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**INVERTEBRATE
ZOOLOGY**
Crustacea

**A REVISION OF THE AUSTRALIAN SPECIES OF PENAEINAE (CRUSTACEA
DECAPODA: PENAEIDAE)**

By W. DALL

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A REVISION OF THE AUSTRALIAN SPECIES OF PENAEINAE (CRUSTACEA DECAPODA: PENAEIDAE)

By W. DALL*

[Manuscript received November 26, 1956]

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Summary

Twenty-eight Australian species of Penaeinae, of which six are new, are fully described and figured. Full keys to genera and species, and a glossary of special terms, are included. The zoogeography of Australian and Indo-West Pacific Penaeinae is discussed.

I. INTRODUCTION

Although the Penaeidae have long been of commercial importance in other parts of the world, notably in the Gulf of Mexico (Gunter 1950), it is only recently that an appreciable industry has developed in Australia. As a result of commercial and exploratory trawling, several species not recorded in Australian waters or regarded as rare have appeared commonly, the known range of others has been extended, and several new species have been found.

The following 21 species have been described or recorded from Australian waters to date (Hess 1865; Haswell 1879, 1882; Miers 1884; Bate 1888; Whitelegge 1890, 1900; Schmitt 1926; Hale 1927; Racek 1955):

Penaeus maccullochi Schmitt; *P. plebejus* Hess; *P. latisulcatus* Kishinouye; *P. semisulcatus* de Haan; *P. monodon* Fabricius (—*P. carinatus* Dana; —*P. caerules* Stebbing); *P. esculentus* Haswell; *P. merguensis* de Man; *P. indicus* Milne Edwards; *P. serratus* Bate (—*Penaeopsis challengerii* de Man); *Penaeopsis norae-guiniae* (Haswell); *P. mogiensis* (Rathbun); *Metapenaeus monoceros* (Fabricius); *M. endeavouri* (Schmitt); *M. incisipes* (Bate); *M. mastersii* (Haswell); *M. macleayi* (Haswell); *Trachypenaeus currirostris* (Stimpson); *T. granulatus* (Haswell); *T. anchoralis* (Bate).

To these may be added the following doubtful species which are possibly synonyms: *Penaeus batei* Miers, 1884, Torres Strait (probably a *Metapenaeopsis* sp.); *Penaeus*

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villosus Guérin, "Australia" (in Voy. "Coquille" II and Alcock (1906); quite probably *Metapenaeus monoceros* or *M. mastersii*); *Penaeus gracilis* Dana, Port Jackson (Bate 1888; an immature *Metapenaeopsis* sp.).

The present revision is based on material examined from eastern, northern, and western Australia largely collected since 1949 except for eight uncommon species from the collection of the Australian Museum. Of the species previously recorded, *Penaeus indicus*, "*Penaeus serratus*", and the doubtful species *Penaeus batei*, *P. villosus*, and *P. gracilis*, have not yet been found by the writer. There is every possibility of *P. indicus* being found in numbers on the northern coast of Australia, but *Penaeopsis serratus* is a deep-sea species and is probably rare. *Penaeus maccullochi* is regarded as a malformed *P. plebejus*, and *Metapenaeus incisipes* as a synonym of *M. monoceros*. All holotypes and allotypes and most paratypes have been lodged in the collection of the Australian Museum, Sydney.

II. MORPHOLOGICAL FEATURES AND DEFINITIONS

There are several major works on the Penaeidae, all of which except that of Bate (1888) deal with species outside Australian waters (Alcock 1901, 1905, 1906; de Man 1911; Burkenroad 1934a, 1934b; Kubo 1949). Kubo's monograph is the most outstanding and comprehensive. An exhaustive comparative account is given of the morphological features of the family, and the systematic part includes full descriptions and keys to subfamilies, genera, and species.

The present revision follows the general scheme of Kubo's (1949) specific descriptions, and for the most part the same terminology is used. Keys include all established Indo-West Pacific species. Order of presentation of genera and species is the same as that in the keys, and does not indicate any supposed phylogenetic relationships (for this see Kubo (1949)).

Features of systematic importance in the Penaeidae are rostrum, carapace, carination of the abdomen, telson, antennules, antennae, mandibles, maxillules, 3rd maxilliped, pereopods (walking legs), secondary sexual characters (♂ petasma and appendix masculina and ♀ thelycum), and the gastric mill or stomodaeal apparatus (see Kubo (1949) for detailed treatment of these features).

Length and other measurements.—These are made to the nearest millimetre. Total lengths may be approximations owing to the strongly flexed abdomens of some specimens. Length (total length) is taken overall from tip of rostrum to tip of telson with abdomen extended if possible. Carapace length is from postorbital margin to median posterior border. Lengths of other parts are always maximum distances between extreme points unless otherwise noted.

Carapace and rostrum (Fig. 1).—In addition to features shown, some genera possess thin sutures (Fig. 15).

Antennules.—The 1st 3 segments constitute the peduncle. Arising on the lateral base of the 1st segment is the spinous *stylocerite*, and from the median side there is often a foliaceous *prosoartema*.

Antennae.—The 1st and 2nd segments are large, the 2nd (*basicerite*) bearing the *scaphocerite* (antennal scale) and 3rd to 5th segments. The 5th (*carpocerite*) carries the long flagellum.

Pereiopods and 3rd maxillipeds.—Lengths of these are measured by extending them along the ventral surface of the body, their extent being referred to suitable prominent morphological features.

Petasma, appendix masculina, and thelycum (Figs. 2–28).—The petasma is always considered as lying parallel to the ventral surface of the body.

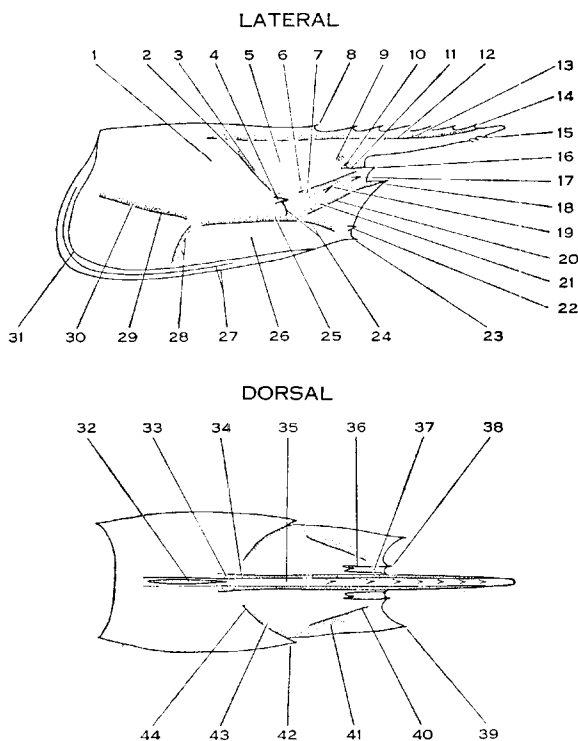


Fig. 1. Diagrammatic representation of carapace to show features of taxonomic importance.

