 mm (ZRC 1992.9506); E, female, 7.1×9.0 mm (ZRC 1992.9497); F, female, 4.2×5.2 mm (ZRC 1992.9518).

Stimpson (1858, 1907) suggested classifying *Harrovia albolineata* under the genus *Ceratocarcinus* Adams & White (1849). His specimen, which was collected in Hong Kong, probably belonged to the species *Harrovia albolineata* as he described a small tubercle or spine on the carpus of the cheliped of the specimen and the ambulatory legs were without spines. As only one species is known from Hong Kong, Gee's (1925) record is also tentatively referred to *H. albolineata*.

Miers (1879) and Gordon (1934) examined the type specimens of *Harrovia albolineata* and provided figures for them. Neither, however designated a lectotype for *Harrovia albolineata* or redescribed the species in detail.

Buitendijk (1950) examined a specimen collected from the Straits of Malacca and identified it as *H. albolineata*. This specimen currently could not be found in the ZRC but is provisionally recognised as *H. albolineata* by the authors on the basis of the description of the anterolateral teeth provided by Buitendijk and the habitat it was collected from. She also examined another specimen (ZRC

1965.10.19.93) which she named *Harrovia* sp. with a suggestion that it could be *H. elegans* de Man, 1887. Castro (1989) also cited this record. We have re-examined this specimen and it is tentatively identified as *H. albolineata*. The tubercle on the carpus of the cheliped and the G1 are in agreement with what is here defined as *H. albolineata* but its third and fourth anterolateral teeth differ somewhat (see later).

The specimens examined by Johnson (1962) are deposited in the ZRC. His specimens are a mixture of two species *Harrovia albolineata* (Singapore and Peninsular Malaysia) and *H. cf. elegans* De Man, 1887 (Peninsular Malaysia). It is useful to note here that Sakai (1932) synonymised *H. japonica* Balss, 1921, with *H. elegans* de Man, 1887, and subsequent workers have followed this decision. There are however, good reasons to regard both as valid taxa on the basis of the anterolateral teeth. The margins of the first and second anterolateral teeth in *H. japonica* are concave and the edges of the teeth are strongly spiniform, whilst the third and fourth anterolateral teeth are highly acute, spiniform and curving distinctly forward. In *H. elegans*, the margins of the first and second anterolateral teeth are less acute, weaker, and directed obliquely outwards (P.K.L.N., D.G.B.C., unpubl.).

Lanchester (1900) collected three specimens which he called *H. tuberculata* Haswell, 1880 (BMNH 1900.10.22.43-45). They proved to be *H. albolineata* on re-examination and are one male and two females, not three females as Lanchester has stated. There is a tubercle on each of the carpi of the chelipeds and the legs of these specimens are short and stout, being in agreement with the definition of *H. albolineata* in the present paper. Lanchester's other specimens (BMNH 1900.10.22. 40-41) upon re-examination also proved to be *H. albolineata*.

Takeda (1989) reported a specimen of *Harrovia albolineata* from Ohshima, Japan, which seems to agree with the present definition of that species, especially in the shape of the anterolateral teeth.

Through the courtesy of Dr H. L. Chen (IOAS), the authors also examined two specimens (IOAS X17B83) labelled as *H. tuberculata*, collected from the Beibu Gulf, South China Sea in 1962. These were found to be *H. albolineata* instead. From the description and figures of another specimen from the Nansha (=Spratly Islands, South China Sea) illustrated by Chen & Xu (1991), it seems likely that their *H. tuberculata* (nec *H. tuberculata* Haswell, 1880) is probably *H. albolineata* as well, since they described a tubercle on the carpus of the cheliped of this specimen. Chen & Xu (1991) also show a figure of the type male of *H. tuberculata* Haswell, 1880 (type locality Australia) provided by Dr Desmond Griffin from the Australian Museum, but this species differs from *H. albolineata* in possessing more strongly incised anterolateral margins, with more truncate teeth, and in having a strong spine on the ambulatory merus.

Several other workers have confused *Harrovia albolineata* with *H. elegans*. Specimens collected by Professor Herdman from the Gulf of Manaar (India)



and examined by Laurie (1906) (BMNH 1934.1.16.68 and 1907.5.22.194-5) were re-examined. These specimens should be referred to *H. elegans* instead because their third and fourth anterolateral teeth are acute, conical and large (see next paragraph). Herdman's specimens were collected approximately 2000 km from the type locality of *H. elegans* (Elphinstone Island) (fide De Man, 1887). The Indian specimens reported by Jones & Sankarankutty (1961) and Sankarankutty (1966) as *H. albolineata*, are probably *H. elegans* as well. A figure of the specimen provided by Jones & Sankarankutty (1961) emphasized the third and fourth large, acute and conical anterolateral teeth, a feature of *H. elegans*.

Serène et al. (1958) identified a series of specimens from Vietnamese waters as *Harrovia albolineata* and provided a very detailed characterization of what they believed to be this species. They also discussed the variation of several characters in detail. As a result, they synonymised *H. albolineata* var. *longipes* Lanchester, 1900, with *H. albolineata*. One problem with Serène et al.'s (1958) study is that they did not provide exact locality and collection data for all their specimens. Although Serène et al. stated that all the specimens were from coral reefs, it is obvious from the catalogue numbers that they were from several separate lots and possibly from different habitats as well. In fact, the specimens examined by Serène et al. (1958) seem to be a mixture of two or three species, viz. *H. elegans*, *H. longipes* and possibly *H. albolineata* as well. *H. elegans* differs from *H. albolineata* s. str. in the following characters: (1) there is no tubercle on the carpus of the cheliped; (2) the third and fourth anterolateral teeth are more acute, conical and larger, the third being slightly larger than the fourth; and, (3) the ambulatory legs are short and stout with dorsal spinules on the meri. On the basis of these characters, some of Serène et al.'s (1958: pl. 7 figs. C, D, text-figs. 12B, C, D, 13A, B) juvenile specimens are here identified as *H. elegans*. Their other specimens however (Serène et al., 1958: pls. 4 fig. C, 6, 7 figs. A, B; text-figs. 7G, 8-10, 13c, 14 (broken-line drawing)), are no doubt *H. longipes* judging by their long and slender ambulatory legs with spinules on the meri. The identity of another juvenile specimen (Serène et al., 1958: pl. 7 figs. E, G; text-fig. 11) could not be established. This specimen had stout legs with spinules on the meri which resembled those of *H. elegans* but the third and fourth anterolateral teeth seem to resemble those of *H. albolineata* instead. However, it had unusual frontal lobes which are deeply cleft and strongly deflexed. In any event, *H. albolineata* is also known from Vietnamese waters (ZRC 1985.11.25). Serène et al.'s (1958) specimens are not deposited at the Muséum National d'Histoire naturelle (Paris, France) or the ZRC (pers. obs.) and are probably still at Nhatrang, Vietnam. The present identification of their juvenile specimens should be regarded as only provisional until they can be re-examined.

