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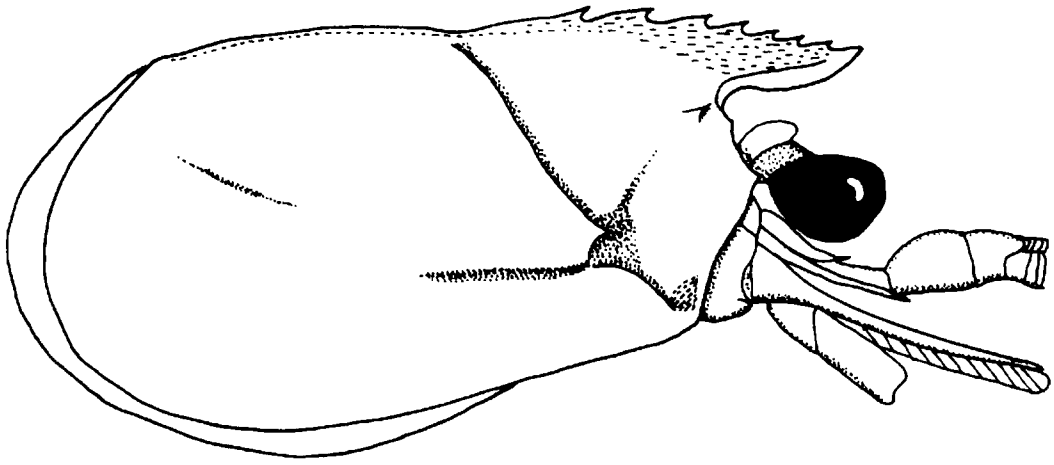

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AUSTRALIAN SPECIES OF SOLENOCERIDAE (PENAEOIDEA: DECAPODA)

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Twenty-seven species of Solenoceridae from Australian seas, including one new species, have been identified (* indicates new records): **Cryptopenaeus clevai*, *C. crosnieri*, *Gordonella kensleyi*, *G. paravillosa*, *Hadropenaeus lucasi*, *Haliporoides cristatus*, *H. sibogae*, **Haliporus taprobanensis*, **Hymenopenaeus aequalis*, *H. halli*, **H. neptunus*, *H. propinquus*, *Mesopenaeus brucei*, **Solenocera alfonso*, **S. annectans*, *S. australiana*, **S. barunajaya*, **S. bifurcata* sp.nov., *S. choprai*, **S. comata*, *S. faxoni*, **S. koelbeli*, **S. melantho*, **S. moosai*, **S. pectinata*, **S. pectinulata*, *S. rathbuni*. Definitions of the family and Indo-West Pacific genera, with a key, are included. Keys to the Indo-West Pacific species are given, together with diagnoses of the Australian species and all diagnoses are accompanied by figures. The zoogeography of the Solenoceridae is discussed briefly. ❐ *Indo-West Pacific, Soleniceridae, Australia, diagnoses, distribution, zoogeography.*

W. Dall, Queensland Museum, PO Box 3300, South Brisbane 4101, Australia; 10 November 1998.

Of the 5 families included in the Penaeoidea (Penaeidae, Solenoceridae, Aristeidae, Benthesicymidae, Sicyonidae) only the species of Penaeidae are well known in Australia (e.g. Dall, 1957; Racek & Dall, 1965; Grey et al., 1983). This is because they are mostly inhabitants of inshore, often shallow waters and some are of considerable commercial importance. In contrast, only 2 species of the Solenoceridae are included by Grey et al. (1983). Kensley et al. (1987) recorded another five known species plus a new species, bringing the total to eight and a further two new species have been described from Australian waters (Pérez Farfante & Kensley, 1985; Crosnier, 1986). The majority of species of the Solenoceridae occur in offshore, deeper waters and are only collected by special or exploratory trawling, but such collections over the last 25 years have shown that there is a much larger range of species than was thought previously . Twenty-six species out of a total of 45 authentic Indo-West Pacific species are now recorded from Australian seas.

There have been a number of key taxonomic papers on solenocerids in recent years by Crosnier (1978, 1984, 1985, 1986, 1988, 1989, 1994a,b) and by Pérez Farfante (1977, 1981 and co-authored papers). Unfortunately, the literature is rather scattered, often in publications not readily available to Australian biologists, is in four languages besides English and mostly on specimens from outside Australian waters. This paper therefore attempts to cover the Australian species in sufficient detail to facilitate identification of local species by fisheries biologists and other non-specialists. As well as 25 known species it includes 1 new species. Definitions are given of the family and eight genera, with keys. Keys to the species of each genus include known Indo-West Pacific species, because it is likely that, in the future, some additional species will be found in Australian seas. The species diagnoses and figures are from specimens in the collections of the Queensland Museum (QM), the Museum & Art Gallery of the Northern Territory (NT) and the Western Australian Museum. All figures were drawn using a stereomicroscope with a camera lucida.

DEFINITIONS

Special taxonomic features. Traditionally, the characteristics of the genitalia (petasma and/or thelycum) have been used as the primary features for specific identification of Penaeoidea, particularly in genera with similar external morphology. The disadvantage of such a system is that, in penaeoids, often specimens of only one sex are available, or the specimen is a juvenile. In the Solenoceridae, however, the majority have sufficient distinctive features of the cephalothorax and abdomen, particularly the former, to enable a positive identification to be made. The genitalia have therefore often not been included in species diagnoses and figures in this paper, unless the features of the genitalia are essential for identification. A complete identification

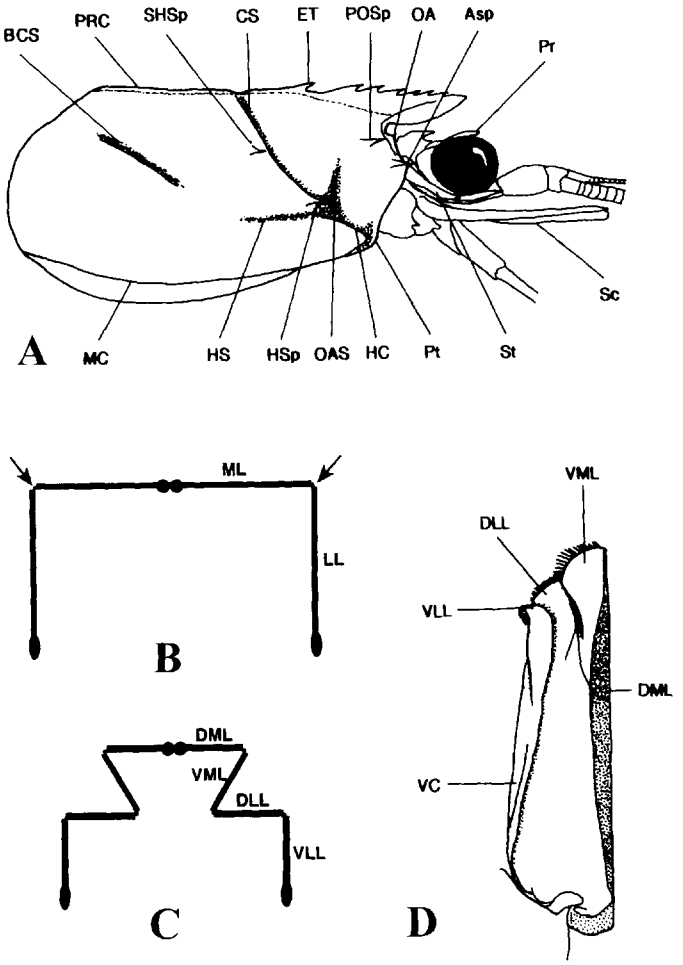

FIG. 1. A, features of taxonomic importance on the cephalothorax of a solenocerid. Asp, antennal spine; BCS, branchiocardiac sulcus (a carina may also be present); CS, cervical sulcus and carina; ET, epigastric tooth (the next tooth is the first rostral tooth); HC, hepatic carina; HS, hepatic sulcus; HSp, hepatic spine; MC, marginal (or sub-marginal) carina; OA, orbital spine (may be only an angle); OAS, orbito-antennal sulcus; POSp, postorbital spine; PRC, postrostral carina; Pr, prosartema; Pt, pterygostomial angle (may be a spine); Sc, scaphocerite; SHSp, suprahepatic (or postcervical) spine; St, stylocerite. B, diagrammatic cross-section of an immature petasma before folding has taken place. The junction of the two halves by cincinnuli is indicated by two solid circles; arrows indicate the direction of infolding; ML, median lobe; LL, lateral lobe. C, cross-section after folding has taken place. DML, dorsomedian lobule; VML, ventromedian lobule; DLL, dorsolateral lobule; VLL, ventrolateral lobule. D, ventral aspect of the right half of a solenocerid petasma; VC, ventral costa; other letters as in B. In a petasma such as this the cincinnuli would extend for the full length of the inner edge of the dorsomedian lobule.

should, of course, include consultation with full descriptions in the literature, which usually include the genitalia.

Cephalothorax. The principal taxonomic features of the cephalothorax of a solenocerid are shown in Fig. 1A. By convention, only half the cephalothorax is shown. Setae have been omitted in all figures of cephalothoraxes, as these are often dense in the Solenoceridae and obscure essential features. Although 'carina' literally means 'a keel', in penaeid taxonomy it is sometimes interpreted to mean a barely discernable, flattened ridge. Such cases as these have not been included as a carina in either the diagnosis or figure. If a carina is included in the diagnosis it usually means an obvious sharp, or at least angular ridge and is shown mostly as an unbroken line. Sulci are included if they are clearly visible and are depicted as stipple.

In six of the eight solenocerid genera the orbito-antennal sulcus runs from near the rim of the orbit to the vicinity of the hepatic spine without a break (although it may be quite weak). In many *Solenocera* species, however, only the posterior part is present (Fig. 1A). It may be deep and extends almost vertically towards the base of the postorbital spine, where it ends and thus could be regarded as an antennal or postantennal sulcus. In other *Solenocera* species there is a weak orbital part indicating that it is a true orbito- antennal sulcus.

The names given by taxonomists to features of the cephalothorax are sometimes not uniform. For example, the postorbital spine may be called a postantennal spine when it is positioned behind the antennal spine, as it is in some genera; the suprahepatic spine is also called the postcervical spine. Definitions and figures of other

anatomical features not shown in Fig. 1A may be found in Dall et al. (1990).

Petasma (Fig. 1B-D). The petasma is developed from the inner rami of the 1st male pleopods and is used to form and implant the spermatophore in the thelycum of the female. In the Solenoceridae the petasma is basically simple, each half being comprised of two longitudinal lobes and coupled with the other half by a median dorsal row of cincinnuli. These lobes are the median and ventral lobes, united by a flexible junction, shown diagrammatically in Fig. 1B. The lobes are in turn subdivided and have been named dorsomedian, ventromedian, dorsolateral and ventrolateral lobules, respectively. They are infolded upon one another to form a channelled structure (Fig. 1C). The thickened free ventral margins are the ventral costae. The distal ends of the lobules may be simple or developed into elaborate structures, often with spinules. A ventral view of the right half of a petasma typical of *Solenocera* species is shown in Fig. 1D.

Appendix masculina. This is formed from the endite of the 2nd male pereopod (Fig. 13E). In the Solenoceridae there are outer and inner projections, sometimes distinguished as the appendix masculina and appendix interna, respecively. As the homology of the inner projection is unknown, in this text they are both referred as the appendix masculina. There is also a spur-like projection on the outside of the base of the appendix masculina.

Thelycum. This is developed on the sterna of the 4th and 5th female pereopods, the spermatophore being implanted on the latter. It is often a quadrangular depression, usually with various internal projections, but occasionally almost featureless and sometimes a convex projection (Figs 13C, 19D). In some species, the features of the thelycum are variable and difficult to interpret and of limited use in the separation of species.

Length. Overall length is difficult to measure accurately in penaeids and often the rostrum and telson are damaged. In this text length is the carapace lenth, i.e. the distance between the posterior rim of the orbit and the posterior rim of the carapace on the midline.

Family SOLENOCERIDAE
(Wood, Mason & Alcock, 1891)

Solenocerinae: Wood, Mason & Alcock, 1891; Crosnier 1978.

DIAGNOSIS. Rostrum laterally compressed, usually shorter than the antennular peduncle, mostly with dorsal teeth only and more than three; ventral teeth if present, restricted to the tip. Antennular flagella usually longer than the peduncle, often longer than the carapace. Prosartema variable, usually prominent, sometimes reduced to a small lobe; ocular scale present, sometimes poorly developed. Cervical sulcus well defined, reaching or nearly reaching the mid-dorsum of the carapace. A postorbital spine (sometimes called postantennal spine) and hepatic spine are always present; antennal spine usually present, other carapace spines variable. Abdomen wholly or partially carinated. Telson with two fixed sub-apical spines, occasionally with moveable lateral spines as well; very rarely without spines at all. Exopods present on thoracic somites 1-7, in some genera on 8 as well; those on the pereopods sometimes reduced. Petasma tubular and simple; appendix masculina with two endites and with a projection on the outer side of the basal segment; thelycum open, often a simple basin shape. Pleurobranchs on thoracic somites 3-8; usually a single arthrobranch, but sometimes two, which may be small or rudimentary on somite 1; two well-developed arthrobranchs on somites 2-7; a podobranch on somite 2, except in *Haliporus* where they are on 2 and 3, sometimes with very small or rudimentary podobranchs on 4-6; epipods on 1-7.

Diagnostic features of the family are the presence of a post-orbital spine, cervical sulcus reaching to or almost to the mid-dorsum, the long antennular flagella and a spur-like projection on the outer side of the basal segment of the appendix masculina. Most inhabit the outer continental shelf down to several hundred metres, with a few occurring at over 1,000m.

The family is comprised of nine genera: *Cryptopenaeus* de Freitas 1979; *Gordonella* Tirmizi 1960; *Hadropenaeus* Pérez Farfante 1977; *Haliporoides* Stebbing 1914; *Haliporus* Bate 1881; *Hymenopenaeus* Smith 1882; *Mesopenaeus* Pérez Farfante 1977; *Pleoticus* Bate 1888; *Solenocera* Lucas 1850. Most inhabit offshore waters, ranging from the middle continental shelf to the oceanic floor, but a few (*Pleoticus muelleri* and *Solenocera* spp.) are found in shallower waters. The key which follows includes all known genera of the Solenoceridae. Three *Pleoticus* spp. are known, of which two are abundant in the W Atlantic; the third, *P. steindachneri* has been recorded only in the deeper waters of the Red Sea (Crosnier 1988). As *Pleoticus* is not otherwise represented in the Indo-West Pacific, it is not dealt with further.

KEY TO THE GENERA OF THE SOLENOCERIDAE

1. Telson with three widely spaced pairs of moveable spines, which may be minute, anterior to a sub-apical fixed pair; with an accessory branchiocardiac carina dorsal to the sulcus 2

   Telson with a single pair of fixed sub-apical spines only, or with none; without an accessory branchiocardiac carina 3

2. Mid-dorsum deeply indented at its junction with the cervical sulcus; with a supra-hepatic (postcervical) spine. A podobranch on the 2nd thoracic somite only . . . . . *Gordonella*

   Mid-dorsum with a shallow depression only in the region of the cervical sulcus; supra-hepatic spine absent. Podobranchs on at least the 2nd and 3rd thoracic somites . . . . . *Haliporus*

3. Dorsal and ventral antennular flagella lamellate and forming a respiratory tube; external ramus of uropod without a distolateral spine . . . . . *Solenocera*

   Dorsal and ventral antennular flagella not forming a respiratory tube, but with the ventral flagellum sometimes flattened; external ramus of uropod with a distolateral spine 4

4. Ventral antennular flagellum strongly compressed proximally, orbital spine well developed . . . . . *Mesopenaeus*

   Ventral antennular flagellum more or less cylindrical, orbital spine absent or only a weak orbital angle present 5

5. Epigastric tooth separated from the 1st rostral tooth by an interval not markedly different from that between the 1st and 2nd rostral teeth. 6

   Epigastric tooth, or epigastric tooth and 1st rostral tooth separated from the remaining teeth by a relatively long interval 8

6. Rostrum low, with ventral margin straight or concave; submarginal carina present . . . . . *Pleoticus*

   Rostrum deep, with ventral margin markedly convex; submarginal carina absent 7

7. Pterygostomian spine present, branchiostegal spine absent; postrostral carina well defined and almost reaching the posterior rim of the carapace . . . . . *Cryptopenaeus*

   Branchiostegal spine present, pterygostomian spine absent; postrostral carina not extending much beyond the top of the cervical sulcus . . . . . *Hadropenaeus*

8. Post-cervical (supra-hepatic) spine absent. Epigastric and 1st rostral tooth separated from the remaining teeth by a relatively long interval . . . . . *Hymenopenaeus*

   Post-cervical (supra-hepatic) spine present Epigastric tooth separated from the 1st rostral tooth by a relatively long interval . . . . . *Haliporoides*

Cryptopenaeus de Freitas, 1979

Cryptopenaeus de Freitas, 1979; Pérez Farfante & Kensley, 1997.

DIAGNOSIS. Carapace and abdomen robust, integument firm, mostly glabrous or minutely punctate. Rostrum short, not exceeding the 2nd antennular segment, ventral margin convex, tip horizontal or slightly upturned; with dorsal teeth only, the distance between the epigastric and 1st tooth similar to that between the 1st and 2nd. Antennal, postorbital, hepatic and pterygostomian spines present. Cervical sulcus deep, but not reaching the mid-dorsum; hepatic sulcus deep and long, the anterior end almost reaching the base of the pterygostomian spine; hepatic carina well defined; orbito-antennal sulcus shallow and wide. A dorsal carina on abdominal somites 2-6. Telson with a pair of short fixed sub-apical spines, no moveable lateral spines. Eye of medium size and reaching the tip of the 1st segment of the antennular peduncle; a foliaceous prosartema present, extending beyond the eye. Antennular flagella similar, cylindrical and long. Mandibular palp two-segmented, the segments subequal in length, the distal narrower than the basal and tapering to a rounded apex. Exopods on all thoracic appendages.

Petasma with ventrolateral lobule distally free from the dorsolateral lobule; both with firm integument; right and left petasmal halves united by cincinnuli only for about the proximal half of their length. Thelycum simple, open.

This genus at present includes four species, all rather similar, attaining a large size (over 50mm) and inhabiting depths of 200-500m.