LATERAL: 1, Cardiac region; 2, cervical carina; 3, cervical sulcus; 4, hepatic spine; 5, gastric region; 6, gastro-orbital carina; 7, orbito-antennal sulcus; 8, epigastric or first rostral tooth; 9, post-ocular sulcus; 10, gastrofrontal sulcus; 11, gastrofrontal carina; 12, adrostral carina; 13, adrostral sulcus; 14, last rostral tooth; 15, last ventral rostral tooth; 16, orbital or supra-orbital spine; 17, postorbital spine; 18, antennal spine; 19, postantennal spine; 20, antennal carina; 21, orbito-antennal sulcus; 22, branchiostegal spine; 23, pterygostomial spine; 24, hepatic carina; 25, hepatic sulcus; 26, pterygostomial region; 27, marginal region; 28, inferior carina and sulcus; 29, branchio-cardiac carina; 30, branchiocardiac sulcus; 31, pterygostomial sulcus.

DORSAL: 32, Postrostral or median sulcus; 33, adrostral sulcus; 34, adrostral carina; 35, postrostral carina; 36, gastrofrontal carina; 37, gastrofrontal sulcus; 38, orbital or supra-orbital spine; 39, antennal spine; 40, gastro-orbital carina; 41, orbito-antennal sulcus; 42, hepatic spine; 43, cervical sulcus; 44, cervical carina.

Gastric mill (Fig. 15).—Use of this as a systematic feature is due to Kubo (1949). Cardiac plate and zygo-cardiac ossicle are the most useful.

Colour.—The colour in Penaeidae is variable and should not be used alone for specific recognition. However, once the variation is known, in the field, colour and general facies often enable quick identifications to be made. Estuarine juveniles are sometimes differently marked from adults. There is a tendency for prawns from

deeper or more turbid waters to have much darker colours, with red predominating, than those from shallower or clear waters. There is some indication also that colours may vary throughout the geographic range of a species.

Branchiae (gills).—These are of the usual macrurous decapod shape. The rudimentary gills are minute, sometimes microscopic. The *mastigobranchiae* (*epipodites*) are filamentous, long, and often forked.

III. TAXONOMY

Family PENAEIDAE Bate

Penaeidae Bate, 1888, pp. 220–9. Kubo, 1949, pp. 192–3.

Body compressed, rostrum usually well developed, armed with teeth; eye well developed; antennule with 2 flagella and a stylocerite on 1st peduncular segment; antennal scale very large; mandible with incisor and molar processes not separated by a deep cleft, palp foliaceous 2-segmented; maxillula with 3 laciniae, palp (endopodite) unsegmented or segmented; maxilla foliaceous with 2 laciniae, each typically bifid; 1st maxilliped with a slender endopodite, unsegmented, or 5-segmented; 2nd and 3rd maxillipeds pediform with 7 segments; 1st to 3rd pereopods chelate, gradually increasing in length backwards; last 2 pereopods usually with a simple dactylus. Petasma, appendix masculina, and thelycum well developed. Gills numerous, arthrobranchiae in a double series. Ossifications of gastric mill well developed. Cardiac plate with longitudinal row of spinules on inner surface, sometimes without spinules.

KEY TO THE SUBFAMILIES OF THE PENAEIDAE

(Non-specialists should consult Barnard (1950) for key to families of the suborder Natantia, which includes the Penaeidae.)

1. Upper antennular flagellum inserted near posterior border of 3rd antennular segment, much shorter than the other, with 7 pleurobranchiae of which all but the last are usually rudimentary; mastigobranch on last thoracic somiteAristaeinae
Upper antennular flagellum inserted on apex of 3rd antennular segment, equal or subequal to the other; with 2–6 pleurobranchiae all fully functional; no mastigobranch on last thoracic somite2
- 2(1). Cervical sulcus reaching to or almost to dorsum; postorbital spine present; mastigobranch on 7th thoracic somiteSolenocerinae
Cervical sulcus reaching not more than $\frac{2}{3}$ distance between hepatic spine and dorsum, often much less; postorbital spine absent; no mastigobranch on 7th thoracic somite ...3
- 3(2). Prosartema present; exopods usually present on 2nd and 3rd maxillipeds; pleopods with 2 rami; pleurobranchiae on 4th to 6th thoracic somitesPenaeinae
Prosartema absent; no exopods on 2nd and 3rd maxillipeds; pleopods with 1 ramus only; no pleurobranchiae on 4th to 6th thoracic somitesEusicyoninae

Subfamily PENAEINAE Burkenroad

Penaeinae Burkenroad, 1934b, p. 72. Kubo, 1949, pp. 260–2.

Rostrum well developed, armed dorsally with teeth, sometimes ventrally armed as well; hepatic and antennal spines usually present; cervical sulcus not reaching dorsum; posterior dorsum of abdomen carinated; telson usually with median dorsal sulcus, tapering to a point, with or without lateral spines. A foliaceous prosartema on inner side of basal segment of antennular peduncle, flagella inserted

on apex of 3rd segment; 2nd segment of mandibular palp lamellar, usually closing a respiratory canal formed by apposition of antennular peduncles and antennal scales; maxillipeds with large endopods; 3rd maxilliped long, pediform, sometimes sexually dimorphic; pereopods usually not differing greatly in thickness and length, but sometimes last 2 very slender and filiform; exopods usually present on 1st 4 pereopods. Appendix masculina usually with 2 segments, sometimes with 1 or 3; thelycum with simple open or with closed seminal receptacle. Arthrobranchiae on last thoracic somite usually absent, anterior arthrobranch of penultimate somite usually rudimentary or absent; a podobranch on 2nd maxilliped only; no mastigobranchiae on 7th and 8th thoracic somites.