The identity of Serène et al.'s (1976) material from Ambon, Indonesia, could not be ascertained as neither description nor figures were provided.

There are four adult characters which are diagnostic in separating *H. albolineata* from *H. longipes*: 1. the structure of the G1; 2. the length of the

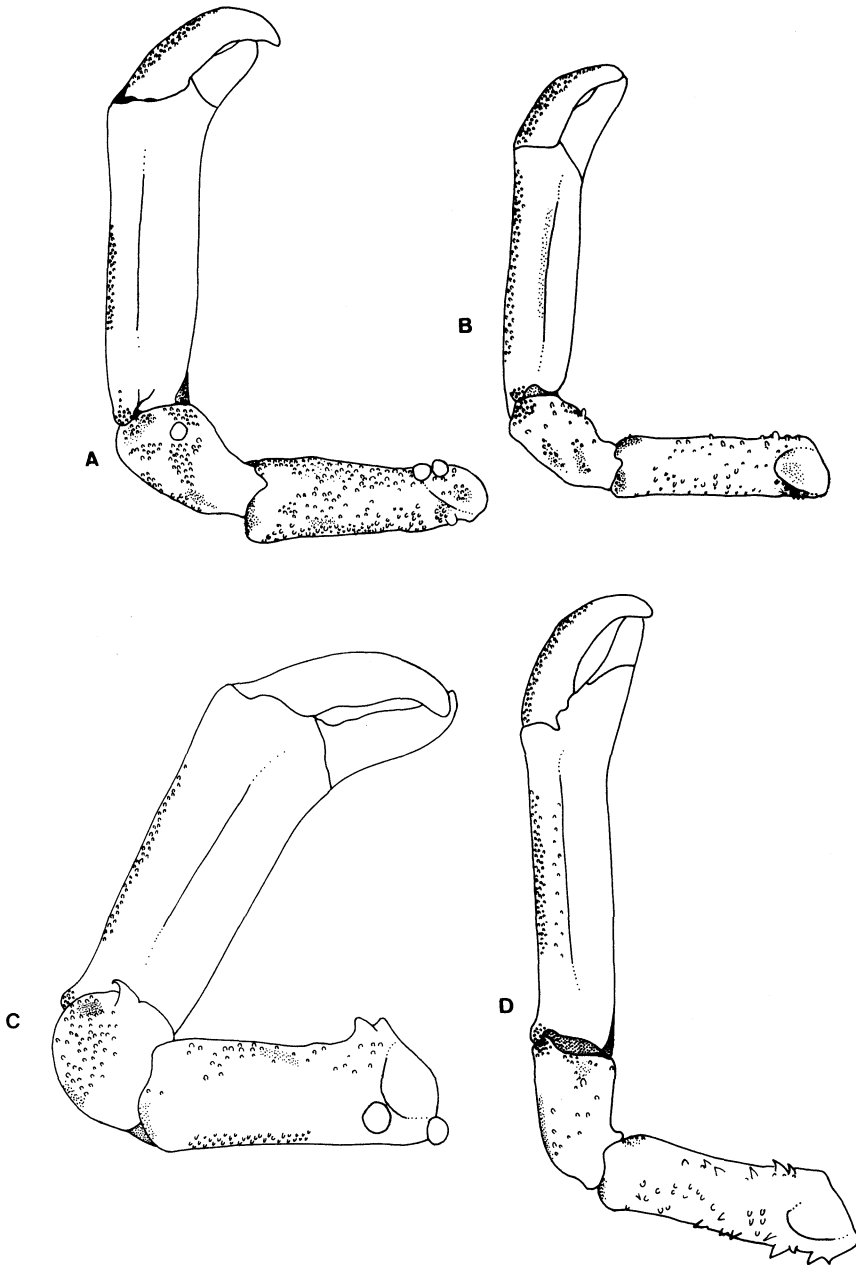


Fig. 4. Left cheliped, dorsal view. A, *Harrovia albolineata* Adams & White, 1849, detached appendage, of either the lectotype or paralectotype (BMNH 43.6); B, *Harrovia longipes* Lanchester, 1900, holotype, male, 6.4×8.3 mm (BMNH 1900.10.22.42); C, D, variation in left cheliped. C, *Harrovia albolineata*, male, 6.2×7.8 mm (ZRC 1992.9482); D, *Harrovia longipes*, female, 8.0×11.0 mm (ZRC 1992.9519).