KEY TO THE SPECIES OF *CRYPTOPENAEUS*

1. Anterior end of hepatic carina strongly recurved ventro-posteriorly . . . . . *C. clevai*

   Anterior end of hepatic carina not recurved 2

2. Postrostral carina with a shallow notch behind the level of the top of the cervical sulcus; a spine on the basis of the 3rd pereopod . . . . . *C. catherinae*

   Postrostral carina without such notch; no spine on the basis of the 3rd pereopod 3

3. Scaphocerite exceeding the tip of the antennular peduncle by about 0.25 its own length; sternite of 5th female pereopod with two rounded anterior prominences . . . . . *C. crosnieri*

   Scaphocerite about as long as the antennular peduncle; sternite of 5th female pereopod with a single rounded anterior prominence . . . . . *C. sinensis*

C. clevai and *C. crosnieri* have been collected from Australian waters; *C. sinensis* has been recorded from NW Australia (Pérez Farfante & Kensley, 1985), but the figures of the petasma and appendix masculina appear to be those of *C. clevai*; *C. catherinae* appears to be endemic to E Africa (off Mozambique). All of these species are uncommon at present.

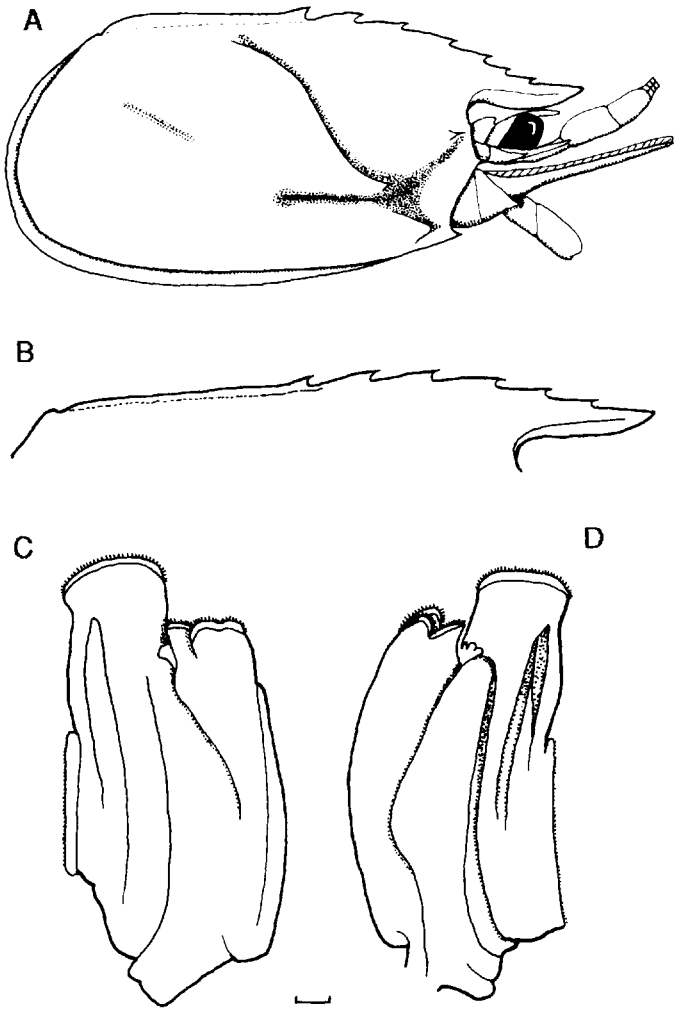

FIG. 2. *Cryptopenaeus clevai* Crosnier, 1984. A, F, 45mm, WAMC24250, 12°51'S 118°25'E, 449m. B, M, 35mm, profile of carapace dorsum. C, ventral left half of petasma, male 40mm WAMC21408, 17°S 119°28'E, 435m. D, dorsal left half of petasma, WAMC21408. (Scalebar = 1mm)

Cryptopenaeus clevai Crosnier, 1984
(Fig. 2A-D)

Cryptopenaeus clevai Crosnier, 1984: 26-31, figs 1a-b, 2, 3a; 1994b.
Cryptopenaeus sinensis Pérez Farfante & Kensley, 1985.

MATERIAL: NTCR007064, F, 56.5mm; WAM21396, F, 64mm; 21398, M, 38.5mm, F, 53.5mm; 21401, F, 55mm; 21408 4M, 40-42mm; 24250 2M, 35, 36mm, 3F, 26, 43, 47.5mm

DIAGNOSIS: Rostrum with 6-7 teeth including the epigastric and reaching the middle of the 2nd segment of the antennular peduncle; four teeth on the carapace. Upper rostral profile sigmoid with the highest point at the 1st rostral tooth, descending to the orbital margin and then ascending towards the tip, the general appearance markedly 'hump-backed' in large specimens, less so in those below 40mm length (Fig. 2B). Postrostral carina prominent, almost reaching the posterior edge of the carapace and without a depression or notch. Carapace glabrous; orbital angle almost absent; antennal and pterygostomian spines small, postorbital and hepatic spines prominent. Anterior end of hepatic carina recurved ventro-posteriorly; hepatic sulcus deep; cervical carina prominent, the carina and sulcus ending well short of the dorsal midline. Branchiocardiac sulcus well defined and occupying the middle third of the branchial region. Prosartema reaching 0.3 of the 2nd antennular segment; scaphocerite exceeding the tip of the antennular peduncle by about 0.25 its length. First pereopod with large spines on the basis and ischium and a small spine midway along the merus; 2nd pereopod with a spine on the basis only; no spines on the 3rd pereopod.

Petasma (Fig. 2C,D). Distal end of the dorsolateral lobule flattened and fringed with minute spinules; recurved laterally with four small backwardly directed teeth; distal ventro-lateral lobule divided distally, one broad with a slight distal indentation, the other acute and both fringed with minute spinules.

Colour. Deep pink to red with whitish markings, rostrum bluish.

REMARKS. The Western Australian Museum has a large collection of this species, which has often been trawled at around 450m depth.

DISTRIBUTION. NW Australia, 390-450m. Known range, Indonesia (type locality), Japan, Taiwan, N Australia, New Caledonia, Wallis and Futuna I., 300-540m

Cryptopenaeus crosnieri
Pérez Farfante & Kensley 1985
(Fig. 3)

Cryptopenaeus crosnieri Pérez Farfante and Kensley 1985: 280-287, figs 1-4.

MATERIAL: QMW15825, 2 F, 35, 40mm; 15826, M, 33.5mm [allotype]; 15839, 2 F, 42, 44mm; 16214, F, 49mm; 16222, 2 F, 45.5, 46.5mm.

DIAGNOSIS. Dorsal rostral margin convex, rostral teeth including epigastric 7-9 , usually 8, the rostrum reaching about the distal end of the 1st segment of the antennular peduncle in adults. Postrostral carina well-defined, almost reaching the posterior border of the carapace and without a notch or depression. Postorbital and hepatic spines large and slender, antennal and pterygostomian spines smaller. Hepatic carina ending beside a shallow, elongate depression which extends towards the pterygostomian spine; branchiocardiac sulcus extremely faint. Prosartema long and narrow and reaching almost half the 2nd antennular segment. Antennular flagella subequal in length and 1.5-2.0 the length of the carapace; scaphocerite exceeding the antennular peduncle by up to 0.25 its length. First pereopod with a prominent basial spine, a similar ischial spine and a small spine about halfway along the ventral edge of the merus; a large basial spine on the 2nd pereopod. Abdomen with a low dorsal carina on the posterior half of the 2nd somite; carina becoming sharp on the 4th to 6th.

Fifth thoracic sternite of female with a subrectangular plate with a deep longitudinal groove on each side, each with a strong lateral ridge joined anteriorly by a transverse ridge; coxa of 5th pereopods produced inwards in a plate bearing an anteriorly-directed spine; sternite of 4th pereopods with a prominent median ridge with a large blunt anterior tooth.

REMARKS. Pérez Farfante & Kensley (1985) state that there is a 'very minute' spine on the merus of the 3rd pereopod in this species, but no such spine could be found on the above specimens.

Colour predominantly deep pink to red with whitish markings (Crosnier, 1994b)

DISTRIBUTION. NW Australia, E Australia 16°-30°S, 230-440m. Known range, Kai I. (Indonesia), N Australia.

Gordonella Tirmizi, 1960

Gordonella Tirmizi, 1960: 372; Crosnier, 1988 (emend): 586-587; Pérez Farfante & Kensley, 1997.

DIAGNOSIS. Integument soft, with prominent accessory lateral carinae on the carapace and abdomen, which appear to reinforce it. Rostrum straight, sharply tapering and slightly upturned, with dorsal teeth only and not exceeding the 2nd segment of the antennular peduncle. Distance between the epigastric tooth and 1st rostral tooth similar to that between the remaining teeth. Cervical sulcus ending in a deep notch in the dorsum; carapace strongly convex behind this notch. Antennal, postorbital, suprahepatic (postcervical), hepatic and pterygostomian spines present. Abdomen relatively slender, with dorsal carinae on all somites. Telson pointed apically, with a pair of sub-apical spines and with three pairs of small widely spaced moveable spines on the lateral border. Eye small and fully pigmented, ocular scale reduced, stylocerite poorly developed. Antennular flagella identical, cylindrical, filiform and very long. Mandibular palp 3-segmented, the distal segment slender; incisor process of the mandible long and entire; molar process small. Exopods on all thoracic appendages, those on the pereopods very small.

This genus was originally erected by Tirmizi (1960) to include what was mistakenly thought to be a new species, *G. polyarthra,* but which turned out to be a poorly preserved specimen of *Haliporus villosus* Alcock & Anderson, 1894. However, this species is sufficiently different from other species of *Haliporus* to warrant the

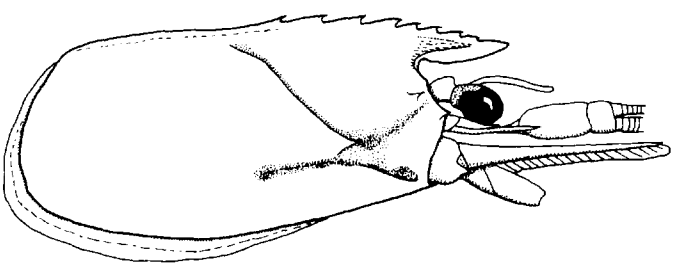

FIG. 3. *Cryptopenaeus crosnieri* Pérez Farfante & Kensley, 1985. QMW15825, F, 35mm, 28°11'S 153°54'E, 230m.

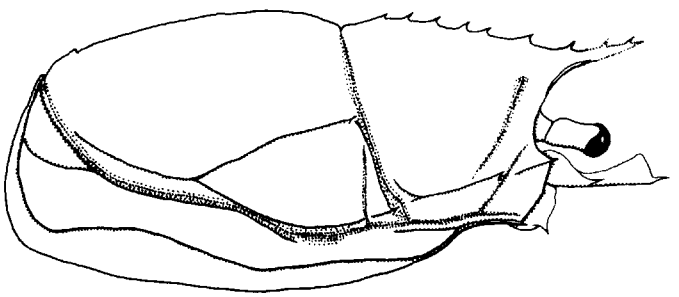

FIG. 4. *Gordonella paravillosa* Crosnier, 1988. QMW00456, F (paratype), 47.5mm, 17°45'S 148°01'E, 1,147-1,132m.

retention of the genus, which has been fully redefined by Crosnier (1988), and now includes three species, all from the Indo-West Pacific. *Gordonella* has close affinities with *Haliporus*, and the species of both genera have rarely been caught at depths less than 750m, most inhabiting the 1,000-6,000m range.

Only three species, all rather different in appearance from most other solenocerids, are included in this genus.

KEY TO THE SPECIES OF *GORDONELLA*
(after Crosnier, 1988)

1. Integument entirely covered by a dense, short pubescence 2
   Integument glabrous . . . . . *G. kensleyi*
2. Prosartema absent . . . . . *G. paravillosa*
   Prosartema present . . . . . *G. villosa*

The type locality of *G. kensleyi* Crosnier, 1988 is New Caledonia, but it has also been collected from 2,450m on the Lord Howe Rise (A. Crosnier pers. com.) and thus could be considered to be an Australian species as well as *G. paravillosa*. It has not been described and figured here as no specimens were available. *G. villosa* is known only from the Indian Ocean and may be present off Western Australia. *Gordonella* species appear to be uncommon, if not rare, but this apparent rarity may be due to their habitat depths, which are rarely fished.

Gordonella paravillosa Crosnier, 1988
(Fig. 4)

Gordonella paravillosa Crosnier, 1988: 589, figs 2d, 3c, 12a, 13, 14, 15a-e, 16a-f

MATERIAL: QMW13224, F, 47.5mm, paratype.

DIAGNOSIS. Cephalothorax bulbous in profile, abdomen relatively slender with long pleopods. Cuticle of the carapace thin and flexible and covered with setae. Rostrum upturned, exceeding the eye, teeth fairly evenly spaced, the 1st smaller than the others or vestigial; adrostral carina short; postrostral carina extending almost to the posterior edge of the carapace, a small tubercle towards the posterior end. No orbital angle; post-orbital spine post-antennal in position; post-orbital, antennal, hepatic, suprahepatic, pterygostomian spines present and of similar size; spines and carinae sharp. A short antennal carina present and an orbito-antennal sulcus running below the postorbital spine to its junction with the hepatic sulcus. Postorbital spine extended posteriorly in a carina, interrupted by the cervical sulcus. A postorbital sulcus running parallel to the orbital margin from the base of the rostrum to the carina behind the postorbital spine. Hepatic carina extending posteriorly from the pterygostomian spine to the level of the base of the hepatic spine; hepatic sulcus extending from its junction with the orbito-antennal sulcus to its junction with the branchiocardiac sulcus. The latter deep and reaching the posterior mid-dorsum; branchiocardiac carina prominent and with an accessory parallel carina on its dorsal side, which ends at a small vertical sulcus just behind the hepatic spine; suprahepatic spine with a carina which extends posteriorly to meet the latter. Marginal carina well defined, running from its juction with the hepatic carina to the posterior mid-dorsum of the carapace. Cervical sulcus deep and interrupting the postrostral carina with a deep cleft; cervical carina extending from the suprahepatic spine to the hepatic spine. Eye small; prosartema absent; antennular flagella cylindrical and longer than the carapace. Abdomen dorsally and mid-laterally carinated on all six somites; telson with a pair of fixed sub-apical spines and three pairs of mobile lateral spines. Thelycal plate of the 4th pereopods subtriangular, apex facing posteriorly, that of the 5th pereopods similar but markedly larger.

REMARKS. Because of the very soft and flexible cuticle, there tends to be some distortion of preserved specimens, making interpretation of features of the carapace difficult. However, Fig. 4, taken from a paratype, agrees closely with that of the holotype (Crosnier, 1988, fig. 12a). The missing tip of the rostrum in the paratype was taken from this figure. Crosnier records the

length of the this paratype as 43mm, presumably a typographical error, as it was found to be 47.5mm.

G. paravillosa is similar to *G. villosa*, but as the holotype is poorly preserved and damaged, the only reliable means of separating the two species at present is by the key feature i.e. the lack of a prosartema on the antennular peduncle.

The long pleopods and thin cuticle suggest that *G. paravillosa* is at least partly pelagic.

DISTRIBUTION. Indonesia (Celebes region, 1280 m), off NE Queensland, 17-18°S 148°E, 1147-1200m (type locality), and New Caledonia (A. Crosnier, pers. com.)

Hadropenaeus Pérez Farfante, 1977

Hadropenaeus Pérez Farfante, 1977: 315-316; Pérez Farfante & Kensley, 1997.

DIAGNOSIS. Body fairly robust, integument firm, rostrum short, not exceeding 1/3 of the 2nd segment of the antennular peduncle, with dorsal teeth only, the distance between the epigastric and 1st rostral tooth similar to that between the 1st and 2nd teeth. Orbital and pterygostomian spines absent; postorbital, antennal, hepatic and branchiostegal spines well defined. Cervical sulcus almost reaching the middorsum; hepatic sulcus present; branchiocardiac carina absent, sulcus barely defined or absent. Abdomen dorsally carinated on 3rd to 6th somites. Telson with a pair of fixed sub-apical spines, without lateral moveable spines. Prosartema foliaceous and reaching at least as far as the eye. Antennular flagella longer than the carapace, subcylindrical, rarely with the ventral flagellum slightly flattened. Mandibular palp 2-segmented, the two subequal in length, the distal segment tapering to a blunt apex. First pereopod with a spine on the basis, ischium and merus. Fifth pereopod slender and much longer than the 4th. Epipods on all thoracic somites. Outer ramus of the uropod with a distolateral spine reaching as far as the lamella of the uropod. Petasma with terminal part of the ventrolateral lobe plate-like with thickened cuticle; ventromedian lobule broadly expanded distally. Basal sclerite of appendix masculina produced into an elongate ventrolateral spur. Thelycum of open type, not enclosing a seminal receptacle.

This genus so far contains only four species, of which two are from the Atlantic; all are similar in general appearance and have been recorded from the 100-600mdepth range, but more usually 200-500m.

KEY TO THE INDO-WEST PACIFIC SPECIES OF *HADROPENAEUS*

Dorsal carina of 6th abdominal somite without lateral moveable spines, posterior margin of somite not crenate. Rostrum with a small accessory adrostral carina just below the bases of the teeth . . . . . *H. lucasii*

Dorsal carina of 6th abdominal somite with 4 lateral moveable spines on either side, posterior margin of somite crenate. Rostrum without an accessory adrostral carina . . . . . *H. spinicauda*

Of the two Indo-West Pacific species only *H. lucasii* has been recorded from Australia.

Hadropenaeus lucasii (Bate 1881) (Fig. 5)

Solenocera lucasii Bate, 1881: 185.
Philonicus lucasii Bate, 1888.
Pleoticus lucasii Bate, 1888.
Haliporus modestus Rathbun, 1906.
Haliporus lucasi Bouvier, 1908.
Haliporus lucasii de Man, 1911.
Hymenopenaeus lucasii Burkenroad, 1936; Anderson & Lindner, 1945; Kubo, 1949.
Hymenopenaeus lucasi Crosnier & Forest, 1973; Crosnier, 1978.
Hadropenaeus lucasi Crosnier, 1984, 1989, 1994a,b; Kensley,Tranter & Griffin, 1987.
Hadropenaeus lucasii Pérez Farfante, 1977; Hayashi, 1984b,c.