The subfamily comprises 15 genera: *Miyadiella* Kubo; *Penaeus* Fabricius; *Funchalia* Johnson; *Metapenaeopsis* Bouvier; *Artemesia* Bate; *Parapenaeus* Smith; *Penaeopsis* Bate; *Trachypenaeopsis* Burkenroad; *Macropetasma* Stebbing; *Metapenaeus* Wood-Mason & Alcock; *Protrachypene* Burkenroad; *Xiphopeneus* Smith; *Atyopenaeus* (Alcock); *Trachypenaeus* (Alcock); *Parapenaeopsis* (Alcock). Of these genera *Miyadiella*, *Artemesia*, *Macropetasma*, and *Protrachypene* each contain one species. The genera *Artemesia*, *Protrachypene*, and *Xiphopenaeus* are so far restricted to the Atlantic or Pacific America. Species of the aberrant genus *Miyadiella*, and of *Macropetasma*, *Penaeopsis*, and *Trachypenaeopsis*, which to date are recorded elsewhere in the Indo-West Pacific region, may occur on the northern coasts of Australia. The remaining eight genera are represented in Australian waters: *Penaeus*, *Funchalia*, *Metapenaeopsis*, *Parapenaeus*, *Metapenaeus*, *Atyopenaeus*, *Trachypenaeus*, and *Parapenaeopsis*.

There is a possibility that the International Commission of Zoological Nomenclature may exercise its plenary powers to adjust the spelling of *Atyopeneus* Alcock, *Trachypeneus* Alcock, and *Parapeneopsis* Alcock and other generic names derived from *Peneus* Weber, 1795, to conform with the spelling of the root name *Penaeus* Fabricius, 1798, validated by the Commission in 1955. Pending this decision the spelling *Atyopenaeus*, *Trachypenaeus*, and *Parapenaeopsis* has been adopted in the present revision.

KEY TO THE GENERA OF PENAELINAE

1. A single arthrobranch on 6th and 8th thoracic somites; ophthalmopod greatly elongate.
 1st segment of antennular peduncle not excavated for reception of cornea which is as wide as optic peduncle *Miyadiella* Kubo
 An anterior and a posterior arthrobranch on 6th and no arthrobranch on 8th thoracic somite; ophthalmopod not markedly elongate. 1st segment of antennular peduncle excavated for reception of cornea, which is much wider than optic peduncle 2
- 2(1). A pleurobranch on last thoracic somite; an epipodite on 3rd maxilliped; ventral rostral teeth usually present 3
 No pleurobranch on last thoracic somite; no epipodite on 3rd maxilliped; ventral rostral teeth absent 4
- 3(2). Incisor process of mandible short, almost right-angled; body glabrous; pterygostomial angle blunt; telson without spines or with 3 pairs of movable spines ... *Penaeus* Fabricius
 Incisor process of mandible elongate, scimitar-like; body densely pubescent; telson with 3 pairs of fixed spines *Funchalia* Johnson
- 4(2). Petasma symmetrical; 3rd maxilliped usually without basal spine 5
 Petasma asymmetrical; 3rd maxilliped with basal spine *Metapenaeopsis* Bouvier

- 5(4). Telson with a large pair of subapical fixed spines; a spine, which may be minute, on the ventral distomedian border of 1st segment of antennular peduncle 6
 Telson without a pair of large subapical fixed spines but often with lateral movable spines (excepting *Parapenaeopsis stylifera* (Milne Edwards)); no spine on the ventral distomedian border of 1st segment of antennular peduncle 9
- 6(5). Telson with fewer than 4 pairs of fixed spines; basis and ischium of 1st pereopod each with a spine 7
 Telson with 4 pairs of fixed spines; basis and ischium of 1st pereopod unarmed *Artemesia* Bate
- 7(6). Carapace with longitudinal sutures *Parapenaeus* Smith
 Carapace without longitudinal sutures 8
- 8(7). Branchiostegal spine present; petasma with a pair of large spiniform distolateral projections *Penaeopsis* Bate
 Branchiostegal spine absent; petasma with a pair of tubular distolateral projections *Trachypenaeopsis* Burkenroad
- 9(5). Exopods on 2nd to 4th pereopods 10
 Exopods absent on 2nd to 4th pereopods *Macropetasma* Stebbing
- 10(8). A pleurobranch on 7th thoracic somite; no exopod on 5th pereopod
 *Metapenaeus* Wood-Mason & Alcock
 No pleurobranch on 7th thoracic somite; an exopod on 5th pereopod 11
- 11(10). Second maxilliped with well-developed exopod; chelae of pereopods of usual shape 12
 Second maxilliped without exopod; chelae of pereopods with short fingers and much-lengthened palm *Protrachypene* Burkenroad
- 12(11). Dactyls of 4th and 5th pereopods of usual penaeid shape, not subdivided; usually not more than $\frac{1}{2}$ free portion of rostrum unarmed 13
 Dactyls of 4th and 5th pereopods markedly elongate, filamentous, and subdivided; $\frac{3}{4}$ free portion of rostrum unarmed *Xiphopenaeus* Smith
- 13(12). Carapace with longitudinal sutures; thelycum a broad concave anterior plate with rounded anterior margin and transverse posterior plate; ischial spine absent on 2nd pereopod 14
 Carapace without longitudinal sutures; thelycum with narrow anterior plate partly enclosed by 2 raised narrow posterolateral plates; ischial spine on 2nd pereopod *Atyopenaeus* (Alcock)
- 14(13). Mastigobranchiae on 3rd pereopods *Trachypenaeus* (Alcock)
 Mastigobranchiae absent on 3rd pereopods *Parapenaeopsis* (Alcock)

Genus *PENAEUS* Fabricius

Penaeus Fabricius, 1798. Bate, 1888 (part), p. 229. De Man, 1911, p. 95. Balss, 1914, p. 13. Burkenroad, 1934b, p. 74. Kubo, 1949, pp. 268-70. Barnard, 1950, pp. 582-3.
Peneus Alcock 1901, p. 14; 1906, p. 7.

Rostrum toothed ventrally. Carapace without longitudinal or transverse sutures; cervical and orbito-antennal sulci and antennal carinae always present. Hepatic and antennal spines pronounced, pterygostomial angle rounded. Telson with deep sulcus, without fixed subapical spines, with or without lateral movable spines. First antennular segment without a spine on ventral distomedian border. Antennular flagella shorter than carapace. Maxillulary palp with 2 or 3 segments, usually 3. Maxilliped 3 sexually dimorphic. Basal spines on 1st and 2nd pereopods, exopods on 1st 4 pereopods, usually present on 5th. Petasma pod-like with thin median lobes, usually with small thickened distal protuberances and forming a posterior tube-like projection; lateral lobes usually with thickened distal rounded margins. Appendix masculina with an ovoid distal segment, bearing numerous

spinules. Thelycum usually with an anterior process, variable in shape, lying between the coxae of 4th pereopods and seminal receptacle occupying ventral surface of last thoracic sternite, receptacle often closed by 2 flaps which meet or overlap on the mid line; seminal receptacle sometimes open. Zygocardiac ossicle consisting of a principal tooth followed by a longitudinal row of smaller teeth which often end in a cluster of minute teeth. Pleurobranchiae on 3rd to 8th thoracic somites; a rudimentary arthrobranch on 1st, and a posterior arthrobranch on 7th thoracic somites; mastigobranchiae on 1st to 6th thoracic somites. Body glabrous.