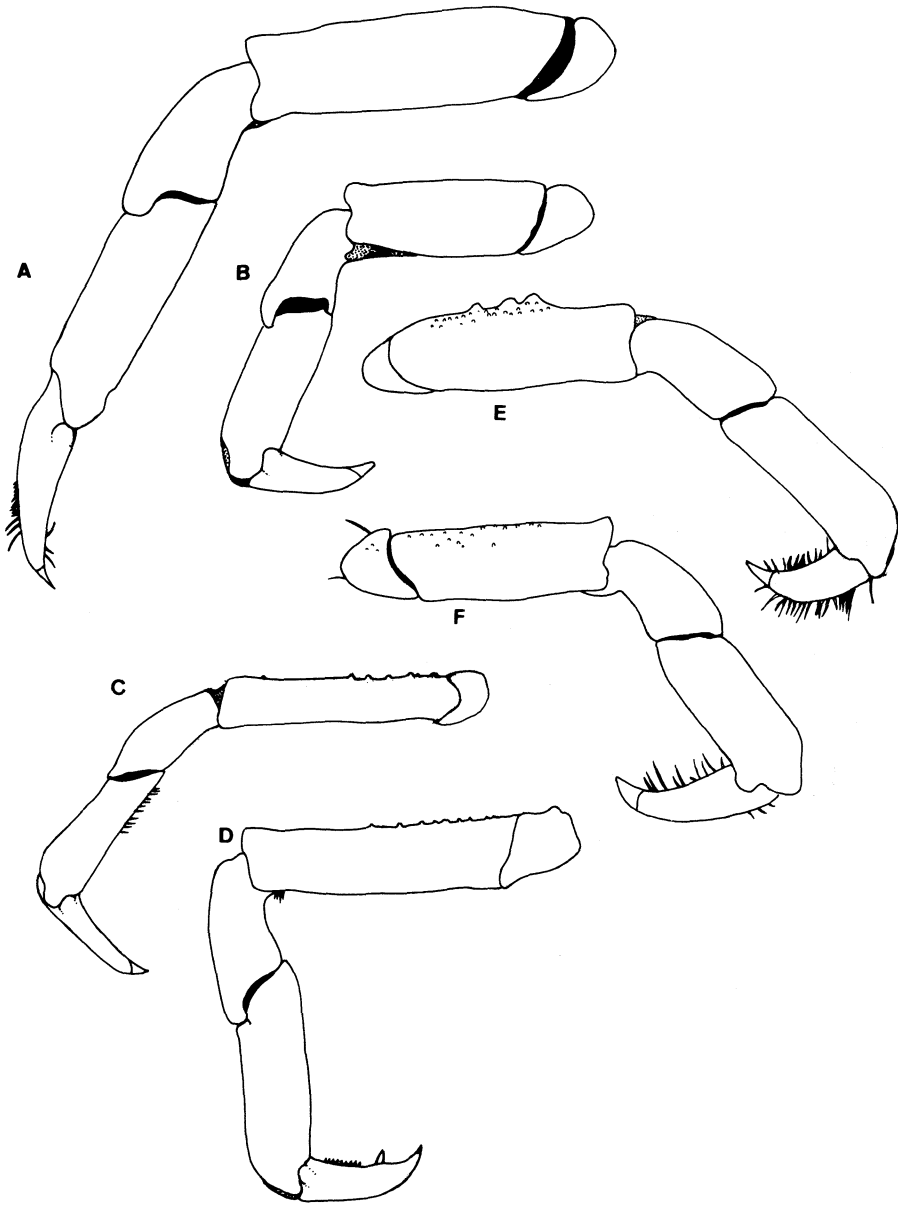


Fig. 5. Ambulatory legs, side view. A, B, second ambulatory leg and fourth ambulatory leg respectively, *Harrovia albolineata* Adams & White, 1849, detached appendage, of either the lectotype or paralectotype (BMNH 43.6); C, D, second ambulatory leg and fourth ambulatory leg respectively, *Harrovia longipes* Lanchester, 1900, holotype, male, 6.4×8.3 mm (BMNH 1900.10.22.42); E, F, second ambulatory leg and fourth ambulatory leg respectively, *Harrovia albolineata*, male, 5.0×6.3 mm (ZRC 1992.9483).

TABLE I  
Differences between *Harrovia albolineata* Adams & White, 1849, and *Harrovia longipes* Lanchester, 1900

| <i>Harrovia albolineata</i>  | <i>Harrovia longipes</i>   |
|--|--|
| (1) Distal part of G1 bent at an approximately right angle. More spines along the groove.  | (1) Distal part of G1 bent at about 45°. Fewer spines along the groove.  |
| (2) Ambulatory legs short and stout, ratio of length to width of fourth ambulatory merus: 2.2-2.5  | (2) Ambulatory legs long and slender, ratio of length to width of fourth ambulatory merus: 3.0-3.3                       |
| (3) No spinules lining the anterior margin of the ambulatory merus.  | (3) Spinules lining the anterior margin of the ambulatory merus.   |
| (4) One large tubercle at the distal inner margin of carpus of cheliped. Several tubercles on proximal inner and outer margins of merus. | (4) Absence of large tubercle on the carpus of chelipeds. Several spinules on proximal inner and outer margins of merus. |
| (5) Third and fourth anterolateral teeth usually large and strongly developed.   | (5) Usually only the fourth anterolateral teeth distinct.  |
| (6) Carapace shape less hexagonal.   | (6) Carapace shape more hexagonal.   |
| (7) More pubescence on the carapace.   | (7) Less pubescence on the carapace.   |
| (8) Carapace usually with four dorsal tubercles (two epigastric and two epibranchial).   | (8) Carapace usually has two dorsal tubercles on the epigastric region.  |
| (9) Habitat preference - sandy-muddy grounds.  | (9) Habitat preference - coral reefs.  |
| (10) Crinoid host: <i>Comatula purpurea</i> .  | (10) Crinoid hosts: <i>Comaster gracilis</i> and <i>Comaster multifidus</i> .  |

ambulatory legs; 3. the absence/presence of spinules on the anterior margin of the merus of the ambulatory legs; and 4. presence or absence of large tubercles on the carpus and merus of the chelipeds (see table I). Each of these characters will now be discussed:

1. The structure of the G1. The difference is in the orientation of the distal part of the G1. The distal part of the G1 of the type specimen of *H. albolineata* is bent at approximately right angles (see fig. 6A, C) and has more spines along the groove. In *H. longipes*, the distal part of the G1 is bent at approximately 45° with distinctly fewer spines along the groove for the G2 (see fig. 6B, D). The general shape of the G1 of *H. albolineata* is also slightly more twisted at the proximal part compared to *H. longipes* (see fig. 6A, B). The distal part of the G1 of *H. albolineata* at times can be bent slightly more downwards, viz. ca. 110° (fig. 7D, E, I, J). Most of the specimens (ZRC 1984. 243, 244, 6373-6375, ZRC 1985. 1411, 1422-1424, 1432, 1435-1439, 243-244) were dredged from deeper waters (ca. 20 fathoms), but as they agree well with the typical *H. albolineata* in all other respects, these differences are here regarded as intraspecific variations. The extreme variant is a specimen collected from Singapore, examined by Buitendijk (1950), which was identified by her as *Harrovia* sp. The distal part of the G1 of this specimen points more downwards (fig. 7E, J) than in those of the rest of the specimens and the third and fourth anterolateral teeth are large,

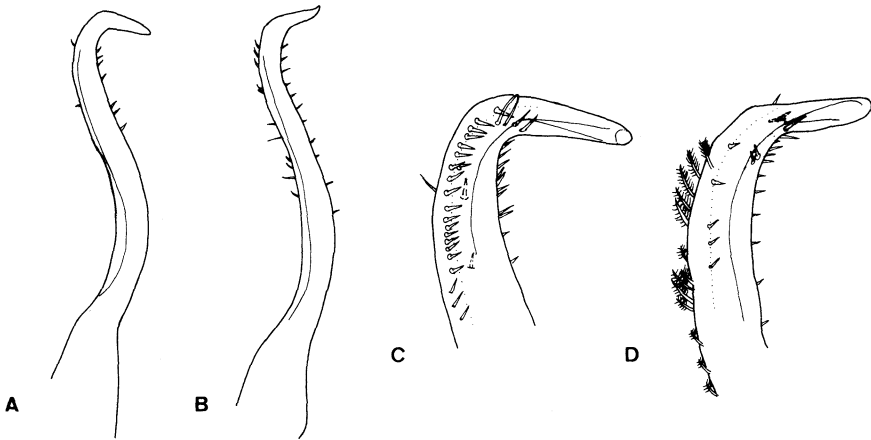


Fig. 6. Left G1, ventral view. A, *Harrovia albolineata* Adams & White, 1849, lectotype, male, 7.0×8.9 mm (BMNH 43.6); B, *Harrovia longipes* Lanchester, 1900, holotype, male, 6.4×8.3 mm (BMNH 1900.10.22.42); C, D, distal part of left G1, ventral view; C, *Harrovia albolineata*, lectotype, male, 7.0×8.9 mm (BMNH 43.6); D, *Harrovia longipes*, holotype, male, 6.4×8.3 mm (BMNH 1900.10.22.42).

acute, conical and slightly spiniform in shape (fig. 2F). In the last aspect, it resembles specimens from Sri Lanka that we have identified as *H. elegans*. However, it differs from *H. elegans* in having very few minute tubercles (not spines) lining the ambulatory meri and a large tubercle on the carpus of the cheliped. These characters compel the authors to refer the specimen to *H. albolineata*, albeit with some reluctance.

2. The length of the ambulatory legs. The ambulatory legs of *Harrovia albolineata* are short and relatively stout, length to width ratio of the fourth ambulatory merus being approximately 2.2-2.5 (fig. 5A, B). The legs of *H. longipes* are distinctly longer and more slender, the length to width ratio of the fourth ambulatory merus being about 3.0-3.3 (fig. 5C, D).

3. The absence/presence of spinules along the anterior margins of ambulatory legs. In *Harrovia albolineata*, there are no traces of spinules lining the anterior margin of the meri, except in the case of some specimens which have numerous very small tubercles on the ambulatory legs (fig. 5E, F). In *H. longipes* however, the anterior margin of the ambulatory meri are distinctly armed with numerous spinules (fig. 5C, D) contrary to what Lanchester (1900: 729) described: “no tubercles on the ambulatory legs”.

4. Presence absence of large tubercles on the carpus and merus of the chelipeds. On the distal inner margin of the carpus of *Harrovia albolineata*, there is a distinct tubercle which can be blunt, sharp or slightly hooked (fig. 4A, C). On the proximal inner margin of the merus there exist one to three large tubercles, whereas on the proximal outer margin, there are one or two large tubercles (fig. 4A, C). The tuberculation on the meri in *H. longipes* varies