MATERIAL. QMW15876, F, 8mm; 15877, F, 7.5mm. 2M, 7.5, 8mm; 158028 M, 7.5mm; 15888, F, 21mm; 15898, 3F, 13.5, 14.5, 20mm; 16205, M, 20mm.

DIAGNOSIS. Carapace almost entirely glabrous, with some pubescence in the rostral area; abdomen glabrous. Rostral upper edge straight and almost horizontal, teeth prominent, ventral margin convex; rostral teeth, including epigastric 6-8, mostly 7; 3rd rostral tooth around the level of the orbital margin; rostrum reaching about as far as

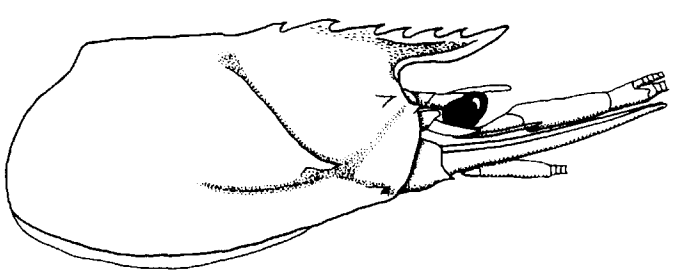

FIG. 5. *Hadropenaeus lucasii* (Bate, 1881). QMW15888, F, 21mm, 27°55'S 154°E, 555m.

the 1st segment of the antennular peduncle. Adrostral carina reaching the last rostral tooth; an accessory carina extending from the base of the 2nd to the penultimate rostral tooth, the two carinae enclosing a shallow, setose channel; postrostral carina ending just behind the level of the cervical sulcus. Orbital angle absent, but the lower orbit extended into a short inwardly-directed shelf. Hepatic carina absent, the sulcus shallow, inclined anteroventrally and ending in a depression below the prominent branchiostegal spine. Prosartema exceeding the eye; antennular flagella long and of unequal length. First pereopod with long spines on the basis and ischium, a smaller spine at the mid-length of the merus; a long spine on the basis of the 2nd pereopod; in both sexes coxa of the 4th and 5th pereopods with conspicuous antero-median spines. Abdomen with a well-developed dorsal carina on the 3rd to 6th somites, rounded on the 3rd, keel-like on the 4th to 6th. (For description of petasma and thelycum see Pérez Farfante, 1977; Crosnier, 1978).

REMARKS. Rostrum blue; carapace red to light pink, with whitish patches; abdomen with vertical bands of red, lighter colour between; uropods similarly banded, other appendages red.

DISTRIBUTION. N Australia and E Australia 17°-28°S, 300-590m. Known range, Madagascar through the Indian Ocean and W Pacific, Japan to Hawaii and Wallis and Futuna Is, 180-600m. The type locality is the Kai I. and *H. lucasii* has recently been collected here and also further south in the Arafura Sea (Crosnier 1994a). The collections off E Australia further extends the range of this species.

Haliporoides Stebbing, 1914

Haliporoides Stebbing 1914: 20; Pérez Farfante & Kensley, 1997.

DIAGNOSIS. Carapace elongate, integument flexible; rostrum exceeding the middle of the 2nd segment of the antennular peduncle, with dorsal teeth and often with ventral rostral teeth towards the tip, ventral margin straight or concave; the interval between the epigastric tooth and the 1st rostral teeth appreciably greater than that between the remaining teeth. Postorbital, antennal, pterygostomian, hepatic and supra-hepatic (postcervical) spines present; orbital and branchiostegal spines absent. Cervical sulcus reaching the mid-dorsum but not incising it; hepatic sulcus long, reaching or almost reaching the base of the pterygostomian spine; orbito-antennal and branchiocardiac sulci clearly defined; a sharp submarginal carina present. Eye large, maximum length 0.2 or more the length of the carapace. Antennular flagella similar in length, subcylindrical and three times or more the length of the carapace. Mandibular palp 3-jointed, 4th and 5th pereopods of similar length, 1st pereopod with or without a basial spine; small exopods on all pereopods and maxillipeds. Pleopods large in relation to the pereopods, suggesting that the genus is at least partly natatory.

KEY TO THE INDO-WEST PACIFIC SPECIES OF *HALIPOROIDES*

1. Rostrum with 6-8 dorsal teeth plus epigastric and 1-2 ventral teeth, slender and slightly down-curved or straight . . . . . *H. sibogae*

   Rostrum with 10-11 dorsal teeth plus epigastric, blade either very high and strongly down-curved, or high with slightly upcurved tip 2

2. Rostral blade very high and down-curved with 1-2 ventral rostral teeth. . . . . *H. triarthrus*

   Rostral blade high, arched behind the 1st ventral rostral tooth and slightly upcurved at the tip; 2-4, usually 3 ventral rostral teeth. . . . . *H. cristatus*

These three species are similar in appearance and overlap in some of their features e.g. rostral teeth. *H. sibogae* is particularly variable and two subspecies have been named:

H. sibogae madagascarensis Crosnier, 1978 and *H. sibogae australiensis* Kensley, Tranter & Griffin, 1987. The latter authors found that all the Australian specimens examined belonged to this subspecies. *H. triarthrus* also includes a subspecies, *H. t. vniroi* (Crosnier, 1978). These subspecies do not key out satisfactorily and are best identified by a table (Kensley et al., 1987).

Of the three *Haliporoides* species *H. sibogae* and *H. triarthrus* are commercially abundant, while *H. cristatus* appears to be fairly common.

Haliporoides cristatus
Kensley, Tranter & Griffin, 1987
(Fig. 6A)

Haliporoides cristatus Kensley, Tranter & Griffin, 1987: 265, figs 1, 2, 5G-L.

MATERIAL: QMW11285, 2F, 23, 23mm; 14288, M, 17.5mm; 14308, M, 20mm, F, 18mm; 15857, F, 27.5mm; 15889, 3M, 17.5, 19, 19mm; 5F, 17, 18, 20, 20.5, 21mm; 15895, F, 25mm; 15902, F, 28mm; 16216, F, 32mm; 16212, F, 34mm.

DIAGNOSIS. Carapace and abdomen finely punctate-setose. Rostrum arched, deep and often

upturned at the tip, reaching from two thirds to the tip of the 2nd segment of the antennular peduncle; with 8-12 dorsal teeth, including the epigastric, and 2-4 ventral teeth (mean 10/3). Adrostral carina prominent; a lower but distinct accessory adrostral carina below the upper rostral teeth. Postrostral carina ending about halfway between the tip of the epigastric and the top of the cervical sulcus. Antennal, postorbital and pterygostomian spines of similar size and larger than the hepatic and supra-hepatic spines, which are also of similar size to one another. A short antennal carina and a shallow orbito-antennal sulcus present. Hepatic carina short; anterior part of the hepatic sulcus shallow, running from the anterior margin of the carapace to the base of the hepatic spine and continuing, slightly deeper, for a similar distance posteriorly. Branchiocardiac sulcus fairly shallow and extending from just behind the end of the hepatic sulcus almost to the posterior margin of the carapace; branchiocardiac carina not defined. Cervical sulcus deep and reaching the dorsum; cervical carina blunt and not prominent; submarginal carina sharp. Prosartema reaching as far as the eye. No spine on the basis of the 1st pereopod. Other features, including the petasma and thelycum as described by Kensley et al. (1987).

REMARKS. Although the carapaces of *H. sibogae* and *H. cristatus* are similar, the rostral shape and number of teeth are quite different. In the field or with fresh specimens, colour may enable quick provisional identifications to be made, but this needs to be verified.

Colour yellowish, with a distinctive white stripe on the dorsal surface of the uropods.

DISTRIBUTION. So far collected only from E Australian waters, from 16°-35°30'S, 250-650m.

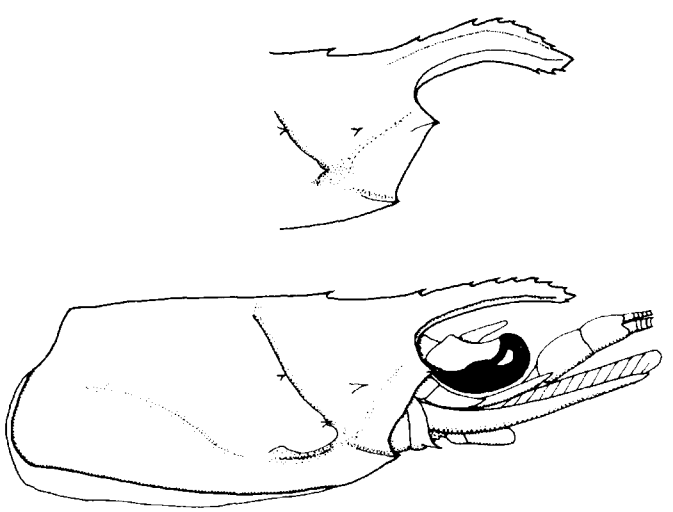

FIG. 6. A, *Haliporoides cristatus* Kensley, Tranter & Griffin, 1975. QMW16212, F, 34mm, 15°58'S 149°56'E, 590m. B, *H. sibogae* (de Man, 1907). QMW15917, F, 34.5mm, 23°35'S 153°20'E, 650m.

Haliporoides sibogae (de Man, 1907) (Fig. 6B)

Haliporus sibogae de Man, 1907: 38; 1911: 7,38; 1913, pl. 3, fig. 10a-b, pl. 4, fig. 10c-q.
Haliporoides sibogae Pérez Farfante, 1977; Crosnier, 1984, 1989, 1994; Grey, Dall & Baker, 1983; Hayashi, 1984b.
Haliporoides sibogae australiensis Kensley Tranter & Griffin, 1987: 269, figs 3-5.
Hymenopenaeus sibogae Crosnier, 1978.
Parahaliporus sibogae Kubo, 1949.

MATERIAL. QMW15882, 2F, 24, 38.5mm; 15887, 5M, 23.5, 23.5, 24.5, 25.5, 30mm; 15890, 2M, 26, 27mm; 15901, F, 29mm; 15917, 3F, 27, 35, 35.5; 16213, F, 35mm; 16216, F, 32mm; WAMC16930, M, 36mm, F, 37mm; 21400, 2F, 36, 42mm; 21409, 2M, 32, 40mm, F, 50mm; 25275, 2M, 28, 31mm; 25276, F, 19mm; 25277, M, 30mm, 2F, 28, 29mm; 25278, M, 27mm; 25279, M, 29mm; 25280, F, 39mm; 25281 F, 31mm; 25283, 2F, 36, 38mm; 25284, F, 38mm; 25285, 2F, 30, 38mm; 25286, F, 40mm; 25287, F, 40mm; 25288, 2M, 22, 30mm, 4F, 37, 38, 39, 40mm.

DIAGNOSIS. Cuticle flexible, carapace finely punctate-setose. Rostrum ascending from the carapace and then down curving slightly; reaching from half the 2nd segment of the antennular peduncle to its tip; teeth 7-9, usually 8 dorsal, including the epigastric, and 1-2 ventral. Postrostral carina ending about half way between the tip of the epigastric tooth and the top of the cervical sulcus. Orbital angle absent, antennal and postorbital spines of equal size and larger than the remaining spines, the postorbital behind the antennal. Hepatic, suprahepatic and pterygostomian spines of similar size. Cervical sulcus deep and almost reaching the mid-dorsum. Hepatic carina short, not strongly defined and extending towards the tip of the pterygostomian spine; the hepatic sulcus fairly shallow anteriorly and reaching from the anterior rim of the carapace to the base of the hepatic spine, where it deepens and extends posteriorly

for a similar distance. A shallow orbito-antennal sulcus present. Branchiocardiac sulcus well defined, almost meeting the hepatic sulcus and almost reaching the posterior rim of the carapace; branchiocardiac carina not sharply defined. Sub-marginal carina sharp. Prosartema not quite reaching as far as the eye. No spine on the basis of the 1st pereopod. Ventro-median lobe of the petasma tapering to a blunt point, sometimes curved, sometimes almost straight. Sternite of the female 5th pereopod without a longitudinal ridge.

REMARKS. Kensley et al. (1987) considered that there were sufficient differences in the eastern Australian specimens to warrant the erection of a new subspecies *H. sibogae australiense*. Their justification for this was the length of the postrostral carina, the size of the suprahepatic spine relative to the hepatic spine, the absence of a longitudinal ridge on the sternite of the female 5th pereopod, the ventromedian lobule of the petasma not distally bent, the zygocardiac ossicle structure and slight differences in the appendix masculina. They found that these features were consistent for all of the Australian specimens examined. However, the Queensland Museum specimens, while agreeing with the *H. sibogae australiense* criteria, also agree closely with both de Man's (1913) figures and Crosnier's (1978) description and figures of the syntype of *H. sibogae* . An exception is the lack of a longitudinal ridge on the female sternite, but even here de Man (1913) figures a thelycum where it is absent and states that in the holotype it is 'faintly carinate'. The figure in Liu & Zhong (1986) is small, but no ridge is shown. Examination of the 10 males and 20 females from the Western Australian Museum, collected from the northwestern region of Australia showed that 4 of the criteria used by Kensley et al. (1987) are unreliable as distinguishing features. The hepatic and suprahepatic spines were variable in size and in only 60% were they of similar size; the extent of the postrostral carina was variable and dependent on the interpretation of 'carina', but in 40% of cases could be said to reach as far as the cervical sulcus; the shape of the thelycal plate on the female 5th pereopods varied from a slight convexity to a round hump or a broad longitudinal ridge and in one case could be said to be 'faintly carinate'; the distal end of the ventromedian lobe of the petasma was curved in three cases and bent in one. The NW Australian specimens could be expected to be closely similar to the type specimens from Indonesia, with consistent differences distinguishing them from the E Australian subspecies, but such differences do not appear to exist and the status of *H. sibogae australiens* is thus very doubtful.

Colour is uniformly red-pink to bright red.

DISTRIBUTION. E Australian coast from 16°-40°S, NW Australia; 350-900m. Fished commercially off E Australia and known as the Royal Red Prawn. Known range, Madagascar to Indonesia, South China Sea, Japan, Australia and New Zealand, 100-900m.

Haliporus Bate, 1881

Haliporus Bate, 1881: 85; 1888: 284; Crosnier, 1988; Pérez Farfante & Kensley, 1997.

DIAGNOSIS. Body glabrous or pubescent, integument soft or firm. Abdomen with lateral carinae; carapace moderately deep. Rostrum variable in length and shape, no ventral teeth; distance between the epigastric tooth and 1st and 2nd teeth not markedly different. Antennal, postorbital, hepatic and pterygostomian spines present. Branchiocardiac sulcus deep, the carina prominent; with an accessory carina above and parallel to the sulcus. Cervical sulcus deep and with a large depression at the dorsum of the carapace. All abdominal somites with a dorsal carina, with or without a terminal tooth. Telson with a pair of small fixed sub-apical spines, and with three pairs of widely spaced mobile spinules, which may be minute. Eye small, maximum diameter 0.09 the length of the carapace or smaller; cornea pigmented and much wider than its peduncle, or about the same width as the peduncle and lightly pigmented. Prosartema present, slightly or well developed, never foliaceous. Stylocerite well developed. Antennular flagella identical, cylindrical and filiform and very long. Mandibular palp with three segments, the 1st annular and very short, the 2nd much longer and wide, the 3rd slender and much shorter than the 2nd. Fourth pereopods a little shorter or clearly longer than the 3rd; 5th much longer than all the other pereopods; no pereopods filiform. Exopods on all thoracic somites; that on the 2nd maxilliped attaining or surpassing the extremity of the merus; that of the 3rd small, single or multi-segmented. Outer ramus of uropods with a strong disto-lateral tooth, not as long as the lamellar part. Pleopods long in relation to the thoracic appendages.

Thelycum of open type, without a seminal receptacle. A rounded projection on the sternite

of thoracic sternite 7, a larger one on sternite 8. Petasma symmetrical with simple structure; dorsomedian lobule very short to short, extending for 0.15-0.30 the length of the petasma; ventromedian lobule spatulate, more or less curved at its extremity; dorsolateral lobule distally wide and sinuous; ventrolateral lobule with extremity well detached, sometimes enlarged, weakly or strongly recurved. Appendix masculina triangular in cross section, with two or three of its faces concave and longer than the appendix interna; the latter either subcylindrical or flattened. Base of the endopods of the 2nd pleopods with a large foliaceous expansion, more or less recurved distally.

Podobranchs always present on somites 2 and 3, sometimes on 4-6 as well, those on 3-6 small to rudimentary.

The above definition is from Crosnier (1988), who revised the genus and its 3 constituent species in detail. These 3 species are included in the following key, also from Crosnier. *H. curvirostris* has so far been collected only from the Pacific at depths between 4,361 and 5,700m; *H. thetis* has been recorded from the Galapagos Is and the Indian Ocean at depths between 2,300 and 3,625m; *H. taprobanensis* appears to live at lesser depths (see below).

KEY TO THE SPECIES OF *HALIPORUS*

1. Integument soft. Eye not exceeding half the 1st segment of the antennular peduncle, the cornea lightly pigmented and of similar width to its peduncle. Distal part of rostrum down-curved . . . . . *H. curvirostris*

   Integument firm. Eye attaining the tip of the 1st segment of the antennular peduncle, the cornea black and much wider than its peduncle. Rostrum straight or upcurved . . . 2

2. No postero-dorsal spine on the 4th abdominal somite; dorsum of 1st to 4th abdominal somites with numerous pits . . . . . *H. thetis*

   A postero-dorsal spine on the 4th abdominal somite; dorsum of 1st to 4th abdominal somites without numerous pits . . . . . *H. taprobanensis*

Haliporus taprobanensis
Alcock & Anderson, 1899
(Fig. 7)

Haliporus taprobanensis Alcock & Anderson, 1899a: 280; Alcock & Anderson, 1899b; Alcock, 1901; Crosnier, 1978, 1984, 1988, 1994; de Freitas, 1985; Liu & Zhong, 1986.

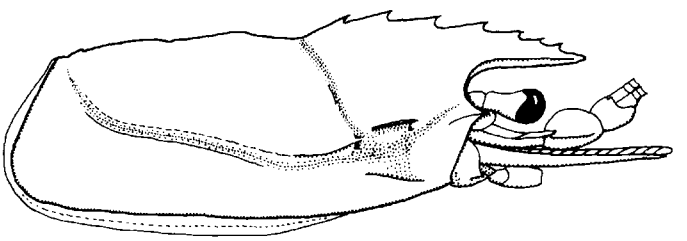

FIG. 7. *Haliporus taprobanensis* Alcock & Anderson, 1899. NTCR006634, F, 53.5mm, 8°38'S 132°E, 525-540m.