Type species *Penaeus monodon* Fabricius (1798) (neotype Holthuis 1949). The genus comprises 28 recognized species of which *Penaeus trisulcatus* Leach, *P. brasiliensis* Latreille, *P. duorum* Burkenroad, *P. aztecus* Ives, *P. setiferus* Linnaeus, and *P. schmitti* Burkenroad are from the Atlantic (see Anderson and Lindner (1945) for key). The remainder are from the Indo-Pacific. All grow to a large size and most occur in numbers on the continental shelf.

KEY TO THE INDO-PACIFIC SPECIES OF PENAEUS

1. Adrostral carina reaching almost to posterior border of carapace; gastrofrontal carina present 2
 Adrostral carina not reaching behind middle of carapace; gastrofrontal carina absent .. 11
- 2(1). Telson armed, usually with 3 pairs of spinules 3
 Telson unarmed 9
- 3(2). Postrostral carina sulcate; not more than 1 ventral rostral tooth 4
 Postrostral carina non-sulcate; usually 2 ventral rostral teeth 8
- 4(3). Sulcus on postrostral carina less than $\frac{1}{2}$ length of carapace; ischial spine on 1st pereopod. 5
 Sulcus on postrostral carina more than $\frac{1}{2}$ length of carapace; no ischial spine on 1st pereopod 6
- 5(4). Seminal receptacle flat, subrectangular; stylocerite reaching $\frac{2}{3}$ to $\frac{3}{4}$ basal segment of antennular peduncle *P. caesi*us, sp. nov.
 Seminal receptacle an inverted dome shape; stylocerite reaching tip of basal segment of antennular peduncle *P. longistylus* Kubo
- 6(4). Rostrum with accessory pair of carinae on blade of rostrum; gastrofrontal sulcus with trifurcate posterior end *P. plebejus* Hess (= *P. maccullochi* Schmitt)
 Rostrum without accessory pair of carinae; gastrofrontal sulcus with bifurcate posterior end 7
- 7(6). Thelycum with apex of anterior plate rounded; seminal receptacle cylindrical, not closed by 2 flaps; adrostral sulcus narrower than postrostral carina. *P. japonicus* Bate
 Thelycum with apex of anterior plate bifid; seminal receptacle flat, closed by 2 flaps; adrostral sulcus as wide as postrostral carina *P. latisculcatus* Kishinouye
- 8(3). Adrostral carinae continuing almost to posterior edge of carapace; anterior plate of thelycum with lanceolate apical process *P. teraoi* Kubo
 Adrostral carinae becoming indistinct posteriorly; anterior plate of thelycum without lanceolate apical process *P. marginatus* Randall
- 9(2). Rostrum with 1 ventral tooth *P. canaliculatus* Olivier
 Rostrum with more than 1 ventral tooth 10
- 10(9). Thelycum with a median longitudinal carina on sternite of 7th thoracic somite; ventral surface of flaps of seminal receptacle not pubescent *P. californensis* Holmes
 Thelycum without a median carina on sternite of 7th thoracic somite; ventral surface of flaps of seminal receptacle pubescent *P. brevirostris* Kingsley
- 11(1). Hepatic carina present 12
 Hepatic carina absent 18

- 12(11). Third maxilliped in ♂ with apical tuft of setae on propodus; lateral lobe of petasma thickened distally; thelycum with seminal receptacle closed by 2 flaps 13
 Third maxilliped in ♂ without apical tuft of setae on propodus; lateral lobe of petasma not thickened distally; thelycum with open seminal receptacle (spp. limited to Pacific America) 16
- 13(12). Fifth pereopods with small but distinct exopods 14
 Fifth pereopods without exopods *P. monolon* Fabricius (= *P. carinatus* Dana)
- 14(13). Postrostral carina sulcate *P. semisulcatus* de Haan
 Postrostral carina non-sulcate 15
- 15(14). Hepatic carina arcuate, extending behind posterior end of antennal carina; rostral teeth 9/2 *P. gracilirostris* Thallwitz
 Hepatic carina straight not extending beyond posterior end of antennal carina; rostral teeth 5-7/3-4 *P. esculentus* Haswell
- 16(12). Adrostral carina reaching as far as epigastric tooth; rostral teeth usually 9/2 *P. vannamei* Boone
 Adrostral carina extending posteriorly to epigastric tooth; ventral rostral teeth more than 2 17
- 17(16). Antennular flagella longer than peduncle; thelycum with prominent pyramidal upheaval on 8th thoracic somite; an expanded coxal projection on 5th pereopod in ♀ *P. stylirostris* Stimpson
 Antennular flagella as long as or shorter than peduncle; thelycum without pyramidal upheaval; no coxal projections on 5th pereopods of ♀ *P. occidentalis* Streets
- 18(11). Third pereopod exceeding scaphocerite by at least dactyl; maxillulary palp 2-segmented 19
 Third pereopod not quite reaching tip of scaphocerite; maxillulary palp 3-segmented *P. orientalis* Kishinouye
- 19(18). Gastro-orbital carina occupying the posterior $\frac{2}{3}$ distance between hepatic spine and orbital angle *P. indicus* Milne Edwards
 Gastro-orbital carina absent or not reaching hepatic spine and occupying the middle $\frac{1}{3}$ distance between hepatic spine and orbital angle 20
- 20(19). Dactyl of 3rd maxilliped adult ♂ $\frac{1}{2}$ propodus; adrostral carina not reaching as far as epigastric tooth *P. merguensis* de Man
 Dactyl of 3rd maxilliped adult ♂ much longer than propodus; adrostral carina reaching just beyond epigastric tooth *P. penicillatus* Alcock

PENAEUS CAESIUS, sp. nov.

Fig. 2A-G

Peneus latisulcatus Schmitt 1926, p. 366 (♂ reg. No. E3157, only).

Material.—QUEENSLAND: 12 miles NNE. of Bowen, 19–25 fm (Aust. Mus. regd. No. E3157), holotype ♂ 147 mm, 37 mm carapace; Palm I., Sept. 1952, allotype ♀ 78 mm, 18 mm carapace. LORD HOWE I. (Aust. Mus. regd. No. P5703): paratype ♀ 90 mm, 22.5 mm carapace. WESTERN AUSTRALIA: Luggar Cove, Cygnet Bay (Aust. Mus.), paratypes 3 ♀, 52, 63, 80 mm. **Juveniles.**—QUEENSLAND: Thursday I., 23.x.1949, ♀ 58 mm; Heron I., August 1955, ♀ 56 mm; Aust. Mus. regd. No. P12177, 2 ♀ 31, 43 mm.