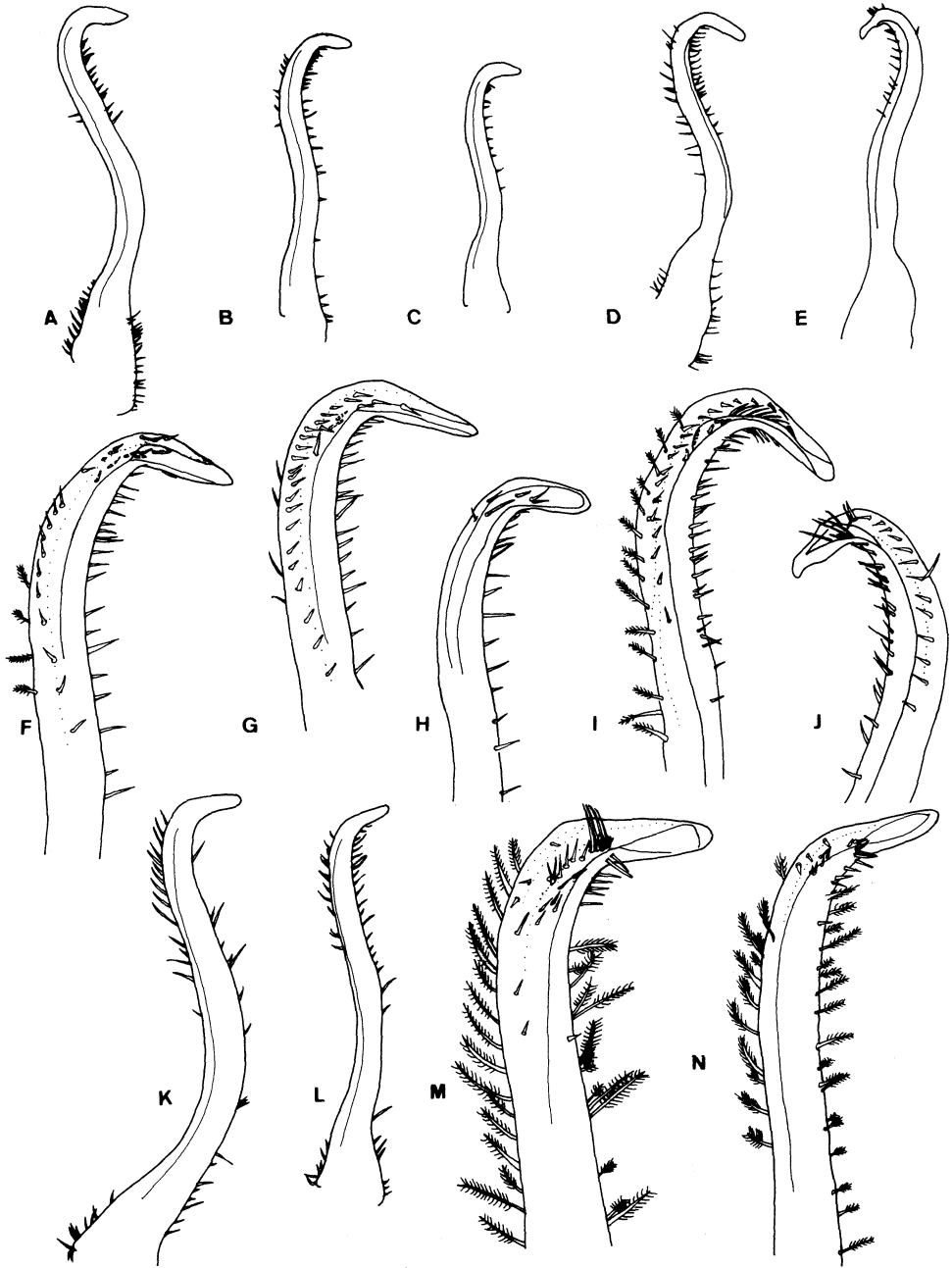


Fig. 7. A-D, *Harrovia albolineata* Adams & White, 1849, male, left G1, ventral view: A, 6.2×8.5 mm (ZRC 1992.9480); B, 4.8×6.1 mm (ZRC 1992.9484); C, 4.0×5.1 mm (ZRC 1992.9481); D, 5.4×7.0 mm (ZRC 1984.6373). E, *Harrovia albolineata* Adams & White, 1849, male, right G1, ventral view, 6.4×9.0 mm (ZRC 1965.10.19.93). F-I, *Harrovia albolineata* Adams & White, 1849, male, distal part of left G1, ventral view: F, 6.2×8.5 mm (ZRC 1992.9480); G, 4.8×6.1 mm (ZRC 1992.9484); H, 4.0×5.1 mm (ZRC 1992.9481); I, 5.4×7.0 mm (ZRC 1984.6373). J, *Harrovia albolineata* Adams & White, 1849, male, distal of right G1, ventral view, 6.4×9.0 mm (ZRC 1965.10.19.93). K-L, *Harrovia longipes* Lanchester, 1900, male, left G1, ventral view: K, 7.5×10.5 mm (ZRC 1992.9498); L, 5.8×7.3 mm (ZRC 1992.9517). M-N, *Harrovia longipes* Lanchester, 1900, male, distal part of left G1, ventral view: M, 7.5×10.5 mm (ZRC 1992.9498); N, 5.8×7.3 mm (ZRC 1992.9517).



somewhat. The meri are covered with small granules in the holotype (fig. 4B) but in several other specimens, there are several spinules along the inner and outer proximal margins of the meri of the chelipeds (fig. 4D).

Other than these characters, there are also several which are useful in distinguishing *H. albolineata* and *H. longipes*, although they are subject to more variation than the previous four characters and are therefore more difficult to use without a good series of specimens for direct comparisons.

Most useful is the form of the anterolateral armature, and this character can be used to identify most specimens. In general, there are four pronounced anterolateral teeth in *Harrovia albolineata* (fig. 1A) and *H. longipes* (fig. 1B). The two species can be separated by the form of their anterolateral teeth. The third and fourth anterolateral teeth in *H. albolineata* (fig. 1A) are both strong and acute, while in *H. longipes*, only the fourth is strong and acute (fig. 1B). In *H. albolineata*, the first tooth is low and subtruncate, the second is low and blunt, the third and fourth teeth are more distinct, distinctly dentiform and unequal in size, the third always slightly smaller than the fourth (fig. 1A, 2A-F). However, there are specimens with the third and fourth anterolateral teeth almost equal in size (fig. 2C, E); with only the fourth anterolateral tooth strongly dentiform and the rest of the lobes fused into one structure without evidence of any clefts (fig. 2B); or with the third and fourth anterolateral teeth resembling that of *H. elegans*, being conical and even more acute (fig. 2F). The last variant differs from *H. elegans* in having a larger fourth lobe instead of the third, and the second lobe is low and blunt instead of truncate. In *H. longipes*, the first, second and third anterolateral teeth are generally lobiform, very low, subtruncate, separated by shallow, and narrow fissures, the fourth tooth is strongly dentiform and much larger, but this character varies somewhat as well (fig. 3A-F). In one specimen, both the third and fourth teeth are strongly dentiform, although the last one is distinctly larger (fig. 3E). Although the size and form of the third and fourth teeth vary, the third tooth in *H. longipes*, even when it is well developed, is always distinctly smaller than the fourth. In *H. albolineata* however, the third tooth is usually strongly dentiform, relatively large and only slightly smaller than the fourth (fig. 2C, D). In some specimens of *H. longipes*, the first, second and third teeth appear to be almost completely fused into one structure (fig. 3C, D) with only the fourth anterolateral teeth distinct. Infestation of the branchial chamber with a bopyrid parasite is known for one specimen of *H. longipes* (fig. 3A).