Hymenopenaeus taprobanensis Burkenroad, 1936; Anderson & Lindner, 1945; Burukovsky, 1974.
Hymenopenaeus kannemeyeri Kensley, 1977.

MATERIAL. NTCR006634, 5F, 41.5, 49.5, 50, 53.5, 56mm; NTCR006635, 2F, 44.5, 46mm.

DIAGNOSIS. Body robust, integument calcified, carapace glabrous, but minutely punctate in some areas. Rostrum with 7-8 teeth, including the epigastric, shape variable, upper margin convex, lower margin convex to straight, reaching from about 0.6 the 2nd antennular segment to 0.5 the 3rd. Adrostral carina sharp, orbital angle absent. Antennal, postorbital and hepatic spines prominent and of similar size; pterygostomian spine smaller. Orbito-antennal sulcus shallow; hepatic sulcus deep and extending from below the base of the post-orbital spine to its junction with branchiocardiac sulcus; hepatic carina sharp but short, ending below the hepatic spine. Branchiocardiac sulcus deep and curving towards the dorsum of the carapace almost at its posterior margin; branchiocardiac carina blunt and almost the same length as the sulcus. A post-hepatic carina extending from the hepatic spine to the end of the hepatic sulcus, then continuing as a blunt ridge parallel to the branchiocardiac sulcus. Submarginal carina sharp. Cervical carina very short; the sulcus deep, both sides meeting at the dorsum of the carapace; postrostral carina with a wide depression at this point; postrostral carina reappearing behind the cervical sulcus as a short hump, with another depression about halfway from the cervical sulcus to the posterior border of the carapace, after which the postrostral carina reappears again as a lower hump. Dorsal carina of the abdomen beginning on the posterior half of the 1st somite and with a posterior spine on somites 4-6 only. Sub-apical fixed spines on the telson small, the lateral moveable spinules minute. Peduncle of the eye with a small internal nodule; prosartema a rigid vertical projection with a large apical tuft of

setae. First segment of the antennular peduncle with an antero-median spine; stylocerite well defined; lateral carina of the 1st segment continued on the 2nd segment for most of its length. Scaphocerite with a lateral and a median ridge. First pereopod with basial and ischial spines and a moveable sub-apical spine on the merus.

REMARKS. Crosnier (1988) should be consulted for details of the genitalia. This species is similar to *H. thetis*, but appears to have a shallower depth range and thus has been collected more often.

DISTRIBUTION. In Australian waters, so far collected only between 8°38' and 9°17'S, immediately to the north of Darwin (i.e. just inside Australian territorial waters), 300-540m (300m is the shallowest depth recorded). Known range, off South Africa 28°21'S, Madagascar, south of India, Indonesia and the Philippines to N Australia, 300-1650m.

Hymenopenaeus Smith, 1882

Hymenopenaeus Smith (1882): 91; Pérez Farfante (1976); Pérez Farfante & Kensley (1997).

DIAGNOSIS. Body fairly slender, cuticle thin; rostrum variable in length, but always well exceeding the eye and acute; usually with only dorsal teeth, the epigastric and 1st tooth separated from the remaining teeth by a longer interval than those between the remaining teeth. Orbital spine absent; postorbital, antennal, hepatic and branchiostegal spines present; pterygostomian spine present or absent. Cervical sulcus deep and reaching the dorsum; branchiocardiac sulcus deep, the carina sharp; posthepatic and submarginal carinae present. Telson with a pair of fixed, prominent sub-apical spines. Antennular flagella similar, cylindrical and longer than the carapace. Mandibular palp 2-segmented, narrow with the distal segment much shorter than the 1st. First pereopod with a spine on the basis and usually on the ischium and sometimes on the merus. Exopods on thoracic somites 1-8. Fourth and 5th pereopods long and extremely slender. External ramus of the uropod with a distolateral spine.

There are seven Indo-West Pacific species in this genus, of which four have been recorded from Australian seas. All species are of similar appearance, mostly small, sometimes difficult to distinguish, and inhabiting the lower continental slope.

KEY TO THE INDO-WEST PACIFIC SPECIES OF *HYMENOPENAEUS*

1. Pterygostomian spine present . . . . . *H. sewelli*
   Pterygostomian spine absent 2
2. Eye small, its greatest diameter <0.12 the length of the carapace . . . . . **H. neptunus*
   Eye medium to large, its greatest diameter 0.15 or more the length of the carapace 3
3. Postrostral carina not distinct behind the cervical sulcus 4
   Postrostral carina distinct behind the cervical sulcus and reaching almost to the posterior rim of the carapace . . . . . *H. obliquirostris*
4. Basis and merus of the 1st pereopod each with a ventral spine; scaphocerite about the same length as the antennular peduncle . . . . . *H. halli*
   Basis and merus of the 1st pereopod without spines; scaphocerite exceeding the antennular peduncle by about 0.25 of its length 5
5. Rostral teeth usually 8 or 9; eye large, maximum diameter 0.22-0.24 the length of the carapace; distal ventromedian lobule of petasma with two projections; sternum of female 4th pereopods with a prominent glabrous transverse projection . . . . . *H. equalis*
   Rostral teeth usually 7, eye of medium size, maximum diameter 0.15-0.18 the length of the carapace; distal ventromedian lobule of petasma with a single rounded projection with a minute incision; sternum of female 4th pereopods with a rounded setose projection . . . . . *H. propinquus*

* The rare species *H. furici* Crosnier (1978) is very close to *H. neptunus*, but only two males are known, collected from NW Madagascar. For identification see Crosnier (1978).

Hymenopenaeus equalis (Bate, 1888) (Fig. 8A)

Haliporus equalis Bate, 1888: 285, pl. 41, fig. 1.
Haliporus aequalis de Man, 1911, 1913.
Hymenopenaeus aequalis Kubo 1949; George, 1967, 1969; Lee & Yu, 1977; Crosnier, 1985; Hayashi, 1985; Liu & Zhong, 1986.
Hymenopenaeus equalis Crosnier & Forest, 1973; Crosnier, 1989, 1994a, b.

MATERIAL. NTCR000627, 2F, 13.7, 14mm.

DIAGNOSIS. Rostrum acute, with ventral margin usually slightly convex, with 7-10 teeth, usually 8 or 9 and reaching from the middle to the tip of the 2nd antennular segment; adrostral carina prominent; postrostral carina becoming indistinct towards the cervical sulcus, with slight indication of a ridge for short distance thereafter. Postorbital and hepatic spines of similar size, antennal spine smaller; branchiostegal spine very prominent, its tip just inside the carapace margin and raised well above its level. Hepatic sulcus beginning at the anterior rim of the carapace, deepening posteriorly and ending in the vicinity of the anterior end of the branchiocardiac sulcus;

TABLE 1. Principal features distinguishing *Hyemnopenaeus equalis*, *H. halli*, *H. neptunus*, *H. propinquus*. * Crosnier (1978, 1989) notes that exceptionally the range may be: *H. equalis* 7-10; *H. halli* 7-9; *H. propinquus* 7-10.

Feature	*H. equalis*	*H. halli*	*H. neptunus*	*H. propinquus*
*Usual number of rostral teeth	9	8	6-7	7
Ventral margin of rostrum	variable, often slightly convex	usually slightly concave	convex	almost straight
Spines on 1st pereopod:				
basis	absent	present	present	absent
merus	absent	present	present	absent
Max. diameter eye/carapace length	0.22-0.24	0.21-0.23	0.1-0.11	0.15-0.18
Scaphocerite and antennular peduncle	exceeding it by about 0.25 its length	equal in length	exceeding it by about 0.2 its length	exceeding it by about 0.25 its length
Distal end of petasma:				
ventromedian lobule	divided in two and fringed with fringed spinules	pincer-shaped end, no fringing spinules	pincer-shaped end, no fringing spinules	single rounded projection, with spinules
ventrolateral lobule	single rounded plate, with distal spinules	pair of plates of similar size, no spinules	pair of plates of dissimilar size, no spinules	single tapering plate with fringing spinules
Thelycal plate of 5th pereopods	a rounded projection, highest posteriorly	a sharp longitudinal ridge not extending over the 4th sternite	a large rounded longitudinal ridge extending well over the 4th sternite	a rounded projection with greatest height medially

hepatic carina not extending beyond the posterior base of the branchiostegal spine. Branchiocardiac sulcus extending from near the posterior end of the hepatic sulcus to the level of the posterior margin of the carapace, the carina of similar length. Cervical sulcus reaching the dorsum, the carina much shorter than the sulcus. An ischial spine on the 1st pereopod. Thelycal plate of the 4th pereopods with a prominent transverse projection; that of the 5th pereopods with a rounded projection, widest anteriorly and round posteriorly, both projections glabrous.

REMARKS. This species is difficult to distinguish from *H. propinquus* (see discussion under this species; see also Table 1).

DISTRIBUTION. NW Australia, 450m. Known range, Japan, Philippines, Indonesia, NW Australia, Wallis and Futuna Is, 300-650m.

Hymenopenaeus halli Bruce, 1966
(Fig. 8B)

Hymenopenaeus halli Bruce, 1966: 216, figs 1, 2; Crosnier, 1978, 1984, 1987, 1994a, b; de Freitas, 1985; Hayashi, 1985.

MATERIAL. QMW15858, 2M, 18.5, 20mm, 3F, 19.5, 20, 25mm; NTCR007957, 3M, 19, 20.5, 21mm; 008021,4M, 18.5,19, 19.5, 20mm, 4 F, 17.5, 20.5, 21, 23mm.

DIAGNOSIS. Carapace glabrous. Rostrum ascending and reaching from the middle to the end of the 2nd segment of the antennular peduncle; the ventral margin usually slightly concave; armed with 8 prominent teeth, including the epigastric. Adrostral carina prominent; postrostral carina becoming indistinct behind the cervical sulcus. Antennal, postantennal and hepatic spines prominent and of similar size; branchiostegal spine very prominent and raised well above the surface of the carapace. Hepatic carina ending at the posterior base of the branchiostegal spine; hepatic sulcus deep and extending posteriorly from just in front of the hepatic spine to its junction with the branchiocardiac sulcus, where it curves ventrally. Branchiocardiac sulcus deep and ending shortly before the posterior rim of the carapace; branchiocardiac carina blunt. A shallow orbitoantennal sulcus present. Cervical sulcus deep and reaching the dorsum, where it is interrupted by the postrostral carina; cervical and submarginal carinas sharp. Eye large, its maximum diameter 0.21-0.23 the length of the carapace. Prosartema not reaching as far as the eye. Antennular peduncle and scaphocerite of similar length. First pereopod with a basial and an ischial spine and a spine on the merus at about 2/3 its length. Ventro-median lobe of the petasma produced into a pincer-like projection; ventrolateral lobe with a pair of flattened, rounded apical plates, of similar size. Sternite of the female 4th pereopod with a very prominent, forwardly-directed spine;

the posterior margin with a pair of flat rounded plates; that of the 5th pereopod with a median carina extending for most of its length.

REMARKS. Bruce (1996) stated that there were two spines on the merus of the single type specimen. All the Australian specimens examined had only one spine, a feature also noted by Crosnier (1978). The pereopod on only one side of a specimen of *H. neptunus* in the present study was also double, so this appears to be an abnormality.

The four Australian *Hymenopenaeus* species are closely similar in appearance and may be difficult to distinguish from the key. Table 1 is an additional guide.

Colour in life is white-yellowish.

DISTRIBUTION. Off the east coast of Australia from 18°-33°47'S, depth range 500-1,000m. Known range, Madagascar to Indonesia, South China Sea, Philippines, Japan, E Australia, Wallis and Futuna Is, 450-1,000m.

Hymenopenaeus neptunus
(Bate, 1881)
(Fig. 8C)

Haliporus neptunus Bate, 1881; 1888; de Man, 1911.
Hymenopenaeus neptunus Crosnier & Forest, 1973; Crosnier, 1984, 1985, 1989, 1994a, b.

MATERIAL. QMW13511, M, 18.5mm, F, 20.5mm; 13525, 3F, 17, 19.5, 25.5mm; 13526, M, 15mm, 2F, 16, 18mm.

DIAGNOSIS. Rostrum variable, slightly to distinctly upcurved, slender, ventral margin convex and reaching from 2/3 to the tip of the 2nd segment of the antennular peduncle; with 6-7 teeth in all; adrostral carina prominent. Postrostral carina not interrupted by the cervical sulcus and extending a short distance behind it, where it becomes indistinct. Antennal, postorbital and hepatic spines large and of similar size; branchiostegal spine larger and very prominent. Only a faint indication of an orbito-antennal sulcus below the postorbital spine.

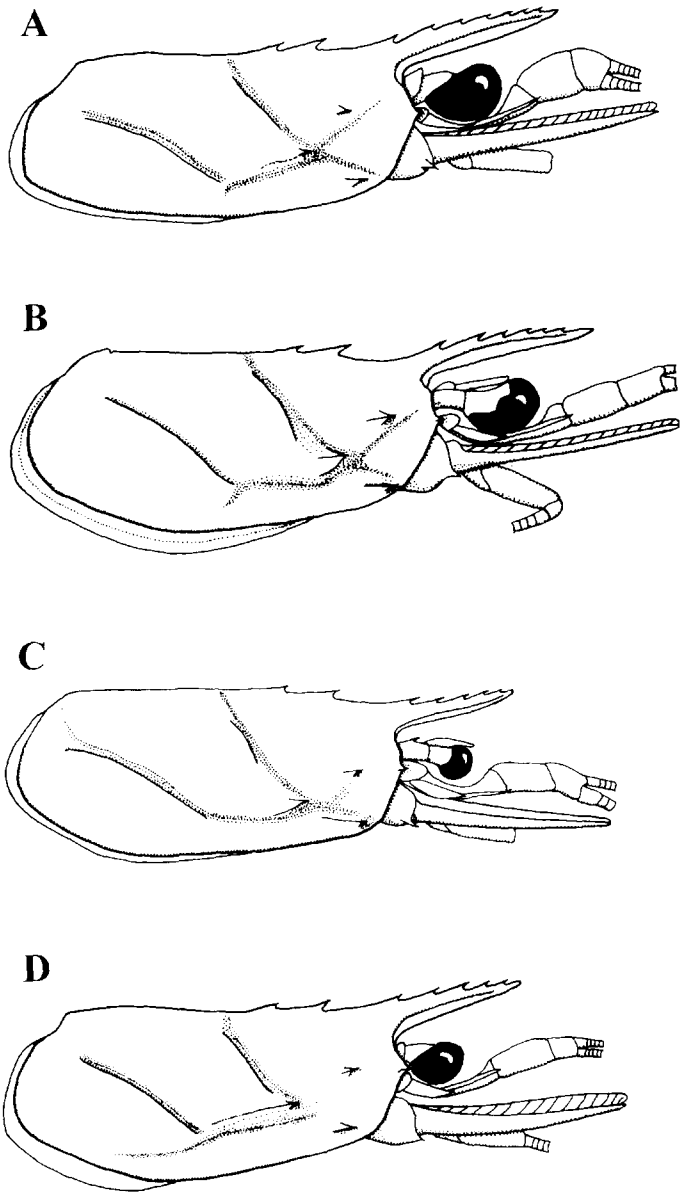

FIG. 8. A, *Hymenopenaeus aequalis* (Bate, 1888). NTCR000627, F, 13.7mm, 17°55'S 118°19'E, 450m. B, *Hymenopenaeus halli* Bruce, 1966. NTCR007957, M, 20.5mm, 19°S 150°39'E, 750m. C, *Hymenopenaeus neptunus* (Bate, 1881). QMW13511, M, 18.5mm, 18°10'S 148°32'E,1100m. D, *Hymenopenaeus propinquus* (de Man, 1907). NTCR007948, M, 13.5mm, 18°37S' 117°02'E, 506m.

Hepatic carina becoming rounded below the hepatic spine; hepatic sulcus wide and shallow above the branchiostegal spine, deepening below the hepatic spine and extending posteriorly to join the branchiocardiac sulcus. The latter deep, almost reaching the posterior dorsal margin of the carapace; branchiocardiac carina prominent, extending for about 0.75 the length of the sulcus. Cervical sulcus deep and meeting the postrostral carina without indenting it; cervical carina occupying the middle third of the sulcus. Eye small, maximum diameter of the cornea 0.1-0.11 the length of the carapace; prosartema about the same length as the eye. Scaphocerite exceeding the tip of the antennular peduncle by about 0.2 of its length. A large spine on the basis of the 1st pereopod and a spine on the merus at about 0.7 its length. Distal end of the ventromedian lobule of the petasma pincer-shaped, without fringing spinules; ventrolateral lobule with a distal pair of plates of dissimilar size. Thelycal plate of the 4th pereopods with a transverse ridge; that of the 5th pereopods with a prominent rounded longitudinal ridge which extends anteriorly as a pointed projection well over the posterior rim of the 4th sternite.

REMARKS. *H. neptunus* may be easily distinguished from the other Australian species of this genus by its very small eye. It is similar in this respect to *H. furici*, with which it is closely similar, as noted above. The thelyca could provide a satisfactory means of distinguishing the two species, as the thelycum of *N. neptunus* is very distinctive, but so far no females of *H. furici* have been described.

DISTRIBUTION. NE Australia, around 18°S 148°E, depth range 1,000-1,200m. Known range, Indian Ocean to Indonesia, the Philippines, NE Australia, Wallis and Futuna Is, 700-1,500m.

Hymenopenaeus propinquus (de Man, 1907) (Fig. 8D)

Haliporus propinquus de Man, 1907: 140; de Man, 1911; de Man 1913.

Hymenopenaeus propinquus Burkenroad, 1936; Ramadan, 1938; Anderson & Lindner, 1943; Crosnier & Forest, 1973; Kensley, Tranter & Griffin, 1987; Crosnier, 1978, 1984a,b, 1985, 1989, 1994a, b; Burukovsky, 1974.

MATERIAL. NTCR007948, 3M, 13.5, 13.5, 14mm; 3F, 11.5, 14.2, 16mm; QMW15867, F, 19mm; 6F, 16.5, 20, 21, 21.5, 25.5, 26.5mm; 15871, 2M, 20, 22mm; 15873, 4F, 21, 21, 22.5, 23.5; 18056, M, 18.5mm; 3F, 22.5, 23, 24mm.