Diagnosis

Postrostral carina high, narrow and convex when viewed laterally, postrostral sulcus feeble, $\frac{1}{3}$ length carapace. Stylocerite reaching $\frac{2}{3}$ – $\frac{3}{4}$ basal segment of antennular peduncle. Fourth abdominal somite without a dorsal carina. Anterior plate of thelycum spinous anteriorly, seminal receptacle with parallel sides, ventral surface flat, flaps somewhat reflected. With a blue circular patch on 3rd abdominal somite.

Description

Rostrum.—Teeth 10–13/1. Reaching to or almost to tip of antennular peduncle, curving downwards to ventral tooth, distal portion horizontal or slightly upcurved. Fifth tooth usually level with anterior edge of carapace. Postrostral carina feebly sulcate, narrow, and high anteriorly, rostrum having a markedly convex appearance reaching its greatest height at 2nd tooth. Postrostral sulcus $\frac{1}{3}$ length carapace. Adrostral carina ending at $\frac{1}{40}$ length carapace from posterior border, sulcus twice width of postrostral carina.

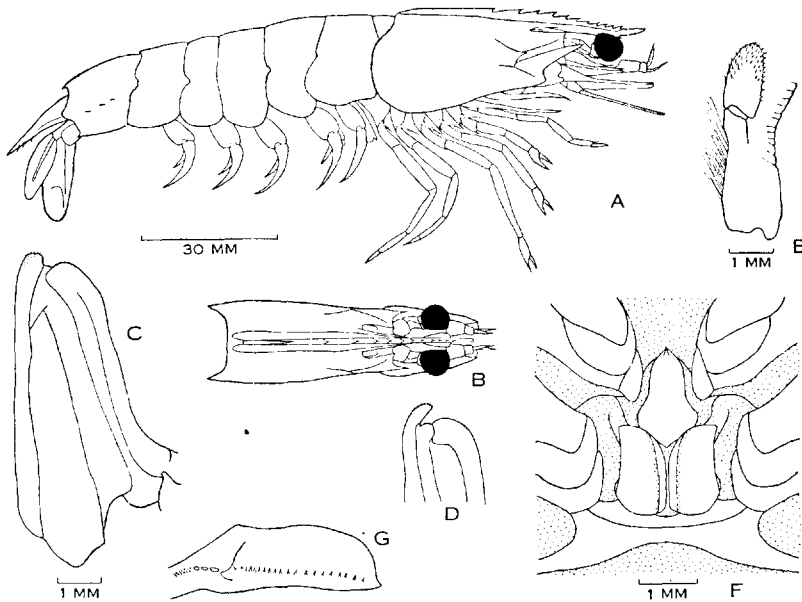


Fig. 2.—*Penaeus caesiuss*, sp. nov. A, holotype; B, dorsal cephalothorax; C, inner aspect of left half of petasma; D, outer lateral distal portion of petasma (same scale); E, appendix masculina; F, thelycum of allotype; G, cardiac plate and zygocardiac ossicle of allotype.

Carapace.—Gastrofrontal sulcus deep extending to $\frac{1}{3}$ carapace, a bifurcate posterior extremity, small carina causing this bifurcation reaching nearly $\frac{1}{2}$ length sulcus; gastrofrontal carina very high and narrow anteriorly, ending in acute orbital angle. Antennal spine long, reaching about $\frac{1}{2}$ 2nd segment of ophthalmopod. Gastro-orbital carina pronounced, ending at $\frac{4}{5}$ distance between hepatic spine and orbital angle. Antennal carina ending below hepatic spine, orbito-antennal sulcus wide anteriorly and narrowing posteriorly to junction with cervical sulcus at hepatic spine. Cervical sulcus $\frac{1}{3}$ length carapace, ending at $\frac{2}{5}$ length carapace. Hepatic carina sloping downwards with a slight bend at its posterior $\frac{1}{3}$ and ending $\frac{1}{4}$ its length from anterior margin of carapace.

Antennules.—Flagella subequal, $\frac{1}{3}$ length peduncle. Prosartema slightly exceeding, stylocerite attaining $\frac{2}{3}$ – $\frac{3}{4}$ basal segment.

Antennae.—Scaphocerite 3 times width, spine slightly exceeding tip of antennular peduncle. Carpocerite almost as wide as long, reaching $\frac{3}{4}$ optic peduncle.

Mandible.—Palp reaching base of carpocerite, distal segment $1\frac{1}{2}$ times width, twice length triangular basal piece. Incisor process with 2 teeth separated by a deep notch, molar process rectangular, posterior corner angular.

Maxillule.—Palp 3-segmented. Basal segment with slightly convex setose inner basal edge, outer edge with rounded protuberance at base bearing a tuft of setae; a curved spine on inner edge with base at $\frac{3}{4}$ segment, a row of about 15 spines on posterior surface. Second segment $\frac{1}{4}$, 3rd $\frac{1}{2}$ length basal segment.

Thoracic appendages.—Third maxilliped not quite reaching tip of 1st segment of antennular peduncle in ♂, reaching as far as or slightly exceeding it in ♀; dactyl ♂ $\frac{3}{4}$ propodus which bears a small apical tuft of setae $\frac{1}{4}$ length dactyl. First pereopods reaching from base to $\frac{1}{2}$ carpocerite; 2nd exceeding it by dactyl; 3rd reaching from base to $\frac{1}{2}$ 2nd segment of antennular peduncle; 4th and 5th reaching from base to tip of carpocerite. An ischial spine on 1st pereopod, slightly smaller than basal spine.

Abdomen.—Fourth somite somewhat angular dorsally, but not carinated, deeply incised on posteromedian margin; 5th and 6th somites with a carina, that of 5th ending in a small tooth, that of 6th ending in a larger downcurved spine. Telson armed with 3 pairs of small spines (telson damaged in both holotype and allotype). Sixth abdominal somite with 3 barely perceptible lateral cicatrices.

Gastric mill (Fig. 2G).—Cardiac plate with 19-23 spinules. Zygocardiac ossicle a principal tubercle followed by 2-3 smaller blunt tubercles, and an irregular row of 15-28 minute spinous tubercles. Prepyloric ossicle acute, with 9 lateral tubercles and beside these an irregular cluster of very minute tubercles. Cardiac ossicle deeply concave, urocardiac bluntly pointed, pterocardiac tapering and sigmoidal.