The carapace shape of *H. albolineata* (fig. 1A) tends to be less hexagonal than that of *H. longipes* (fig. 1B) which gives it an impression of being squarish. There is also generally more pubescence on the dorsal surface of the carapace. Four large tubercles are present on the dorsal surface of the carapace, two on the epigastric regions and two on the epibranchial regions (fig. 1A). These tubercles are sometimes absent, giving the specimens a very smooth and even appearance. The carapace of *H. longipes* is usually less pubescent and smoother (fig.

1B). Sometimes only two tubercles are present on the epigastric regions, but in some specimens, even these are absent.

There seems to be a variation in the broadness of the anterior segments of the sternum within *Harrovia albolineata*. Some specimens (ZRC 1984.6373-6373-6375, ZRC 1985.1432) have broader sterna than others (ZRC 1969.11.25). This is not a constant character and is probably only an intra-specific variation.

Other than differences in external morphology between *H. albolineata* and *H. longipes*, the two species also differ in their host and habitat preferences (table I). *Harrovia albolineata* prefers substrates with sandy-muddy grounds, the waters being rather turbid, whereas *H. longipes* prefers coral reefs with relatively clearer waters. The preferred crinoid host of *H. albolineata* seems to be *Comatula purpurea* (J. Müller, 1843), and almost all the present specimens (for which hosts are known) have been collected from this species. *Harrovia longipes* however, is usually collected from *Comaster gracilis* (Hartlaub, 1890), and occasionally from *Comaster multifidus* (J. Müller, 1841) (Ng & Lim, 1990; present observations). All three species of crinoids belong to the family Comasteridae.

### ***Harrovia longipes* Lanchester, 1900**

(pl. 1B; text-figs. 1B, 3, 4, 5C, D, 6B, D, 7K-N, 8A)

*Harrovia albolineata* var. *longipes* Lanchester, 1900: 729, pl. 44 fig. 3 (Singapore); Flipse, 1930: 80, 90 (list only).

*Harrovia albolineata* - Serène et al., 1958: 200, pl. 4C, 6, 7A, B, fig. 7G, 8, 9, 13C, 14 (broken-line drawing) (part) (Vietnam); Serène, 1968: 63 (part) (list only); Lim & Ng, 1988: 217 (Southern Is., Singapore); Števičić et al., 1988: 1311 (part) (list only); Ng & Lim, 1990: 257 (Singapore) (nec Adams & White, 1849)

Material examined. — Holotype - male (6.4 × 8.3 mm) (BMNH 1900.10.22.42), Singapore, leg. W. F. Lanchester, 1899/1900.

Others. - 2 males, 8 females (ZRC 1992.9496-9505), Southern Islands, Singapore, leg. G. Lim, 1987. - 1 female (ZRC 1992.9506), Pulau Semakau, Singapore, leg. B. Goh, 15.vi.1987. - 1 male (ZRC 1992.9507), Pulau Hantu, Singapore, leg. D. Vandenspiegel, v.1992. - 2 males, 7 females (ZRC 1992.9508-9516), Raffles Lighthouse, Singapore, leg. D. Vandenspiegel, viii.1992. - 1 male, 2 females (ZRC 1992.9522-9524), reef between Pulau Sudong & Pulau Pawai, Singapore, no data on collector, 23.v.1965. - 1 male, 1 female (ZRC 1992.9525-9526), reef edge at Pulau Ayer Chawan, Singapore, leg. R. Lee, 20.xi.1968. - 1 female (ZRC 1992.10916), Singapore or Malaysia, no other data. - 1 male, 3 females (ZRC 1992.9517-9520), Pulau Bidung, Peninsular Malaysia, leg. D. G. B. Chia & J. Low, 27.vi.1992. - 1 female (ZRC 1992.9521), Pulau Gelok, Peninsular Malaysia, leg. D. G. B. Chia & J. Low, 27.vi.1992.

Diagnosis. — Carapace hexagonal, regions not well-defined, usually with two tubercles on epigastric regions, but these sometimes absent; surface usually thinly pubescent; anterolateral margins separated into four teeth; separated by shallow, narrow fissures, the first, second and third teeth generally lobiform, very low, subtruncate, the margins usually straight or slightly convex, sometimes fused with each other to form one entire structure, the fourth distinct and much larger; frontal margin with small median fissure, slightly deflexed,

appearing straight from dorsal view, shallow median cleft; chelipeds cylindrical, carpus without large tubercle or spine on distal inner margin, several tubercles on the inner and outer proximal margin of merus; ambulatory legs slender, ratio of length to width of fourth ambulatory merus 3.0-3.3, anterior margin of the ambulatory merus lined with spinules; distal part of G1 bent approximately 45°.

Remarks. — The previous confusion of *Harrovia longipes* with *H. albolineata* (fide Serène et al., 1958) has been discussed earlier under *H. albolineata*. We feel that Lanchester's taxon is not only valid, but differs from *H. albolineata* so substantially that it merits recognition as a separate species, i.e. *H. longipes* stat. nov.

Reasons were provided in the earlier section for identifying some of Serène et al.'s specimens as *H. longipes*. As for Lim & Ng (1988) and Ng & Lim's (1990) specimens of *H. albolineata*, all are now identified as *H. longipes*, because of their long and slender legs with spinules, the absence of the large tubercle on the carpus of the cheliped and the third anterolateral lobe being much smaller than the fourth.

The differences in the external morphology and ecology between of *H. longipes* and *H. albolineata* have already been discussed in the previous section.

General biology. — In captivity, the crabs are usually found on the oral surface of the crinoid. When approached they may wave their chelipeds as an attempt to fend off possible intruders of the crinoid. In situ observations of *H. longipes* in the reef suggest that the animal does not defend its host very adamantly: when prodded excessively, it often moves to the aboral side of the crinoid. When the crab is disturbed even further (e.g., the crinoid is manually handled) it either drops off the crinoid or hides on the aboral side of the crinoid (Ng & Lim, 1990).