DIAGNOSIS. Rostrum acute, ascending, with 6-7 dorsal teeth, including the epigastric (rarely 8-10), and reaching from the middle to the end of the 2nd segment of the antennular peduncle; ventral margin almost straight; adrostral carina prominent; postrostral carina ending just before the cervical sulcus. Postorbital and hepatic spines prominent and of similar size; antennal spine smaller; branchiostegal spine very prominent, set back from the edge of the carapace, its tip well above the level of the carapace. Orbito-antennal sulcus barely discernable; hepatic carina extending posteriorly only to the base of the branchiostegal spine; hepatic sulcus deep, starting just anterior to the hepatic spine, usually ending well behind the beginning of the branchiocardiac sulcus and curving posterio-ventrally; branchiocardiac sulcus deep and ending level with the posterior rim of the carapace; anteriorly almost meeting the hepatic sulcus; branchiocardiac carina of similar length. Cervical sulcus deep and reaching the dorsum, the cervical carina well defined but markedly shorter than the sulcus. An ischial spine on the 1st pereopod, no spines on the basis or merus. Apex of the ventro-median lobe of the petasma rounded, edged with small spinules and with a minute incision; ventrolateral lobe with a single tapering apical plate. Thelycal plate between the 4th pereopods with a rounded median projection and covered uniformly with setae; plate between the 5th pereopods also a rounded projection, its greatest height across its middle region.

REMARKS. The rostrum of *H. propinquus* is usually sharper than that of *H. equalis*, but as noted previously is difficult to distinguish from it and also from *H. halli*. Table 1 compares the 4 Australian species.

Colour in life is white-yellowish.

DISTRIBUTION. NW Australia, east coast from 16°55'-33°43'S, 500-900m. Known range, Madagascar to Indonesia, Philippines, Australia, Wallis and Futuna Is, 450-1200m.

Mesopenaeus Pérez Farfante, 1977

Mesopenaeus Pérez Farfante, 1977: 331; Pérez Farfante & Kensley, 1997.

DIAGNOSIS. Body stout, carapace short and deep, integument thick, firm. Rostrum short, deep, ventral margin convex, no ventral teeth; epigastric and 1st rostral tooth separated by an interval similar to that between the 1st and 2nd teeth. Orbital, postorbital, antennal and hepatic spines present; branchiostegal and pterygostomian spines absent. Cervical sulcus almost

reaching the middorsum of the carapace; hepatic sulcus deep; branchiocardiac sulcus and carina, submarginal carina, lacking. Abdomen dorsally carinate from 3rd to 6th somites. Telson with a pair of prominent fixed subapical spines. Prosartema long and flexible. Antennular flagella not much longer than the carapace and dissimilar; dorsal flagellum subcylindrical and slender, ventral flagellum markedly depressed. Mandibular palp 2-segmented, the articles broad and of similar length. First pereopod with a fixed spine on the basis and ischium. Fourth and 5th pereopods not markedly slender proximally, 5th longer than the 3rd and 4th. Exopods on all maxillipeds and pereopods. Lateral ramus of uropod armed with a disto-lateral spine reaching the distal end of the lamella. Petasma simple, the distal part of the dorsolateral lobule projecting well beyond the apices of the adjacent lobules. Thelycum open, simple.

Mesopenaeus is similar to *Hadropenaeus*, but is distinguished from this and other solenocerids by its flattened ventral antennular flagella. *Mesopenaeus* is also similar in appearance to some *Solenocera* species, but these latter lack an external spine on the lateral ramus of the uropods, as well as possessing channelled ventral antennular flagella. All *Mesopenaeus* species inhabit a zone from the outer continental shelf to the upper half of the continental slope.

KEY TO THE INDO-WEST PACIFIC SPECIES OF *MESOPENAEUS*

1. Rostrum usually with 7-8 dorsal teeth; scaphocerite about the same length as the antennular peduncle; ventral border of the merus of 1st pereopods with a large spine . . . . . *M. mariae*

   Rostrum with 6 dorsal teeth; scaphocerite exceeding the antennular peduncle by about 0.2 its length; ventral border of the merus of 1st pereopods without a spine . . . . . *M. brucei*

Only three species of this genus have been described, the third, *M. tropicalis* (Bouvier, 1905) being from the Atlantic. *M. mariae* Pérez Farfante & Ivanov (1982) ranges from the Indian Ocean to Japan, but so far has not been collected from Australian waters. Thus *M. brucei* is the only Australian species.

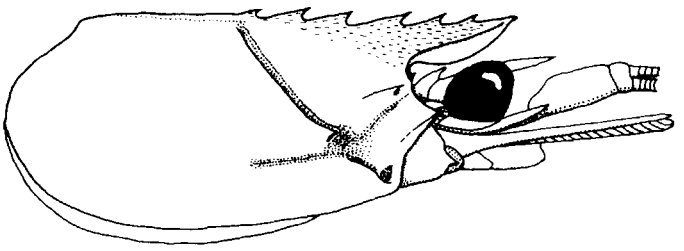

FIG. 9. *Mesopenaeus brucei* Crosnier, 1986. QMW15912, F, 26.5mm, 21°57'S 153°25'E, 330m.

Mesopenaeus brucei Crosnier, 1986
(Fig. 9)

Mesopenaeus brucei Crosnier, 1986: 20, figs 1,2; 1994b.

MATERIAL. QMW15912, F, 26.5mm; NTCR003028, 2M, 26.5, 27mm (paratypes); NTCR004564, F, 26mm (allotype).

DIAGNOSIS. Carapace glabrous, except on the rostrum and adjacent areas, and the pit in front of the hepatic spine where it is finely pubescent. Rostrum deep, reaching as far as the eye, with 6 very prominent teeth, including the epigastric, dorsal surface horizontal, the ventral margin strongly convex; postrostral carina well-defined behind the epigastric tooth, but gradually flattening towards the posterior margin of the carapace; tip of epigastric tooth at 0.52-0.55 the length of the carapace from its posterior margin. Orbital spine small, but distinct; antennal and hepatic spines large and of similar size, postorbital spine larger. A shallow orbito-antennal sulcus present; hepatic sulcus sharp, but short, ending anteriorly in a shallow arc on the ventral side of a shallow, pear-shaped pterygostomian pit; hepatic sulcus deep, running from near the pterygostomian pit to the level of the 1st rostral tooth. Cervical sulcus deep, almost reaching the dorsum of the carapace, but not interrupting the postrostral carina; cervical carina sharp and almost the same length as the sulcus. Eye large; prosartema with a rigid spinous tip, devoid of setae and almost reaching half the 2nd antennular segment. Antennular flagella dissimilar, the dorsal flagellum subcylindrical, the ventral thicker and laterally compressed in its proximal part. First pereopod with basial and ischial spines; no spine on the merus. Ventromedian lobule of the petasma with a large distal shovel-shaped distal expansion.

REMARKS. The key features are the best for separating *M. brucei* from *M. mariae*. In addition the latter has a folded hat-like expansion of the ventromedial lobule of the petasma, whereas in *M. brucei* it is flat and shovel- or axe-shaped.

DISTRIBUTION. So far limited to Rowley Shoals, NW Australia (17°41'S 118°42'E); Arafura Sea (Indonesia, 9°49'S 130°07'E) and off Swain Reefs, NE Australia (22°35'S 153°48'E), 260-360m.

Solenocera H. Lucas, 1849

Solenocera Lucas, 1849; Bate, 1881; Alcock, 1901; de Man, 1911; Stebbing, 1914; Burkenroad, 1934, 1936; Kubo 1949; Barnard, 1950; Balss, 1959; Pérez Farfante & Bullis, 1973; Crosnier, 1978; Pérez Farfante & Kensley, 1997.

Parasolenocera Wood-Mason & Alcock, 1891; Alcock, 1901.

DIAGNOSIS. Moderately robust, medium-sized prawns, with firm cuticle; pereopods well developed, pleopods not exceptionally long. Carapace glabrous except for the rostral area which is setose. Antennular flagella wide and when apposed forming a respiratory tube, often as long or longer than the carapace. Rostrum laterally compressed, usually deep and not exceeding the 1st segment of the antennular peduncle and with dorsal teeth only. Postorbital, antennal and hepatic spines present; branchiostegal and pterygostomian spines present or absent, but never with both. Cervical sulcus reaching to or almost to the dorsal midline. First and 2nd abdominal somites narrowing towards the dorsal mid-line so that the cephalothorax may be flexed almost at right angles to the abdomen. Exopods on thoracic somites 1 to 7. Telson usually armed with fixed subapical spines, never with lateral moveable spines. Lateral ramus of uropod without a distolateral spine.

The species of this genus are inhabitants of the continental shelf and slope, from about 15m down to several hundred metres, sometimes to greater depths. The body form suggests that they are predominantly benthic and environmental data for a few species indicate that soft substrates are preferred. The long respiratory tube and ability to flex the cephalothorax upwards almost 90° to the abdomen, indicates that they bury deeply in these soft sediments. It is by far the largest genus within the Solenoceridae, with at least 21 Indo-West Pacific species, mostly with similar facies.

KEY TO THE INDO WEST PACIFIC SPECIES OF *SOLENOCERA*

1. Pterygostomian spine present 2
   Pterygostomian spine absent 4
2. Postrostral carina distinct behind the cervical sulcus; anterior part of the hepatic carina recurved posteriorly to form a quadrangular lobe 3
   Postrostral carina absent behind the cervical sulcus; anterior part of the hepatic carina almost straight . . . . . *S. comata*
3. Cervical carina with a shallow notch about 1/3 its length above the hepatic spine . . . . . *S. africana*
   Cervical carina without a notch . . . . . *S. algoensis*
4. Postrostral carina reaching to, or almost to, the posterior border of the carapace and clearly defined along its length 5
   Postrostral carina extending little if any beyond the cervical sulcus, or poorly defined 13
5. Postrostral carina interrupted by a deep notch at the level of the cervical sulcus 6
   Postrostral carina not interrupted by a deep notch at the level of the cervical sulcus (often a shallow depression in this region). 8
6. Postrostral carina high and blade like; postrostral sulcus feebly developed, less than 1/3 the length of the carina or absent. 7
   Postrostral carina low along its length; postrostral sulcus more than 1/2 the length of the carina and widening posteriorly . . . . . *S. koelbeli**
7. Postrostral carina highest posteriorly, sloping steeply towards the posterior border of the carapace . . . . . *S. alticarinata*
   Postrostral carina highest anteriorly, tapering gradually towards the posterior border of the carapace . *S. choprai*
8. Telson without a pair of subapical fixed spines . . . . . *S. crassicornis***
   Telson with a pair of subapical fixed spines 9
9. Post-rostral carina behind the cervical sulcus distinctly humped in profile, with a median tooth or with a small median nodule†; branchiocardiac sulcus and carina well defined, the former running from the posterior edge of the carapace almost to the hepatic sulcus . . *S. alfonso*†
   Post-rostral carina behind the cervical sulcus only slightly and smoothly convex in profile and without a median tooth or nodule; branchiocardiac sulcus and carina feebly defined 10
10. Anterior part of the hepatic carina slightly curved, but not bordering the ventral side of a clearly-defined shallow depression at its anterior end . . . . . *S. bifurcata*
    Anterior part of the hepatic carina distinctly curved and bordering the ventral side of a clearly-defined shallow depression at its anterior end. 11
11. Anterior part of the hepatic carina forming a shallow arc, much less than a semicircle, round the lower border of a shallow depression near the pterygostomian angle; ventral margin of rostrum convex 12
    Anterior part of the hepatic carina forming a deep, upward-facing arc, almost a semicircle, round the lower border of a shallow depression near the pterygostomian angle; ventral distal margin of rostrum usually straight, sometimes slightly concave . . . . . *S. melantho*

12. Postrostral sulcus a series of pits and not dividing the carina into two posteriorly; north Australian seas . . . . . *S. australiana*

    Postrostral sulcus consisting of long depressions and pits, usually dividing the carina into two posteriorly; Malaysia, Strait of Malacca. . . . . *S. halli*

13. Anterior end of hepatic carina curving ventroposteriorly, blunt or forming a sharp, almost spinous point. . . . 14

    Anterior end of hepatic carina not curving posteriorly, either straight or ending in an upward-facing arc . . 20

14. Anterior hepatic carina sharp or spinous 15

    Anterior hepatic carina blunt or forming an angle. . . 18

15. Rostrum short, reaching about half the length of the cornea 16

    Rostrum reaching or exceeding the distal end of the cornea . . . . . *S. barunajaya*

16. Dorsal carina present on abdominal somite 3; maximum diameter of the eye equal to or exceeding 0.18 the length of the carapace; prosartema not reaching as far as the eye 17

    Dorsal carina absent on abdominal somite 3; eye small, maximum diameter about 0.14 the length of the carapace; prosartema exceeding the distal end of the cornea. . . . . *S. faxoni*

17. Usually 7 rostral spines, including the epigastric; hepatic carina ending in a spine that just reaches the anterior border of the carapace; no spine on the basis of the 2nd pereopod . . . . . *S. spinajugo*

    Usually 6 rostral spines, including the epigastric; hepatic carina ending in a prominent point that exceeds the antero-ventral border of the carapace; a spine on the basis of the 2nd pereopod . . . . . *S. moosai*

18. Rostrum short, not reaching as far as the distal end of the eye; anterior end of hepatic carina rounded 19

    Rostrum long, well exceeding the eye, and reaching to about half the 2nd segment of the antennular peduncle; anterior end of hepatic carina almost angular . . . . . *S. annectens*

19. Six or seven rostral teeth including the epigastric; inferior antennular flagellum with 39-53 segments *S. pectinulata*

    Eight or nine rostral teeth including the epigastric; inferior antennular flagellum with 57-77 segments . . . . . *S. pectinata*

20. Rostrum slender, reaching about 1/3 the length of the cornea . . . . . *S. bedokensis*††

    Rostrum deep, reaching at least 1/2 the length of the cornea 21

21. Epigastric tooth well behind the level of the hepatic tooth; ventral margin of rostrum strongly convex; length of the superior antennular flagellum 1.3-1.43 times that of the carapace and the inferior flagellum with 55-59 segments . . . . . *S. rathbuni*§

    Epigastric tooth at about the level of the hepatic tooth; ventral margin of rostrum slightly convex; length of the superior antennular flagellum 2.1-2.2 times that of the carapace; inferior flagellum with 89-109 segments . . . . . *S. waltairensis*§§

* *S. koelbeli* Starobogatov, 1972 is probably a synonym of *S. alfonso* form *inermis* (Ivanov, 1994).

** =*S. subnuda* Kubo, 1949; see discussion under *S. bifurcata*.

† See discussion under *S. alfonso*.

†† *S. bedokensis* Hall was described from one damaged specimen and may not be a valid species; it is similar to *S. utinomii* Kubo (also described from one damaged female). Also *S. zarenkovi* Starobogotov is so badly damaged that its identity must remain very doubtful (Ivanov, 1994).

§ *S. phuongi* Starobogotov is probably a junior homonym of this species (Ivanov, 1994).

§§ The identity of *S. gurjanovae* Starobogotov is doubtful; it may be conspecific with *S. waltairensis* (Ivanov, 1994).

S. hexti Alcock has not been included, because Alcock (1901: 20) considers that the antennules could not form a respiratory tube, suggesting a *Mesopenaeus* species; also the flagella are shorter than the carapace, another *Mesopenaeus* feature. The figure in Starobogatov (1972) clearly shows a suprahepatic spine, which indicates a *Gordonella* or *Haliporoides* species, but the carapace shape is that of a *Solenocera* or *Mesopenaeus*.

The following 14 species have been identified from Australian waters : *S. alfonso*, *S. annectans*, *S. australiana*, *S. barunajaya*, *S. choprai*, *S. comata*, *S. bifurcata* sp. n., *S. faxoni*, *S. koelbeli*, *S. melantho*, *S. moosai*, *S. pectinata*, *S. pectinulata*, *S. rathbuni*.

Solenocera alfonso Pérez Farfante, 1981 (Fig. 10)

Solenocera alfonso Pérez Farfante, 1981: 631, figs 1-5.
Solenocera alfonso, form *alfonso* and form *inermis* Crosnier, 1989: 58.

MATERIAL. Form *alfonso*: NTCR006632, F, 30mm; NTCR007924, 2F, 30, 31.5mm. Form *inermis*: QMW15799, F, 16.5mm.

DIAGNOSIS. Rostrum deep, almost straight dorsally, convex and upturned ventrally, with 6-8, usually 7 teeth. Form *alfonso*: Postrostral carina distinctly convex, but low and broad, well-defined anteriorly and with a spine about midway between the top of the cervical sulcus and the posterior border of the carapace; carina tapering to zero behind the tooth; postrostral sulcus represented by a series of pits behind the tooth, sometimes anterior to it as well. Form *inermis*: Similar to form *alfonso*, but with only a small nodule in place of the median tooth. Both forms: A small orbital spine present; antennal and hepatic spines of similar size, the postorbital spine larger. Cervical sulcus deep, not quite reaching the dorsum, which is slightly depressed at this point. Hepatic carina beginning just anterior to the hepatic spine and forming a sharp edge bordering a pterygostomian pit. Hepatic sulcus posteriorly not quite reaching the level of the top of the cervical sulcus, where it curves ventrally. Branchiocardiac sulcus well defined,

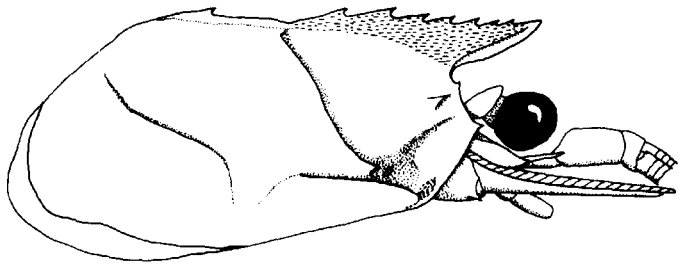

FIG. 10. *Solenocera alfonso* Pérez Farfante, 1981. NTCR007924, F, 30mm, 9°40'S 129°54'E, 298m.

extending from near the posterior margin of the carapace to a broad downward arc, almost meeting the hepatic sulcus; branchiocardiac carina present, but only equal to about 1/2 the length of the sulcus. Thelycum almost featureless; this and other characteristics of the genitalia as described by Pérez Farfante (1981).