Petasma (Fig. 2C, D).—Reaching most anterior portion of coxae of 5th pereopods. Median lobes with thickened minutely tuberculate distal protuberances, which exceed the lateral lobes, separated from them by a shallow, smooth depression; but slightly curved ventrally and separated from the lateral lobes when viewed laterally. Median lobes projecting posteriorly beyond lateral lobes by $\frac{1}{3}$ total length of petasma.

Appendix masculina (Fig. 2E).—Distal piece 1.5 times as long as wide, symmetrical and oval, the distal $\frac{1}{2}$ anterior surface covered with small setae. Distal piece $\frac{1}{2}$ length basal piece.

Thelycum (Fig. 2F).—(Allotype is somewhat immature.) Anterior part of anterior plate with parallel sides and median anterior spine, ventral surface convex; posterior part wide, subpentagonal with concave median depression, angular posteriorly, this angular portion projecting well into seminal receptacle. Seminal receptacle with more or less parallel sides, flaps meeting at mid line, and slightly reflected.

Colour (*freshly preserved allotype*).—Body translucent with narrow blue vertical bands on lower portions of abdominal pleura; circular patch of blue on each side of 3rd abdominal somite, uropods tipped with blue.

Distribution

Lord Howe I.; coast of Queensland; north-western Australia.

Discussion

*P. caesi*us is similar to *P. longistylus* Kubo, from which it may be distinguished by the following features:

Feature	<i>P. caesi</i> us	<i>P. longistylus</i>
Postrostral sulcus	$\frac{1}{3}$ length carapace	$\frac{2}{7}$ length carapace (Kubo 1949, Fig. 109)
Stylocerite	Reaching $\frac{2}{3}$ $\frac{3}{4}$ basal segment of antennular peduncle	Reaching as far as tip of basal segment of antennular peduncle
Second pereiopod	Exceeding carapocerite by dactyl	Exceeding carapocerite by $\frac{1}{2}$ palm
Third pereiopod	Reaching from base to $\frac{1}{2}$ 2nd antennular segment	Reaching tip of antennular peduncle
Cardiac plate	19-23 spinules	28 spinules
Apical projections of median lobes of petasma	Prominent, exceeding the lateral lobes	Not exceeding lateral lobes
Thelycum	Seminal receptacle flat, more or less rectangular, flaps meeting medially, and reflected	Seminal receptacle an inverted dome shape
Circular patch on side of 3rd abdominal somite	Blue	Red
Colour	Translucent with short blue vertical abdominal stripes	Uniformly reddish

The holotype is possibly unusually large for *P. caesi*us, as the 78 mm allotype and the 80 mm and 90 mm ♀♀ appear very nearly sexually mature. If ♀♀ of this species are mature at about 100 mm then its smaller size may be a further feature for distinguishing it from *P. longistylus* (Kubo's ♀ is 151 mm). On the other hand, the colour of *P. caesi*us may alter with increase in size (cf. *P. plebejus*), penaeids often being more or less reddish in deeper waters. The differences between *P. caesi*us and *P. longistylus* are small, and it is possible that a good range of the former would show that the species should be united.

The above 2 species are similar to *P. marginatus* Randall, but the latter possesses 2 or more ventral rostral teeth. *P. caesi*us and *P. longistylus* may be distinguished from *P. latisulcatus* Kishinouye and *P. japonicus* Bate by the presence, in the first 2 species, of a high, convex, postrostral carina, and of an ischial spine on the 1st pereiopod.

The adult postrostral sulcation in *P. caesi* is not attained until about 60 mm length (cf. *P. japonicus* (Kubo 1949)). Pereiopods of juveniles are also relatively longer than those of adults.

PENAEUS PLEBEJUS Hess

King Prawn, eastern Australia

Fig. 3A-G

Penaeus plebejus Hess, 1865, p. 168, pl. VII, fig. 19. De Man, 1911, pp. 96, 108-11. Racek, 1955, pp. 223-4.

Peneus plebejus Schmitt, 1926, pp. 367-70.

Penaeus canaliculatus Haswell, 1879; 1882 (not including synonymy). Stead, 1898, p. 209. Whitelegge, 1900, p. 197.

Penaeus canaliculatus var. *australiensis* Bate, 1888, p. 248.

Peneus maccullochi Schmitt, 1926, pp. 370-1.

Material.—Noosa River, Qld., to Lakes Entrance, Vic., 12 specimens 40-203 mm; 43 small juveniles and 40 larger prawns, and the Australian Museum collection, have also been examined.

Description

Rostrum.—Teeth 10-11/1, rostrum slightly recurved beyond ventral tooth, reaching not quite or to tip of antennular peduncle. The 5th tooth above anterior edge of carapace. An accessory rostral carina running forward from 1st rostral tooth, extent and distinctness depending on maturity, indistinct in prawns below 50 mm length. Adrostral sulcus as wide as postrostral carina.

Carapace.—Gastrofrontal sulcus deep, extending to $\frac{1}{6}$ carapace, a trifurcate posterior extremity. Orbito-antennal sulcus wide anteriorly, narrowing to junction with the narrow cervical and hepatic sulci. Hepatic carina curving obliquely downwards anteriorly, ending $\frac{1}{6}$ its length from carapace margin.

Antennules.—Outer flagellum longer than inner and $\frac{1}{2}$ length peduncle. Prosartema almost reaching distal end of basal segment; stylocerite attaining more than $\frac{1}{2}$, but not exceeding $\frac{3}{4}$ basal segment.

Thoracic appendages.—Dactyl 3rd maxilliped 0.6-0.7 length propodus, in ♂ bearing an apical tuft of setae $\frac{1}{2}$ length dactyl. Third maxilliped reaching tip of basal segment of antennular peduncle; 1st pereopod reaching base of carpocerite; 2nd exceeding carpocerite by dactyl; 3rd almost reaching as far as 1st segment of antennular peduncle; 4th and 5th reaching as far as 1st. Ischial spine absent on 1st pereopod.

Abdomen.—Dorsally carinated from middle of 4th somite, 5th with 1 small lateral, 6th with 3 lateral cicatrices. Telson with 3 pairs of spines.

Gastric mill (Fig. 3G).—Cardiac plate with 23-24 spinules; zygo-cardiac ossicle with principal 4-2-3 large teeth and a number of small teeth.

Petasma (Fig. 3D, E).—Median protuberances projecting very slightly ventrally over distal margins of lateral lobes. (In a 190 mm ♂ these protuberances overhang the distal margins by almost $\frac{1}{3}$ whereas in *P. latisulcatus* they cover $\frac{1}{2}$.)