The characteristic striped pattern on the carapace of many individuals (especially smaller ones) is almost certainly for camouflage. The pattern of the crabs is a classic case of disruptive coloration, and not only helps it blend into the background of the crinoid colour pattern but also breaks up its outline. The crabs usually occur as single animal per crinoid, although in a few instances, they are present as heterosexual pairs. In these pairs, the males are usually the smaller of the two but possess stronger chelipeds (relative to their body length) compared to the females.

#### Morphology of the first zoea

Lim & Ng (1988) reported what they believed to be the first zoeae of *Harrovia albolineata* following the current definition of the species (i.e. sensu Serène et al., 1958). By the current nomenclature, the specimens of Lim & Ng (1988) are in fact, *H. longipes* Lanchester, 1900. During the present study several ovigerous females of *H. albolineata* s. str. were obtained from dredging, and the first zoeae

hatched in the laboratory. The description of the first zoea of *H. albolineata* s. str. is presented below.

Description of the first zoea. — Length of carapace (fig. 8B) ca. 0.6 mm. Carapace with slightly hooked dorsal, short lateral and short rostral spines, the latter being slightly arched. Regions adjacent to lateral and dorsal spines finely tuberculated, with scattered short setae, anterolateral margin lined with numerous sharp denticles. Eyes sessile. Abdomen (fig. 8C) with five somites, sixth fused to telson. Dorsal surface of somite 2 with a pair of robust, lateral knobs, somites 3 to 5 each with a pair of distinct upward and backward directed spines. Somites 2-5 with a pair of posterolateral processes each, blunt on somite 2, sharp on somites 3-5. Dorsal surfaces of somites 2-5 with 2, 2, 2, 2 short setae respectively; somite 2 with two additional long hairs. Posterodorsal margins of somites 2-5 with 6, 8, 8, 6 minute denticles respectively. Pleopods absent on all somites. Telson (fig. 8C) bifurcate, margins of furcal prongs spinulose, each with 1 large lateral spine and 1 small dorsal spine. Inner margin of telson fork with 3 pairs of large setose spines.

Antennule (fig. 8D) uniramous, unsegmented, cone-shaped, with 2 stout and long, 2 thin and short aesthetascs.

Antennal exopod (fig. 8E) approximately equal in length to spinous process, both sharply tapering. Spinous process with 2 rows of spinules on distal margin. Outer margin of exopod with 1 thick median and 1 shorter median spine; distal part with 2 rows of spinules.

Mandible (fig. 8F, G) heavily chitinised, both with inter-digitating incisor and molar processes, palp absent.

Coxal endite of maxillule (fig. 8H) with 6 stout setae (4 terminal, 2 subterminal), basal endite with 5 serrated spines and 1 tubercle. Endopod 2-segmented, proximal segment with 1 long seta, distal segment with 2 subterminal and 4 terminal setae.

Coxal and basal endites of maxilla (fig. 8I) bilobed, with 2, 5 setae on proximal lobes and 6, 4 setae on distal lobes respectively. Endopod bilobed, with 3 setae on proximal lobe, 5 on distal; outer margin with fringe of fine hairs. Scaphognathite with 4 stout, plumose marginal setae; tip strongly tapered, plumose.

Coxa of first maxilliped (fig. 8J) bare, basis with 10 setae (2, 2, 3, 3, proximal to distal). Endopod five-segmented, setation from proximal to distal segment 3, 2, 1, 2, 5. Exopod constricted medially, appearing 2-segmented, with 4 stout, setose terminal natatory setae.

Coxa of second maxilliped (fig. 8K) bare, basis with 4 setae (1, 1, 1, 1). Endopod 3-segmented, setation from proximal to distal segment 1, 1, 5. Exopod constricted medially, with 4 stout, setose terminal setae. Third maxilliped absent.

Remarks. — The first zoea of *Harrovia albolineata* s. str., when compared with that reported by Lim & Ng (1988) of *H. longipes* (as *H. albolineata*, nec Adams &