REMARKS. As pointed by Pérez Farfante (1981) this large species is distinctive, the spine on the postrostral carina being the most obvious single feature. However Crosnier (1989) has identified a form without a spine, being identical in other respects, and naming it form *inermis*, the type being form *alfonso*. Crosnier notes that the 2 forms of *S. alfonso* were never collected from the same locality in the Philippines, but the presence of form *inermis* off NE Australia indicates that this form is not limited to the Philippines. Form *inermis* could be confused with *S. australiana*, *S. halli* and *S. melantho* and the key includes distinctive features of *S. alfonso* besides the postrostral spine. Crosnier (1989) gives a detailed analysis of the differences separating these four species.

DISTRIBUTION. Australian waters in the Arafura Sea, 283-298m. Known range, Philippines, N Australia, 90-550m.

Solenocera annectens (Wood-Mason, 1891)
(Fig. 11)

Parasolenocera annectens Wood-Mason in Wood-Mason & Alcock, 1891: 276; Alcock & McArdle, 1901; Alcock, 1901.
Solenocera annectens Crosnier, 1984, 1989, 1994.

MATERIAL. NTCR007077, F, 23.5mm.

DIAGNOSIS. Rostrum straight and tapering, reaching about half the 2nd segment of the antennular peduncle; with 7-8 teeth close together and widely separated from the epigastric, which is at 1/3 the carapace. Postrostral carina ending at the top of the cervical sulcus, the dorsum being slightly indented at this point. A small orbital spine present; antennal and hepatic spines of similar size, postorbital spine larger. Orbito-antennal sulcus short, reaching about the level of the antennal spine. Hepatic carina short and starting in front of the tip of the hepatic spine and forming a blunt point at its anterior end, which projects beyond the pterygostomian angle. Hepatic sulcus posteriorly reaching the level of the top of the cervical sulcus, where it curves downward. Branchiocardiac sulcus deep, reaching almost to the posterior border of the carapace and curving ventrally at its anterior end, not quite meeting the hepatic sulcus. Genitalia as described by Crosnier (1984).

REMARKS. The long, tapering rostrum of this species is distinctive. It appears to be a deeper water solenocerid.

DISTRIBUTION. NW Australia 14°01'S 122°08'E, 443m. Known range, Andaman Sea, Indonesia, Philippines, Arafura Sea, nearly always at depths greater than 400m down to 900m.

Solenocera australiana
Pérez Farfante & Grey, 1980
(Fig. 12, 19B)

Solenocera australiana Pérez Farfante & Grey, 1980: 421-434, figs 1-5; Grey et al., 1983; Crosnier, 1989.

MATERIAL. QMW12826, F, 28mm; 15838, F, 32.5mm; 17417, 2F, 20, 22mm; 17419, F, 33.5mm; 18084, F, 37.5mm; 18085, M, 21.5mm, 2F, 27.5, 31mm.

DIAGNOSIS. Rostrum deep and reaching to about the extremity of the eye; with a total of 8-10 teeth, usually 9, with the 4th or 5th above the orbital margin. Postrostral carina well defined, blunt and reaching almost to the posterior edge of the carapace; postrostral sulcus usually a series of pits, sometimes formed into a short sulcus, usually with pits. Orbital angle sharp, antennal and hepatic spines of similar size, postorbital spine large; cervical sulcus reaching almost to the dorsum, which is only barely indented at this point. Orbito-antennal sulcus deep, almost vertical and reaching the base of the postorbital spine. Anterior hepatic carina curving ventrally round an ovoid shallow depression at the pterygostomian angle, forming an arc much less

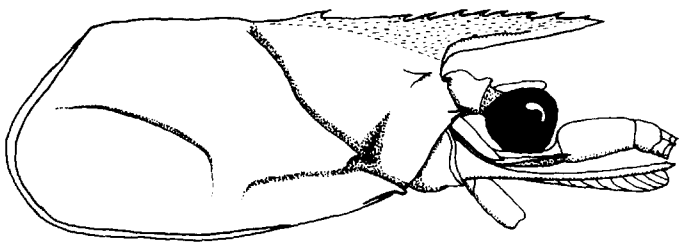

FIG. 11. *Solenocera annectans* (Wood-Mason, 1891). NTCR007077, F, 23.5mm, 14°01'S 122°08'E, 443m.

than a semicircle (Fig.19B). Hepatic sulcus extending posteriorly and almost joining the branchiostegal sulcus, which is indistinct, but almost reaches the posterior edge of the carapace. Antennular flagella 1.4-1.7 the length of the carapace, longer in juveniles. Coxa of the 5th pereopod in mature females bearing a large, forwardly-directed spine, which reaches almost as far a the anterior edge of the segment. For details of petasma and thelycum see Pérez Farfante & Grey (1980, figs 4, 5).

REMARKS. *Solenocera australiana* has been confused with *S. melantho*, which also occurs in Australian seas. Features distinguishing these two species are listed under the latter species. *S. halli* (not recorded from Australia) also has close affinities with these two and all three are compared in detail in Pérez Farfante & Grey (1980). See also comments under *S. alfonso*.

Carapace colour in life, pink red to orange; telson, pleopods, uropods, dark red; antennular flagella, bright red (see colour photograph in Grey et al., 1983, pl. 5).

DISTRIBUTION. So far known only from Australian seas, from NW Australia to NE Queensland, 15-70m.

Solenocera barunajaya Crosnier, 1994
(Fig. 13)

Solenocera barunajaya Crosnier, 1994a: 355-9, figs 1a-c, 2a, 3a-e.

MATERIAL. NTCR000621: M, 13.5mm, 2F, 22.5mm each; 012296: F, 29mm; 012297: 2F, 23, 25mm; 012298: 4F, 27.5, 28, 28mm, 1 damaged.

DIAGNOSIS. Rostrum slightly upcurved and sharply pointed, usually with six teeth including the epigastric and reaching as far as, or slightly exceeding the distal extremity of the cornea. Only the blade of the rostrum above the adrostral carina is finely setose, the carapace entirely glabrous. Postrostral carina reaching only to the posterior edge of the cervical sulcus. Orbital angle blunt, antennal and hepatic spines small, postorbital spine large. Hepatic carina forming a prominent, sharply angular point anteriorly, raised well above the level of the carapace and projecting beyond its margin; underneath this projection, a short channel runs parallel to and just inside the pterygostomian rim of the carapace. Posteriorly, the hepatic carina reaches to the base of the hepatic spine. Hepatic spine overlying a deep pit, with a well-defined posterior orbito-antennal sulcus running towards the base of the post-orbital spine, where it becomes confluent with the shallower anterior part. Cervical sulcus reaching the dorsum, the carina ending a little below this and interrupted at its mid-point by a shallow sulcus, which extends postero-ventrally, reaching the branchiostegite, and forming a junction with the posterior end of the hepatic sulcus and the branchiocardiac sulcus. The latter well-defined and reaching almost to the level of the posterior dorsum of the carapace; branchiocardiac carina not defined. Thelycum with two large and two small anterior bosses, posteriorly with two large, but low bosses, separated by a median longitudinal sulcus (for full descriptions and figures of thelycum and petasma see Crosnier, 1994a).

REMARKS. *S. barunajaya* is similar in appearance to *S. faxoni*, but the small eye of the latter is distinctive. *S. spinajugo* and *S. moosai* are also similar, but the key characters should enable them to be readily separated.

DISTRIBUTION. So far known only from NW Australia, 9°45'-18°19'S, 118°9'-130°E, the Kai

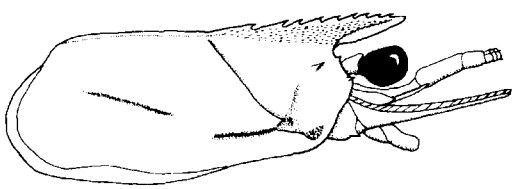

FIG. 12. *Solenocera australiana* Pérez Farfante & Grey, 1980. QMW17419, F, 33mm, Gulf of Carpentaria, 53mm.

and Tanibar Is in the Arafura Sea (the type locality), 240-370m.

Solenocera bifurcata sp. nov. (Fig. 14A-F)

MATERIAL. HOLOTYPE: QMW2385, F, 24mm, off Cape Moreton, SE Qld, depth approx. 200m. ALLOTYPE: QMW18029, M, 19mm, 17°53'S 146°53'E, (off Mission Beach, NE Qld) 162-170m. PARATYPE: QMW4680, F, 26.5mm, off Cape Moreton, SE Qld, depth approx. 200m.

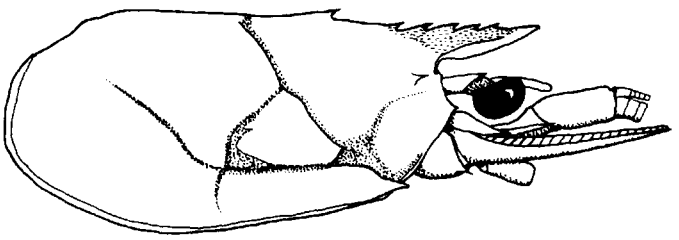

FIG. 13. *Solenocera barunajaya* Crosnier, 1994. NTCR012298, F, 28mm, 9°46'S 129°54'E, 298m.

DESCRIPTION. *Rostrum, carapace, abdomen* (Fig. 14A). Rostrum slightly downcurved with strongly convex lower margin, reaching about half the length of the cornea; with 6-7 teeth including the epigastric; adrostral carina ending at about the level of the last (sub-apical) rostral tooth. Postrostral carina low, almost reaching the posterior margin of the carapace and slightly indented at the level of the cervical sulcus. Carapace entirely glabrous, a setose area confined to the rostrum. Orbital angle blunt, postorbital and hepatic spines large, antennal spine small. Hepatic carina almost straight anteriorly and bordering a shallow depression just inside the pterygostomian angle; posterior end reaching the base of the antennal spine. Posterior end of the hepatic sulcus reaching about the level of the top of the cervical sulcus. Branchiocardiac sulcus barely distinguishable and occupying approximately the middle third of the branchial region. Cervical sulcus deep and not quite reaching the postrostral carina. Dorsal carina of the abdomen beginning at about the anterior third of the 2nd abdominal somite and well developed on the 3rd to 6th somites. Telson with a pair of subapical fixed spines at about 0.16 its length from the tip.

Appendages. Maximum diameter of the cornea about 0.2 the length of the carapace; prosartema reaching as far as the eye; stylocerite reaching about 0.7 the length of the cornea. Antennular flagella 0.7-0.9 the length of the carapace, the ventral flagellum with 46-50 segments, the tip tapering abruptly (Fig.14F). Scaphocerite barely exceeding the antennular peduncle, the tip of the blade slightly exceeding the disto-lateral spine; antennal flagellum about 5 times the length of the carapace. Third maxilliped exceeding the antennular peduncle by at least part of the propodus; the 1st pereopod reaching as far as the eye; the 2nd reaching the tip of the antennular peduncle; the 3rd exceeding the tip of the antennular peduncle by at least the propodus; the 4th exceeding the peduncle by the propodus; the 5th incomplete in all specimens, but with the tip of the merus reaching as far as the eye.

Petasma and Appendix Masculina. Apex of ventromedian lobe of the petasma flat and fringed with spinules, aligned medially; apex of dorsolateral lobe with long spinules and a ventral projection that partly encloses the ventrolateral lobe distally; the latter with two small teeth near the recurved tip (Fig. 14B). Accessory lobule present with about 16 spinules (Fig. 14C). Outer basal projection of appendix masculina rounded and small; inner and outer appendices elongate, subequal in length and tipped with short spinules (Fig. 14E).

Thelycum (Fig. 14D). Coxae of the 4th pereopods with medial tooth-like projections, which almost meet on the midline; behind these a pair of postero-lateral projections on the posterior rim of the sternite. Coxae of the 5th pereopods with a pair of prominent spines, directed antero-ventrally; behind these a pair of large flat medially-directed plates. Just in advance of these plates a single median prominent ovoid conical projection arising from the sternum, with an apical transverse bifurcate projection (more prominent in the paratype than in the holotype).

REMARKS. *S. bifurcata* is superficially similar to *S. subnuda* Kubo (1949) and Hall (1962), but differs substantially in a number of features. However, *S. subnuda* has been relegated to the status of a synonym of *S. crassicornis* Milne Edwards, (H. Milne Edwards, 1837) by Starobogatov (1972) and Liu & Zhong (1986), probably because both species have unarmed telsons, a unique feature in the Solenoceridae. There is little doubt that the species described by these four authors are identical, but the identity of *S. crassicornis* is confused. Bate (1881), who had access to the type from Bombay, noted that it agreed with the author's description. He also had

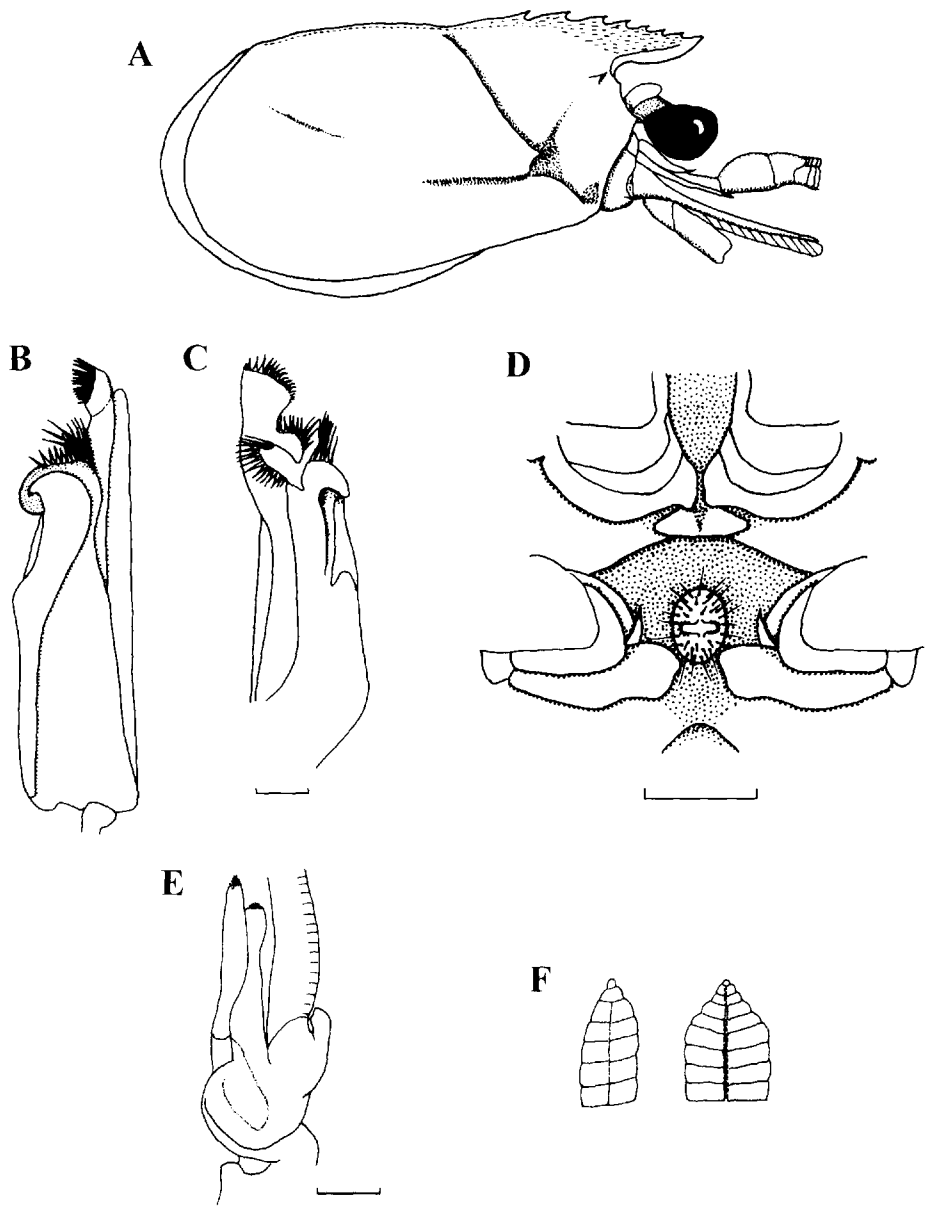

FIG. 14. A, *Solenocera bifurcata* sp. nov. QMW2385, holotype, F, 24mm, southeast Queensland, approx. 200m; B, right half of petasma of allotype, ventral aspect (scalebar = 1mm); C right half of petasma, external aspect; D, thelycum, holotype (scalebar = 1mm); E, Appendix masculina, allotype (scalebar = 1mm); F, tips of upper and lower antennular flagella, holotype.

'Challenger' collection material from 'between Borneo and the Philippine Islands'. Since *S. subnuda* has been described from this area, it could be regarded as further evidence that it is a synonym of *S. crassicornis*. Wood-Mason & Alcock (1891) refer to 'the common Indian littoral form (?*P. crassicornis*)', which lacked a branchiostegal spine, but Bouvier (1908) stated that *S. crassicornis* had 10-12 rostral teeth and a branchiostegal spine. However, no *Solenocera* species have 10-12 rostral teeth and it seems likely that Bouvier had confused it with a species

of another genus. Then Kubo (1949) used Bouvier's (1908) description to separate his species, *S. subnuda* from *S. crassicornis*. Examination of the type would resolve the problem, but Burkenroad (1934) noted that the type no longer existed. Dr A. Crosnier (pers. comm.) considers that *S. subnuda* is an undoubted synonym of *S. crassicornis*. Table 2 lists the differences between *S. bifurcata* and the published descriptions of *S. subnuda* (=*S. crassicornis*).

DISTRIBUTION. Unfortunately, the depths of collection of both the holotype and paratype are not known exactly, but were probably between 100-200m. The allotype was collected from between 162-170m.

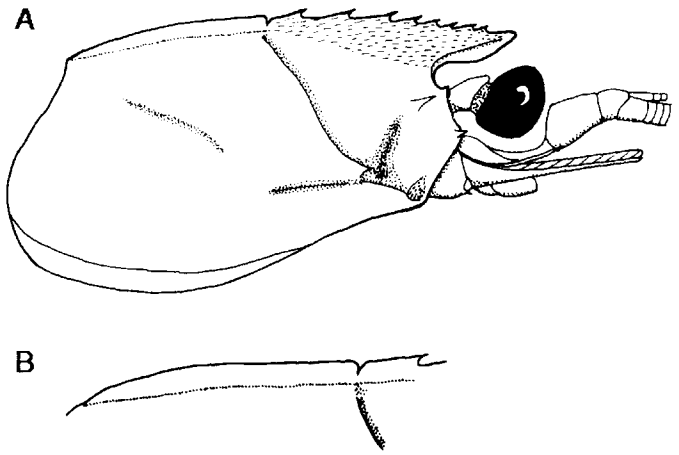

FIG. 15. A, *Solenocera choprai* Nataraj, 1945. QMW18025, F, 28mm, 17°53'S 146°54'E, 162-170m; B, postrostral carina, QMW18026, M, 29mm, 18°07'S 147°11'E, 200m.