Appendix masculina (Fig. 3F).—Distal piece 1.3 times width, inner edge straight, outer edge convex.

Thelycum (Fig. 3C).—A rounded anterior plate lying between coxae of 4th legs and a posterior subrectangular plate, with median groove continuous with anterior piece, fading out posteriorly, flanked by 2 prominent ridges. Flaps of seminal receptacle overlapping medially with outer margins slightly concave.

Colour (live mature specimens).—Body cream to yellow; rostrum finely speckled with dark spots, tip banded; postrostral and abdominal carinae dark brown; posterior edge of carapace and abdominal segments light brown; tips of antennal scales and uropods blue, the fringing setae of both bright red; proximal podomeres of pereiopods and pleopods yellow. *Immature prawns.*—Usually cream, sometimes with blue in place of the brown noted above, and short vertical blue bands on pleura of first 4 abdominal somites.

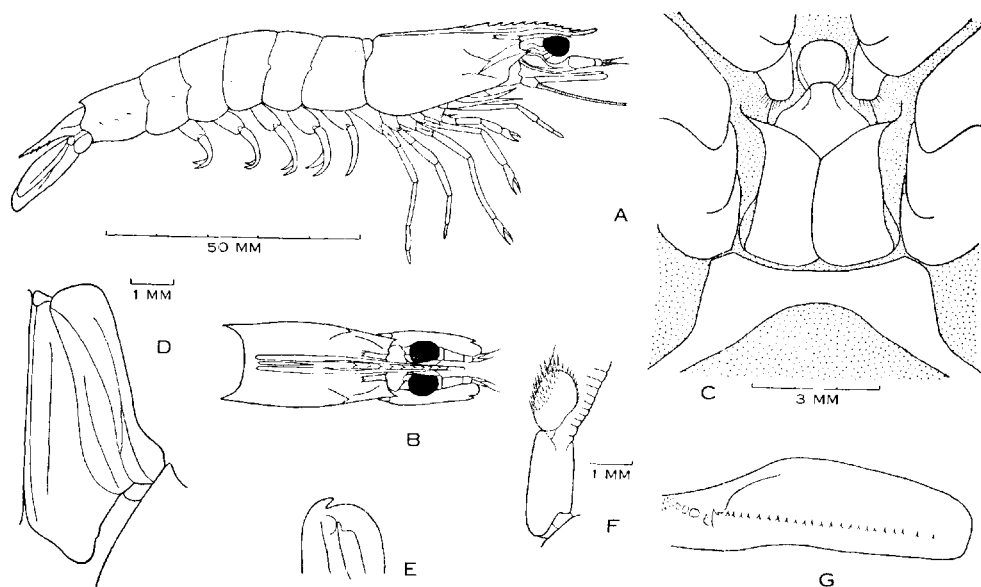


Fig. 3.—*Penaeus plebejus* Hess. A, 121 mm ♀; B, dorsal cephalothorax of same; C, thelycum of 150 mm ♀; D, inner aspect of left half of petasma, 125 mm ♂; E, outer lateral distal portion of petasma (same scale); F, appendix masculina; G, cardiac plate and zygocardiac ossicle.

Distribution

East coast of Australia from Lakes Entrance, Vic., to North Reef, Qld. (Schmitt 1926); Auckland, New Zealand (Pesta 1915). Trawled commercially in New South Wales and in south-eastern Queensland though tending to be of irregular occurrence and often associated with *P. esculentus* in the latter region. Juvenile prawns are often found sheltering under rocks at or just below low water spring tide level round Moreton Bay.

Discussion

Kubo (1949) gives features for distinguishing this species from *P. latisulcatus*, but in immature specimens below 5 cm in length the accessory rostral carinae and the small carinae at the posterior end of the gastrofrontal sulcus are not clear, and are thus difficult to distinguish from *P. latisulcatus*. Large specimens of *P. latisulcatus*

have a minute accessory rostral carina, but this carina in *P. plebejus* of comparable size is extensive and well developed. The following additional features for separating the two species are useful:

Feature	<i>P. plebejus</i>	<i>P. latisulcatus</i>
Rostrum	Reaching not quite to tip of antennular peduncle	Reaching to or beyond tip of antennular peduncle
Postrostral carina	As wide as adrostral grooves	Slightly wider than adrostral grooves
Prosartema	Not quite reaching distal end of basal segment of antennular peduncle	Extending slightly beyond distal end of basal segment of antennular peduncle
Stylocerite	Attaining more than $\frac{1}{2}$ 1st segment of antennular peduncle	Attaining the middle of 1st segment of antennular peduncle
Cardiac plate	23-25 spinules	25-28 spinules
Zygocardiac ossicle	2-3 large tubercles in addition to principal one	3-4 medium-sized tubercles in addition to principal one

Racek (1955) found an immature male of "*Peneus maccullochi*" but states (personal communication) that the X-shaped depression of the postrostral carina as described and figured by Schmitt (1926) was a little different in his specimen, and was in a slightly different place. Since Racek's paper was published he obtained a large specimen with the posterior $\frac{1}{2}$ of the rostrum completely interrupted on the carapace by a smooth break confluent with the adrostral sulci. The rostral blade on either side of this break, which is several millimetres long, is quite smooth. The break has obviously not been freshly made and is the result either of an accident or of a malformation during development. Schmitt (1926) notes that, apart from the interruption of the postrostral carina, there are no features distinguishing *P. maccullochi* from *P. plebejus*. Examination of the holotype of the former by the author confirms this. It therefore seems likely that *P. maccullochi* is a malformed specimen of *P. plebejus*, and is a nomen nudum.

PENAEUS LATISULCATUS Kishinouye

King Prawn, Western Australia

Fig. 4A-G

Penaeus latisulcatus Kishinouye, 1900, p. 12. De Man, 1911, pp. 108-11. Kubo, 1949, pp. 278-82. Racek, 1955, pp. 222-3.

Peneus latisulcatus Schmitt, 1926, pp. 365-7 (not incl. ♂ regd. No. E3157).

Penaeus canaliculatus de Man, 1880, p. 185.

Penaeus canaliculatus Oliv. var.? Lankester, 1901, p. 571.

Penaeus canaliculatus var. *australiensis* de Man, 1902, p. 905.

Material.—WESTERN AUSTRALIA: Cockburn Sound to Warnborough Sound, 20 specimens, 145–193 mm. Australian Museum collection.

Description

Rostrum.—Teeth 8–11/1–2, slightly recurved beyond ventral tooth, reaching tip of antennular peduncle. The 5th tooth just beyond anterior edge of carapace. With a minute accessory carina in specimens above 100 mm, commencing at 2nd tooth and usually becoming indistinct at 3rd tooth. Adrostral carina extending to $\frac{1}{1.5}$ length carapace from posterior border, the adrostral sulcus slightly wider than postrostral carina.