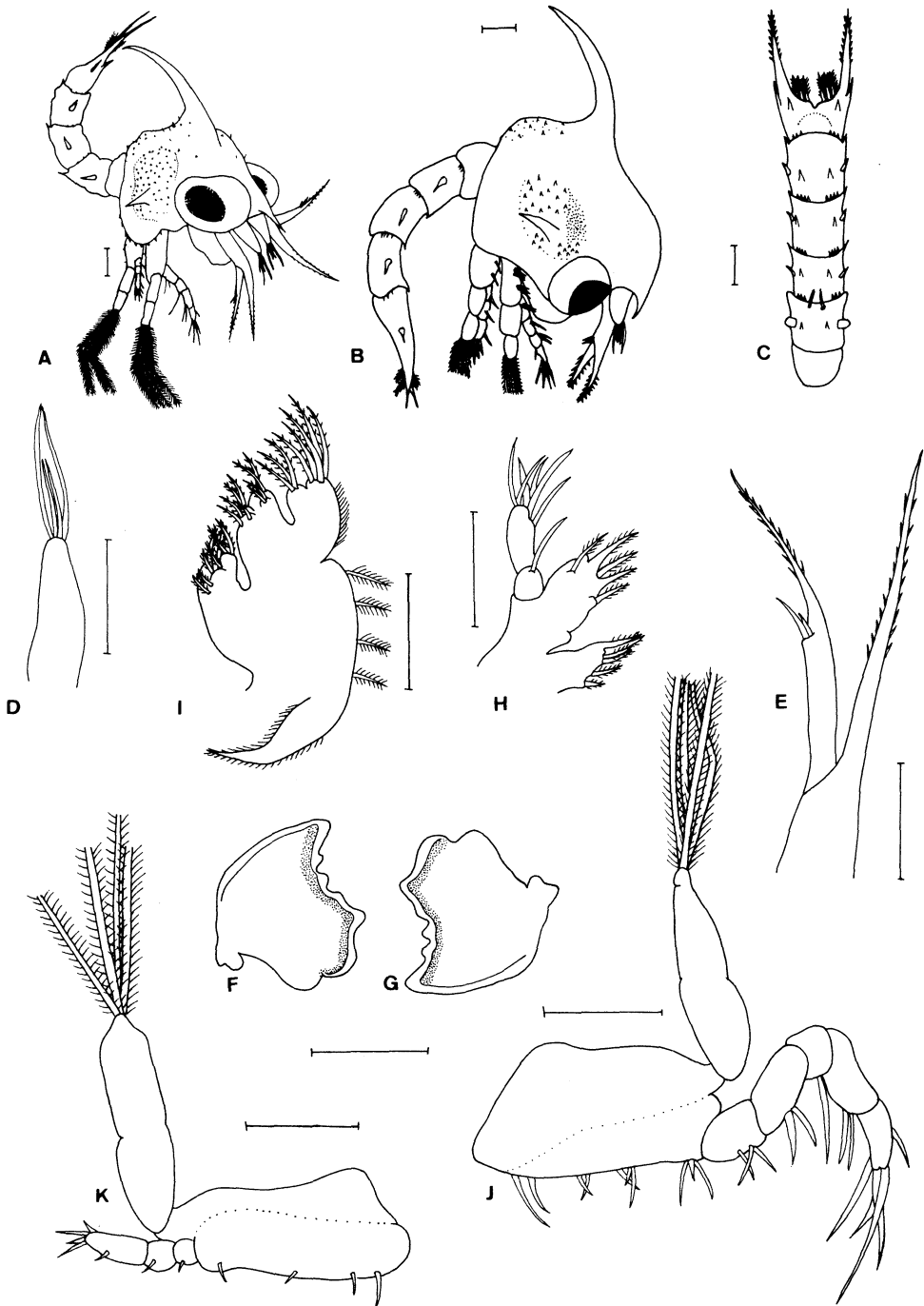


Fig. 8. A, *Harrovia longipes* Lanchester, 1900, first zoea (after Lim & Ng, 1988). B-K, *Harrovia albolineata* Adams & White, 1849, first zoea: B, lateral view; C, abdomen (dorsal view); D, antennule; E, antenna; F, left mandible; G, right mandible; H, maxillule; I, maxilla; J, first maxilliped; K, second maxilliped. Scale bar=0.10 mm.

TABLE II

Differences in the first zoeae of *Harrovia albolineata* Adams & White, 1849, and *Harrovia longipes* Lanchester, 1900

| <i>Harrovia albolineata</i>  | <i>Harrovia longipes</i>   |
|--|--|
| (1) Abdomen<br>Postero-lateral processes blunt on somite 2, sharp on somites 3, 4 and 5. Somite 2 and 5 have 6 denticles each. Somite 2 with 2 setae and 2 hairs. Somite 3 with 2 setae. | (1) Abdomen<br>Postero-lateral processes blunt on somites 2 and 5, sharp on somites 3 and 4. Somites 2 and 5 have 8 denticles each. Somite 2 with 3 setae and devoid of hair. Somite 3 with 4 setae. |
| (2) Maxillule<br>Coxal endite with 6 setae<br>(4 terminal and 2 subterminal)   | (2) Maxillule<br>Coxal endite with 7 setae<br>(3 terminal and 4 subterminal)   |
| (3) Maxilla<br>The basal endite has 5 setae on proximal lobe. Coxal endite bilobed with 2 setae on the proximal lobe and 6 setae on distal lobe.   | (3) Maxilla<br>The basal endite has 4 setae on proximal lobe. Coxal endite bilobed with 5 setae on the proximal lobe and 4 setae on distal lobe.   |
| (4) Second maxilliped<br>setation formula of the three segments of endopod, from proximal to distal 1, 1, 5  | (4) Second maxilliped<br>setation formula of the three segments of endopod, from proximal to distal 1, 1, 6  |
| (5) Rostral spine arched.  | (5) Rostral spine straight.  |
| (6) Larva smaller (0.6 mm).  | (6) Larva larger (0.7 mm).   |

White, 1849), has six characters which are useful in separating the two species, viz., 1. structure of the abdomen; 2. number of setae on the coxal endite of the maxillule; 3. number of setae on the basal and coxal endites of the maxilla; 4. number of setae on the endopod of the the second maxilliped; 5. shape of the rostral spine; and, 6. carapace size (see table II).

The carapace size of the first zoea of *H. albolineata* is ca. 0.6 mm and ca. 0.7 mm for *H. longipes* (fig. 8A, B). The difference in the size of the first zoeae of the two species may not be reliable as this is known to vary in some crabs. It could simply be due to the fact that *Harrovia longipes* is a larger animal in general when compared to *H. albolineata*.

The first zoea of *Harrovia albolineata* s. str., as with other known eumedonids, is very similar to that of typical pilumnid larvae, especially with regard to the short rostral and lateral carapace spines, and the antenna's subequal spinous (protopodal) process and exopod, with the latter possessing two median setae and being distally spinous (see Rice, 1980; Lim & Ng, 1988; Števcic et al., 1988).

General remarks. - The present clarification of the identity of *H. albolineata* s. str. should eventually lead to a better understanding of the taxonomy of the genus *Harrovia*. A revision of the genus by the first two authors is currently in progress. At present, the genus *Harrovia* has 11 known species: *H. albolineata* Adams & White, 1849 (type species), *H. tuberculata* Haswell, 1880, *H. elegans* De Man, 1887, *H. longipes* Lanchester, 1900, *H. japonica* Balss, 1921, *H. plana* Ward,



1936, *H. egeriae* Gordon, 1947, *H. purpurea* Gordon, 1947, *H. frontodentata* Shen et al., 1982, *H. bituberculata* Shen et al., 1982, and *H. ngi* Chen & Xu, 1992 (see Števcíć et al., 1988; Chen & Xu, 1992).

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