Solenocera choprai Nataraj, 1945
(Fig. 15A, B)

Solenocera choprai Nataraj, 1945: 91, figs 1-4; George, 1969; Starobogatov, 1972; Tirmizi, 1972, Crosnier, 1978, 1984, 1989, 1994; Grey et al., 1983 (Non pl. 4 – *S. alticarinata*); de Freitas, 1985; Kensley, Tranter & Griffin, 1987.

Solenocera alticarinata Hall, 1961, 1962; Starobogatov, 1972, pl. 2, fig. 5a-b.

Solenocera koelbeli Burkenroad, 1959.

MATERIAL. QMW15827, M, 21mm, F, 24mm; 15861, 2M, 23.5, 25mm; 15870, 6M, 22-26mm; 15919, F, 22.5mm; 15921, 2F, 26.5, 28mm; 18025, 4F, 25-32.5mm; 18026: 2M, 24, 29mm, 2F, 28, 32.5mm.

DIAGNOSIS. Rostrum slightly downcurved, ventral edge strongly convex, reaching about 0.75 of the eye, with 7-8 dorsal teeth in all, exceptionally 9. Cervical sulcus deep and almost reaching the mid-dorsum, a deep narrow cleft immediately above its end. Postrostral carina high and narrow, its anterior end about the same height as the epigastric tooth, usually decreasing in height throughout its length and ending at the posterior edge of the carapace; sometimes of uniform height, or even slightly rising, through most of its length; a short postrostral sulcus or series of pits present. Hepatic carina ending at the edge of a small round pit just behind the pterygostomian angle. Orbital angle sharp; a small postorbital pit above the postorbital spine; branchiocardiac carina and sulcus well defined. Antennular flagella 1.15-1.4 (mean 1.25) the length of the carapace. Fifth pereopod long and slender and exceeding the tip of the antennular peduncle by 0.5-0.75 the length of the propodus. Petasma and thelycum as figured by Crosnier (1978).

REMARKS. *S. choprai* closely resembles *S. alticarinata* Kubo. The latter could be considered a synonym or perhaps a subspecies, but Crosnier (1978, 1989), who examined a number of specimens of both species, found the differences separating them to be consistent, while admitting these were small. In *S. alticarinata* the postrostral carina increases in height towards the posterior end, whereas in *S. choprai* it usually decreases. However, in some Australian specimens it maintains the same height for about 3/4 of its length, or actually increases slightly (Fig. 15B). Crosnier (1978) also found differences in the thelycum, but so far the petasma of *S. alticarinata* has not been described and figured. *S. alticarinata* appears to be limited to E Asian seas, from the Philippines to Japan, but *S. choprai*, although overlapping in the Philippines, ranges from the Indian Ocean to E Australia.

DISTRIBUTION. From NE Australia from 17°57' to 28°S and NW Australia, 100-200m. Known range, Madagascar to the Gulfs of Suez and Arabia, Pakistan, India, Malaysia, Philippines, through Indonesia to the Kai and Tanimbar Is in the Arafura Sea to E Australia, 50-200m.

TABLE 2. Principal differences between *S. bifurcata* and *S. subnuda* (= *S. crassicornis*).

Character	*S. bifurcata*	*S. subnuda*
Rostral teeth	6-7	8-10
Branchiocardiac sulcus	feeble & short	deep & long
Armature of adult telson	2 sub-apical fixed spines	no sub-apical or other spines
Dorsomedian lobule of petasma	not projecting distally	projecting distally and slightly recurved ventrally
Apex of ventrolateral lobule of petasma	recurved apically with two teeth, partly enclosed by base of dorsolateral lobule	apex directed laterally, not recurved and not partly enclosed
Thelycum	coxa of 5th pereopod with large inner plate and a spine	coxa of 5th pereopod without inner plate or spine
Median boss of thelycum	apex bifurcate	apex not bifurcate

Solenocera comata Stebbing, 1915
(Fig. 16)

Solenocera comatum Stebbing, 1915: 67, pls 13-14; Barnard, 1950; Kensley, 1972, 1974.
Solenocera comatus Burkenroad, 1934, 1939; Anderson & Lindner, 1945.
Solenocera brevipes Kubo, 1949.
Solenocera comata Starobogatov, 1972; Crosnier, 1978, 1984, 1985, 1994; Hayashi, 1984a.

MATERIAL. NTCR007950, M, 12.5mm; 5F, 13, 13.5, 16, 17, 18mm.

DIAGNOSIS. The setose area around the rostrum, typical of the genus, extends further laterally than in other species, but is sparse. Rostrum small and short, reaching about half the cornea; strongly convex ventrally with tip down-turned horizontally; with 5 rostral teeth in all, the epigastric separated from the other teeth which are close together and evenly spaced. Postrostral carina ending at the level of the top of the cervical sulcus. Orbital angle blunt; postorbital, antennal and hepatic spines large; pterygostomian spine present. Posterior orbito-antennal sulcus short and shallow. Hepatic carina starting just in front of the hepatic spine and ending at the the edge of a shallow, sparsely setose, pterygostomian depression. Hepatic sulcus ending posteriorly to a level with the top of the cervical sulcus. Cervical sulcus reaching the dorsum, which is barely depressed at this point; only faint indications of a branchiocardiac sulcus. Petasma and thelycum as described by Crosnier (1978).

REMARKS. This is one of the two species of *Solenocera* so far recorded which have a pterygostomian spine. The other is *S. algoensis*, which has a recurved hepatic carina and which has been recorded only in the western Indian Ocean.

DISTRIBUTION. NW coast of Australia, 15°58'S 120°45'E, 297m. Known range, Western Indian Ocean, Indonesia, Timor Sea, Philippines, Japan, 90-460m.

Solenocera faxoni de Man, 1907
(Fig. 17)

Solenocera faxoni De Man, 1907: 136; 1911: 52, 1913, pl. 5; Kubo, 1949; Crosnier, 1984; Hayashi, 1984a; Kensley, Tranter & Griffin, 1987.

MATERIAL. QMW11421, F, 23.5mm; 13505, F, 27mm; 15308, F, 20mm.

DIAGNOSIS. Rostrum deep proximally, sharply pointed towards the tip, with 5-7 rostral teeth, including the epigastric. Postrostral carina ending opposite the top of the cervical sulcus. Orbital angle weak; postorbital and hepatic spines large, antennal spine small; posterior orbito-antennal sulcus wide but well defined. Hepatic carina ending anteriorly in a sharp point, elevated above the level of the carapace, and ending posteriorly level with the base of the hepatic tooth; hepatic sulcus deep posteriorly and meeting a well-defined transverse sulcus, which runs from the lower branchiostegite to the cervical carina, defining a triangular hepatic area; branchiocardiac sulcus not defined. No dorsal carina on the 3rd abdominal somite. Maximum diameter of the cornea about 0.14 the length of the carapace. Antennular flagella about 1.1 the length of the carapace in the 20 and 27mm specimens above, and 1.3 in a 11.8mm specimen (Crosnier, 1984). Distal edge of the dorsomedian

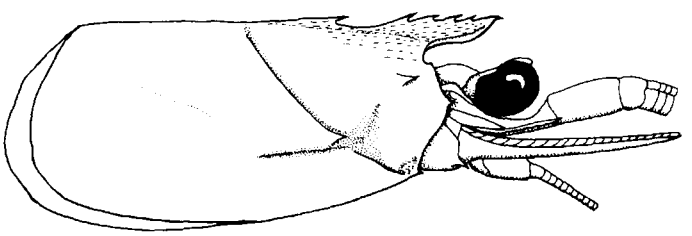

FIG. 16. *Solenocera comata* Stebbing, 1915. NTCR007950, F, 18mm, 15°58'S 120°45'E, 297m.

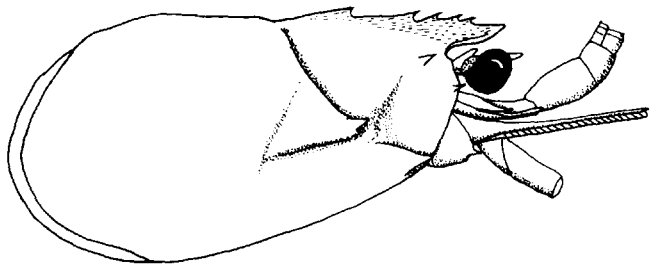

FIG. 17. *Solenocera faxoni* de Man, 1907. QMW15308, F, 20mm, 28°04'S 153°57'E, 400m.

lobe of the petasma entire, thelycal plate between the 5th pereopods with a median sulcus and no anterior boss.

Solenocera faxoni is similar to *S. moosai* and the main features separating the two species are discussed under the latter.

DISTRIBUTION. Australian seas from 33°27' to 17°57'S; Timor Sea and off NW Australia, off Marmion, near Perth (32°S), 380-400m. Known range, Kai I., Indonesia, around N Australia and to Japan, 200-400m; appears to be an uncommon species.

Solenocera koelbeli de Man, 1911
(Fig. 18A, B)

Solenocera koelbeli de Man, 1911: 48; Crosnier, 1978, 1985, 1989; non Starobogatov, 1972.
Solenocera distincta Koelbel, 1884; Yokoya, 1933.
Solenocera depressa Kubo, 1949.
Solenocera vietnamensis Starobogatov, 1972.
Solenocera melantho Lee & Yu, 1977.

MATERIAL. WAMC25273, M, 20mm; 25274 F, 31mm.

DIAGNOSIS. Blade of the rostrum almost horizontal in the smaller male specimen, tending to be depressed at the tip in the larger female; with 8 teeth in all. Cervical sulcus interrupting the postrostral carina with a deep and wide cleft; dorsal carina prominent and flat topped and almost reaching the posterior margin of the carapace (Fig. 18A). Postrostral sulcus at least half the length of the carina, irregular in width, and widening posteriorly (Fig. 18B). Except for the postrostral carina, carapace closely similar to that of *S. choprai*. Inferior antennular flagella with approx. 100 segments and 1.5-1.9 the length of the carapace in the size range examined. Petasma and thelycum as figured by Crosnier (1978, 1989).

REMARKS. *S. koelbeli* is difficult to distinguish from *S. choprai*, the general appearance and genitalia being similar. The key distinguishing features are the relative heights of the postrostral carina, the width of the cleft at the junction of the cervical sulcus and the extent and width of the postrostral sulcus. The height of the postrostral carina is variable in *S. choprai*, sometimes approaching that of *S. koelbeli*, but the carina is usually blade-like in the former and broad and flat-topped in the latter. The postrostral sulcus is usually a series of separated elongate pits, which do not widen posteriorly in *S. choprai*, whereas in *S. koilbeli* it tends to be continuous and widens posteriorly. The cleft at the cervical sulcus is narrow in *S. choprai* and relatively wide in *S. koelbeli*.

DISTRIBUTION. Rare in Australian seas, the only records being west of Northwest Cape, approx. 200m and off the northwest shelf (depth unknown). Known range, Madagascar, Arabian Sea, Indonesia, Philippines, Gulf of Tonkin, Japan, 80-240m, rarely in shallower water down to 25m.

Solenocera melantho de Man, 1907
(Fig. 19A)

Solenocera melantho De Man, 1907: 137, 1911, 1913, pl. 5, fig. 12a-i; Starobogotov, 1972; Pérez Farfante & Grey, 1980; Crosnier, 1984, 1989, 1994; Hayashi, 1984b.
Solenocera prominentis Kubo, 1949; Hoon Soo Kim, 1977; Lee & Yu, 1977.
Non Solenocera melantho, Lee & Yu, 1977.

MATERIAL. NTCR007923, M, 32mm; 4F, 39, 39.5, 41, 42mm; 007974, 4F, 37.5, 41, 43, 46mm.

DIAGNOSIS. Rostrum deep and reaching to about the extremity of the eye; with a total of 8-9 teeth, with the 4th, occasionally the 3rd above the orbital margin. Postrostral carina well defined and reaching almost to the posterior edge of the carapace; postrostral sulcus represented only by

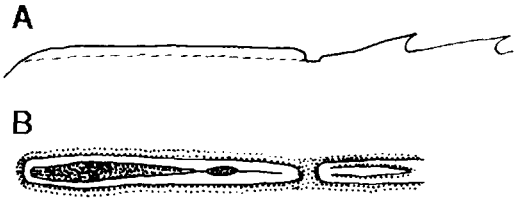

FIG. 18. *Solenocera koelbeli* de Man, 1911. WAMC25273, M, 20mm, 21°48'S 113°56'E, W of NW Cape. A, profile of postrostral carina; B, dorsal view of postrostral carina.

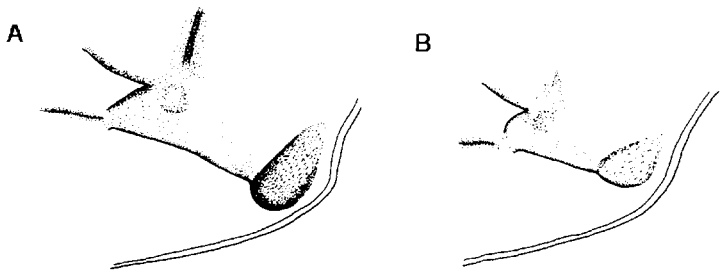

FIG. 19. A, *Solenocera melantho* de Man, 1907. Pterygostomian and hepatic region of the carapace, showing the pterygostomian pit, hepatic carina, anterior hepatic sulcus and hepatic spine. NTCR007923, F, 42mm, 9°46'S 129°54'E, 298m. B, *Solenocera australiana* Pérez Farfante & Grey, 1980. Same features as in A, QMW17419, F, 33mm, Gulf of Carpentaria, 53mm.

1-4 small pits, sometimes with none. Orbital angle sharp, antennal and hepatic spines of similar size, postorbital spine large; cervical sulcus reaching almost to the dorsum, which is only barely indented at this point. Posterior orbito-antennal sulcus deep, almost vertical and reaching the base of the postorbital spine. Anterior end of the hepatic carina curving ventrally around a deep depression at the pterygostomian angle, forming an arc, almost a semicircle (Fig. 19A). Hepatic sulcus extending posteriorly and almost joining an indistinct branchiocardiac sulcus, which nearly reaches the posterior edge of the carapace. Antennular flagella 0.9-1.25 the length of the carapace in females, longer in males and juveniles. Thelycal plate between the 5th pereopods sometimes with a low anterior median ridge, sometimes with none.

REMARKS. *Solenocera melantho* is difficult to distinguish from *S. australiana* and the features in Fig.19 and Table 3 need to be considered in conjunction when identifying these species.

DISTRIBUTION. Australian seas from Scott Reef (14°52'S 121°39'E) to the Arafura Sea (9°46'S 129°54'E), 258-298m. Known range, S Japan and N China Sea, Philippines, Indonesia and NW Australia, 150-300m.

Solenocera moosai Crosnier, 1984
(Fig. 20)

Solenocera moosai Crosnier, 1984: 37, figs 5 a, 6 a, 7 c,d, 1989, 1994.

MATERIAL. QMW15860, 3M, 10.5, 11, 12.5mm; 17052, 5F, 12.5, 12.5, 14.5, 15, 16mm; 17053, 3F, 14.5, 16.5, 16.5mm; 17054, F, 18mm; 17055, 2F, 15, 16mm.

DIAGNOSIS. Rostrum deep proximally, sharply pointed towards the tip, with 5-6 rostral teeth in all, the epigastric widely separated from the 1st rostral tooth. Postrostral carina ending just behind a depression opposite the top of the cervical sulcus. Orbital angle absent or represented by only a low bump; postorbital spine large, antennal and hepatic spines small; posterior orbito-antennal sulcus well defined and joining a wide, shallow anterior sulcus just below the postorbital spine. Hepatic carina ending anteriorly in a sharp point, elevated above the level of the carapace, and ending posteriorly just anterior to the hepatic tooth; hepatic sulcus deep posteriorly and meeting a well-defined transverse sulcus, which runs from the lower branchiostegite to the cervical carina, defining a triangular hepatic area; branchiocardiac sulcus absent. A dorsal carina on the 3rd abdominal somite. Maximum diameter of the cornea at least 0.2 the length of the carapace. Antennular flagella 1.4-1.65 the length of the carapace in larger specimens, and 1.8 in a 12.5mm specimen. Dorsomedian lobe of petasma bilobed distally; thelycal plate of the 5th pereopods with a large low anterior boss.

TABLE 3. Principal features distinguishing *S. melantho* and *S. australiana*. Until shown to be otherwise, the last criteria are the simplest and probably the most consistent for separating the species.

Feature	*S. melantho*	*S. australiana*
Rostral tooth above the orbital margin	3rd or 4th	4th or 5th
Ventral margin of rostrum	straight or slightly concave	convex
Anterior end of hepatic carina	almost a semicircle around a deep depression	a shallow arc around a shallow depression
Tip of superior antennular flagella	with a long taper	with a short taper
Length of adult female antennular flagella	0.9 - 1.25 length of the carapace	1.4 - 1.5 length of the carapace
Dorsolateral lobule of petasma	1 - 13 spinules	>30 spinules
Thelycal plate	sometimes with anterior median ridge; posterior rim with two median setose projections	always without an anterior median ridge; posterior rim slightly concave, without median projections
Usual depth range	150 - 300m	15 - 55m

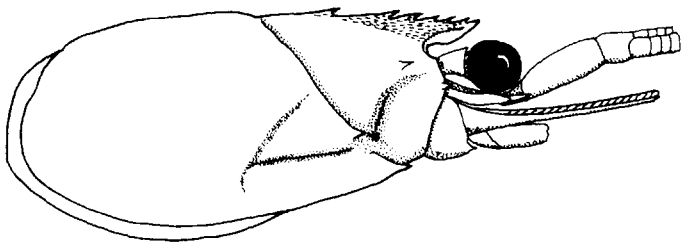

FIG. 20. *Solenocera moosai* Crosnier, 1984. QMW17052, F, 12.5mm, 17°58'S 147°06'E, 300m.

REMARKS. Crosnier (1984) notes that *S. moosai* and *S. faxoni* are closely similar and lists points of difference. The more important of these are included in the key, of which the most reliable is the small size of the eye in *S. faxoni*. Characteristics of the genitalia are additional criteria for distinguishing the two species.

DISTRIBUTION. In Australian seas, recorded only from off Tully, NE Queensland, 260-325m; probably occurs round N Australia. Known range, Makassar Strait, Indonesia (type locality); E of the Tanibar Is, Timor Sea; NE Australia; Philippines, 120-325m, mostly around 200m.

Solenocera pectinata (Bate, 1880)
(Fig. 21A, E)

Philonicus pectinatus Bate, 1888: 279, pl. 38; de Man, 1892.
?*Philonicus cervicalis* Zehntner, 1894.
Solenocera pectinata de Man, 1911 (p. 45, part), 1922; Balss, 1925; Anderson & Lindner, 1945; Nataraj, 1945; Hall, 1961, 1962; George, 1969 (part); Starobogatov, 1972; Crosnier, 1978, 1984, 1989, 1994b.
Non *Solenocera pectinata* de Man, 1913; George, 1967, Michel, 1974 (= *S. pectinulata* Kubo).

MATERIAL. QMW12839, M, 12mm, 3F, 14.5, 15, 15mm; 12841, F, 14.5mm; 17440, F, 12.5mm.

DIAGNOSIS. Dorsal edge of rostrum convex, with 8-9 small teeth including the epigastric; postrostral carina not extending past the top of the cervical sulcus; orbital angle blunt. Postorbital and hepatic spines of similar size, antennal spine small; cervical sulcus deep and ending just below the dorsum, which is slightly depressed at this point; posterior part of the orbito-antennal sulcus deep, its upper end reaching just above the level of the antennal spine. Anterior hepatic carina recurved, forming a blunt projection, raised above the carapace surface; the carina ending posteriorly at the tip of the hepatic tooth. Hepatic sulcus extending posteriorly to about the level of the top of the cervical sulcus; branchiocardiac sulcus barely defined. Inferior antennular flagella 1.13-1.24 the length of the carapace and with 57-63 segments. Distal third of the petasma pectinate, the ventrolateral lobe ending in a single tooth (Crosnier, 1978, fig. 61c-d); accessory lobe with 18-20 spinules (Fig. 21E). Trapezoidal plate of thelycum with a small anterior median boss, median sulcus poorly defined (Crosnier, 1978, fig. 60d-f).

REMARKS. *Solenocera pectinata* is easily confused with *S. pectinulata*, especially because the two species have similar habitats and geographical distribution (see discussion under the latter species).

Carapace colour pinkish-white; abdomen with narrow vertical red bands, blue and pink in between, uropods banded; antennular flagella white tipped, distal 2-3 segments of pereopods blue, proximal parts and pleopods pink.

DISTRIBUTION. In Australian seas from 18°42' S, off Townsville, N Queensland to the Gulf of Carpentaria, 50-100m. Known range, the Arabian Sea to Madagascar, Burma, the South China Sea, the Philippines and the Gulf of Tonkin, through Indonesia to N Australia and Wallis and Futuna Is, from near inshore to 200m.

Solenocera pectinulata Kubo, 1949
(Fig. 21B, C, D)

Solenocera pectinulata Kubo, 1949: 251, figs 8S, 27A-B, 66K-L, 72N-T, 83B, 101, 102C; Starobogatov, 1972; Crosnier, 1978, 1984, 1989; Hayashi, 1984a,b.
Solenocera pectinata de Man, 1911 (part); 1913, pl. 4, fig. 11; Balss, 1914 (part); George, 1967, 1969 (part); Michel, 1974.

MATERIAL. QMW12838, M, 11mm, 2F, 11.5, 12mm; 14320, M, 13.5mm, 4F, 15, 16.5, 17.5, 18mm; 15869, M, 10mm, F, 13mm; 18046, 2M, 10, 12mm, F, 18mm.

DIAGNOSIS. Rostrum acutely pointed, dorsal edge horizontal, with 6-7 prominent teeth including the epigastric; postrostral carina not extending past the top of the cervical sulcus; orbital angle barely discernible. Postorbital, antennal and hepatic spines large; cervical sulcus deep and ending just below the dorsum, which is slightly depressed at this point; orbito-antennal sulcus wide and shallow, almost reaching the base of the postorbital spine, but sometimes virtually absent. Anterior hepatic carina recurved, forming a blunt projection, raised above the

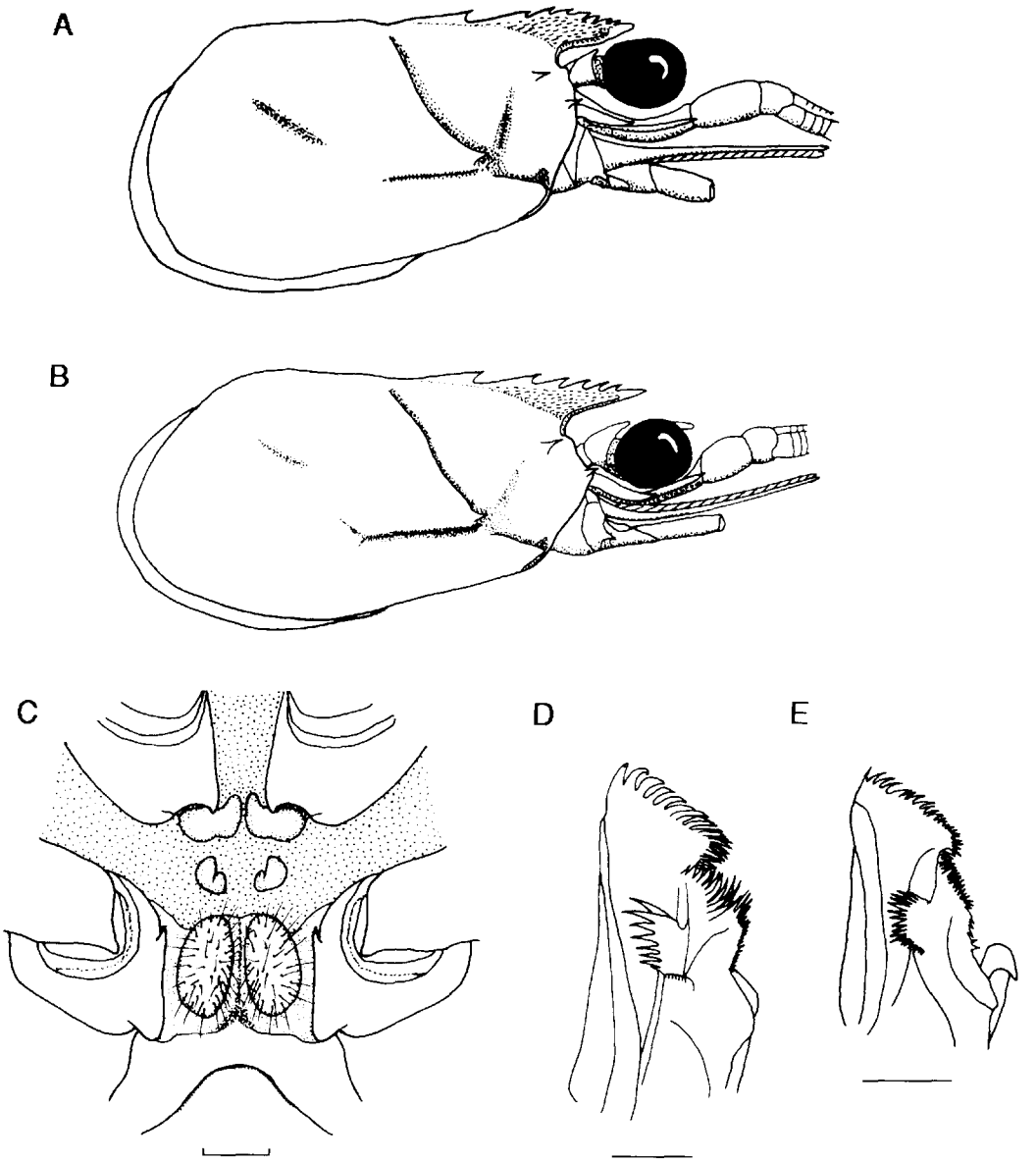

FIG. 21. A, *Solenocera pectinata* (Bate, 1880). QMW12839, M, 12mm, 18°34'S 147°09'E, approx. 75m. B, *Solenocera pectinulata* Kubo, 1949. QMW14320, M, 13.5mm, off Mission Beach, depth unknown. C, *Solenocera pectinulata*, thelycum, QMW14320, F, 18mm (scalebar = 1mm). D, *Solenocera pectinulata*, petasma, distal right half, external aspect, showing accessory lobule, QMW14320, M, 13.5mm. E, *Solenocera pectinata* (Bate, 1880), similar details to D, QMW12839, M, 12mm (A).

carapace surface; the carina ending posteriorly at, or just in advance of the tip of the hepatic tooth. Hepatic sulcus extending posteriorly a little behind the level of the top of the cervical sulcus; branchiocardiac sulcus virtually absent. Antennular flagella 0.9-1.0 the length of the carapace and with 44-53 segments. Distal third of the petasma pectinate, the ventrolateral lobe ending in two teeth (Crosnier, 1978, fig. 61a-b); accessory lobule with about eight large spinules (Fig. 22C). Trapezoidal plate of thelycum with a

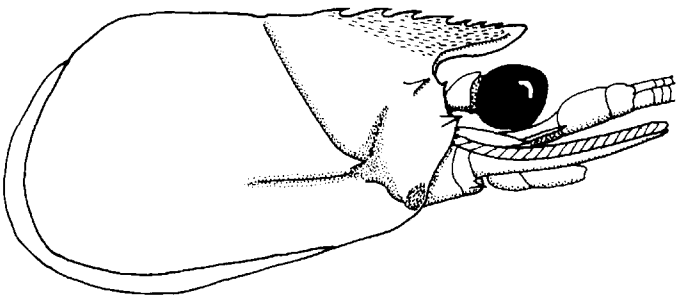

FIG. 22. *Solenocera rathbuni* Ramadan, 1938. NTCR007941, F, 13mm, 19°28'S 118°29'E, 52m.

well defined median sulcus, running between a pair of prominent ovoid bosses (Fig. 22B).

REMARKS. As mentioned above, *Solenocera pectinulata* is difficult to distinguish from *S. pectinata*, especially without the other species for comparison. Also, the antennular flagella, one of the best means of separating the two species, are often missing. The features of Table 4, taken together, will usually give a reliable identification.

DISTRIBUTION. In Australian seas from NE Queensland, from Innisfail to Townsville, 50-200m. Known range, Japan, Philippines, Indonesia, N Australia, W coast of India to Madagascar, 75-350m, mostly above 175m.

Solenocera rathbuni Ramadan, 1938
(Fig. 22)

Solenocera lucasii, Rathbun, 1906: 904, pl. 20, fig. 9; Burkenroad, 1934.
Solenocera rathbuni Ramadan, 1938: 57; Starobogatov, 1972; Ivanov & Hassan, 1976; Crosnier, 1978, 1989, 1994b; Kensley, Tranter & Griffin, 1987.

MATERIAL. QMW14304, M, 20mm; NTCR00624, 3M, 12, 12, 15mm, 3F, 16.5, 17, 18mm; 007941, 4F, 12, 13, 13, 16mm.

DIAGNOSIS. Rostrum deep and reaching about half the cornea, strongly convex ventrally and with a total of 7-8 teeth. Postrostral carina ending opposite the top of the cervical sulcus. Orbital angle sharp, antennal and hepatic spines small, postorbital spine large. Cervical sulcus deep and almost reaching the dorsum, which is scarcely depressed at this point. Anterior end of hepatic carina forming a shallow arc around the ventral side of a shallow depression near the pterygostomian angle. Hepatic sulcus extending posteriorly to about the level of the top of the cervical sulcus; branchiocardiac sulcus virtually absent; orbito-antennal sulcus shallow and not reaching the base of the postorbital spine. Dorsomedian and dorsolateral lobules of the petasma pectinate with long teeth; ventrolateral lobule with a single large tooth. Thelycal plate between the 5th pereopods largely enclosed by two blade-like inner projections of the coxae; thelycal plate with an anterior rounded boss and two lateral conical bosses, the 3 forming a triangle.

REMARKS. *Solenocera rathbunii* is relatively featureless but is closest to *S. waltairensis* which has not yet been reported from Australian waters; the key features appear to be the best for separating the two species.

Carapace colour red to pink with whitish patches; abdomen with narrow red dorsal bands, edged with white; antennular flagella red and white tipped, other appendages red, mostly with some white.

DISTRIBUTION. In Australian waters from SE Queensland to NW Australia, 50-200m. Known range, South of Madagascar, Philippines, Australia, Hawaian Is, Wallis and Futuna Is, 26-440m.

ZOOGEOGRAPHY OF THE SOLENOCERIDAE IN THE INDO-WEST PACIFIC

The four principal families of the Penaeoidea in the Indo-West Pacific are the Penaeidae, Solenoceridae, Aristaeidae and Benthesicymidae (the fifth family, the Sicyonidae, is poorly represented). The species of the Penaeidae are largely inhabitants of inshore areas and the continental shelf. The limits to their distribution are largely determined by temperature, larval advection, oceanic deeps and coastal geography (Dall et al., 1990; Dall, 1991). About half of the Penaeidae are endemic to various sub-regions, but those species living at greater depths generally have a wide distribution. This is also evident in the Aristaeidae and Benthesicymidae, which are deep water inhabitants and mostly have a cosmopolitan distribution (Crosnier, 1978, 1985; Crosnier & Forest, 1973). The Solenoceridae lie between these 2 extremes with 17 of the 45 authentic Indo-West Pacific species apparently with a limited distribution. Some of this may be an artifact. Unless a species is

TABLE 4. Features distinguishing *S. pectinata* and *S. pectinulata*.

Feature	*S. pectinata*	*S. pectinulata*
Rostral teeth	8-9, small	6-7, large & prominent
Dorsal edge of rostrum	slightly convex	straight
Inferior antennular flagella	> 57 segments, 1.3-1.24 length of carapace	44-53 segments, 0.9-1.0 length of carapace
Distal end of ventrolateral lobe of petasma	2 teeth	1 tooth
Accessory lobule of petasma	about 8 large spinules	18-20 spinules of varying size
Trapezoidal plate of thelycum	a small anterior median boss; median sulcus ill-defined	no anterior median boss; median sulcus well-defined, separating a pair of large bosses

common, its apparent distribution may be a function of the extent and intensity of deep-water trawling. With few exceptions, only scientific expeditions trawl below 1,000m and thus species occurring below this depth may appear to be correspondingly rare e.g. *Gordonella* species and two of the three *Haliporus* species. With this proviso it is possible to draw some conclusions about the general distribution of the Solenoceridae.

Lower temperature is an obvious limiting factor to the Penaeidae. The Solenoceridae, being mainly inhabitants of deeper waters, with more uniform temperatures, could be expected to be less influenced by this, but existing records of their distribution show that they are confined within thermal limits similar to that of the Penaeidae, that is, the 15°C minimum winter sea surface temperatures. Like the Penaeidae, the number of species attenuates with increasing latitude outside the tropics, except that in the Solenoceridae the attenuation is not as marked. In Australia 10 out of 57 species (18%) of Penaeidae, compared with 10 out of 26 species (38%) species of Solenoceridae, occur outside the tropics. Since the Penaeidae are mostly shallow-water tropical species their thermal restriction is explicable. In contrast, the distribution of the deeper-water Solenoceridae appears to be something of a paradox. The water temperatures at 400m between 40°N and 40°S latitude range between approx. 9° and 15°C and vary little with latitude or season, the higher temperatures being localised and due to the influence of warm water oceanic eddies (Sverdrup et al., 1970). At higher latitudes the temperatures at 400m begin to fall appreciably and in the southern hemisphere the Subtropical Convergence zone begins at around 40°S. Temperature may also limit the vertical distribution of the Solenoceridae. Only two *Gordonella* and two *Haliporus* species are adapted to depths below 1,500m and most solenocerids live above 900m where the temperature exceeds 5°C (Sverdrup et al., 1970). It may be that it is the temperature of intermediate waters that determine the range of the solenocerids. This temperature limitation also suggests that the Solenoceridae were tropical in origin and have retained the need for warmer water at some stage of their life cycle. Advection of vertically migrating larvae of shallow-water Penaeidae can be significant (Dall et al., 1990), and could also contribute to the limitation of distribution of the Solenoceridae, but virtually nothing is known of their larval ecology.

The other possible barriers to distribution in the Penaeidae are oceanic deeps and coastal geography (Dall, 1991). Oceanic deeps would only have the effect of restricting species to their preferred depth range. Geography of the continental shelf and slope could be an effective barrier, for example, an extensive change from the soft substrates inhabited by *Solenocera* species to rubble or rock.

Of the 16 solenocerid species recorded with limited distribution, some are probably artifacts due to their rarity. It is unlikely, for example, that a species recorded only in the Strait of Malacca would not occur throughout Indonesia, the Philippines and the South China Sea. Eliminating those rare species with probable more extensive geographic ranges leaves seven: four from SE Africa – Madagascar, *Cryptopenaeus catherinae*, *Haliporoides triarthrus*, *Hymenopenaeus furici*, *Solenocera africana*; three from the Australian region, *Haliporoides cristatus*, *Solenocera australiana* and *S. bifurcata*. In this latter region true endemic species are very probably *Solenocera australiana*, a shallow water species and *Haliporoides cristatus*, limited to the east coast. Both are abundant species. *Solenocera bifurcata* is so far rare and is limited to the east coast, but is a relatively shallow water species and thus could be a true endemic species.

There appears to be a barrier to the Penaeidae to the NW of Australia, either due to the Timor Trench or adverse currents or a combination of both (Dall, 1991). This barrier would also be effective to *Solenocera australiana*, which is a continental shelf species, not occurring below

70m. On the west coast the most southern record of a solenocerid is 30°S, not far from the latitude of the 15°C minimum winter isotherm. On the east coast, the southward East Australian Current extends the limit of solenocerid distribution to 38°S, also the latitude of the 15°C minimum winter isotherm. Combined with New Guinea, however, the East Australian Current tends to limit migration to the north (Dall, 1991). Thus there are three endemic species of Penaeidae on the east coast and on present evidence two Solencoceridae.

From the Australian point of view, perhaps the most significant aspect of solenocerid distribution is that Australia, far from being deficient, contains well over half the known species in the Indo-West Pacific.

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