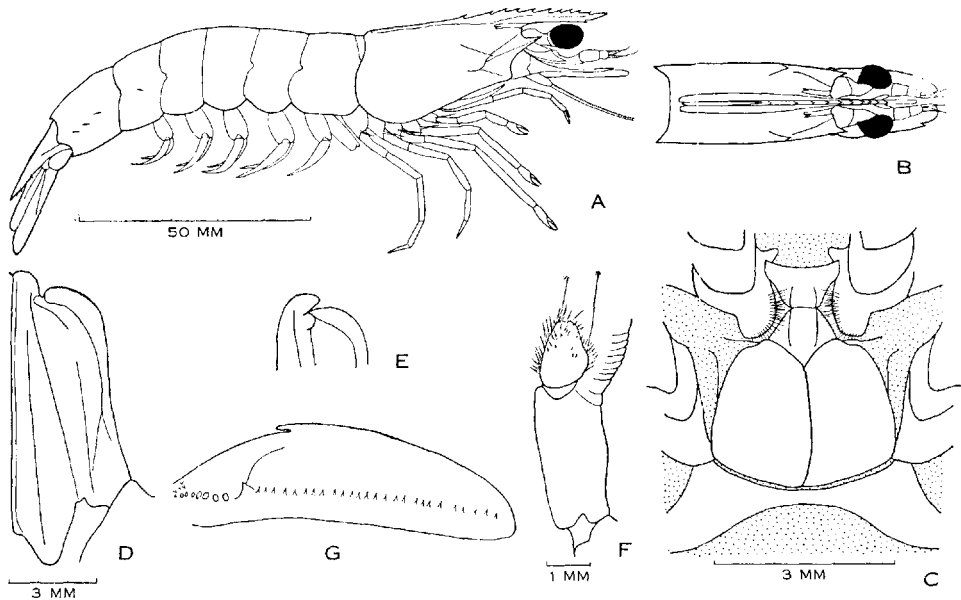


Fig. 4. *Penaeus latisulcatus* Kishinouye. *A*, 145 mm ♂; *B*, dorsal cephalothorax of same; *C*, telson of 189 mm ♀; *D*, inner aspect of left half of petasma, 145 mm ♂; *E*, outer lateral distal portion of petasma (same scale); *F*, appendix masculina, 145 mm ♂; *G*, cardiac plate and zygocardiac ossicle.

Carapace.—Gastrofrontal sulcus deep, extending to $\frac{1}{6}$ carapace, a bifurcate posterior extremity. Orbito-antennal sulcus wide anteriorly, narrowing to junction with the narrow cervical and hepatic sulci. Cervical sulcus extending to $\frac{2}{3}$ length carapace. Hepatic carina curving downwards anteriorly, ending $\frac{1}{6}$ its length from carapace margin.

Antennules.—Outer flagellum longer than inner, and $\frac{1}{2}$ length peduncle. Prosartema reaching distal end, stylocerite attaining $\frac{1}{2}$ basal segment.

Thoracic appendages.—Endopod 3rd maxilliped reaching or slightly exceeding tip of 1st segment of antennular peduncle, dactyl 0.7–0.8 length propodus, which bears an apical tuft of setae reaching $\frac{1}{2}$ dactyl in ♂. First pereopod reaching base of carpocerite, 2nd exceeding it by dactyl; 3rd reaching tip of basal segment of antenu-

lar peduncle, 4th reaching base of carpoperite, exceeding 5th by dactyl. No ischial spine on 1st pereopod.

Abdomen.—Dorsally carinated from middle 4th somite, carina of 6th ending in a spine, barely curved downwards. Fifth somite with 1, 6th with 3 lateral cicatrices. Telson with 3 pairs spines.

Gastric mill (Fig. 4G).—Cardiac plate with 25–28 spinules; zygocardiac ossicle with 3–4 teeth followed by several less distinct teeth and a cluster of minute teeth; prepyloric blunt with 3–4 smaller separated teeth.

Petasma (Fig. 4D, E).—Median protuberances in lateral view projecting ventrally over distal margins of lateral lobes for $\frac{1}{3}$ – $\frac{1}{2}$ thickness of latter.

Appendix masculina (Fig. 4F).—Distal piece 1.2–1.3 times width.

Thelycum (Fig. 4C).—Anterior plate with median channel, 2 pointed distolateral projections, posterior part subrectangular. Seminal receptacle wider than long, flaps overlapping on mid line, outer margins slightly concave in anterior $\frac{1}{2}$, tending to become convex in large impregnated females.

Colour in life.—Rostrum, postrostrum, edges of scaphocerites, abdominal carina, dark brown; body generally, light yellow to brown; pleura of 1st 5 abdominal somites each with short vertical brown stripe (sometimes blue); antennae light pink; pereopods light blue to yellow proximally, pink distally; pleopods yellow; uropods yellow to brown tipped with dark blue.

Distribution

Warnborough Sound to Exmouth Gulf, W.A.; Kangaroo I., S.A. (Schmitt 1926); South Australian waters (Hale 1927); Tokyo Bay, Kagoshima, Japan (Kishinouye 1900); Batjan (Molluccas), and Red Sea (de Man 1911); Penang (Lanchester 1901); Korea and Japanese waters (Kubo 1949). Commercially important in Western Australia; recorded from Thursday I. (de Man 1907), and will probably be found scattered down the east coast of Australia.

Discussion

The above description differs from that of Kubo in the following features:

Present Description	Kubo 1949
Third pereopod reaching distal end of basal segment of antennular peduncle	Third pereopod reaching tip of 2nd segment of antennular peduncle
Fifth pereopod shorter than 4th by dactyl	Fifth pereopod reaching as far as 4th
Appendix masculina distal piece 1.2–1.3 times width	Appendix masculina distal piece 1.6 times width

The Cockburn Sound specimens agree well with the description and Figure 29 of Hale (1927). (See discussion under *P. plebejus* for distinguishing features of *P. latisulcatus*.)

PENAEUS MONODON Fabricius

Fig. 5A-E

Penaeus monodon Fabricius, 1798, p. 408. Holthuis, 1949, pp. 1051-7 (full synonymy *P. monodon* and *P. carinatus*). Kubo, 1949, p. 291 (part synonymy only). Barnard, 1950, p. 584.

Penaeus carinatus Dana, 1852, p. 602, pl. 40, fig. 2. De Man, 1911, p. 101. Racek, 1955, pp. 215-17.

Peneus semisulcatus Alcock, 1906, pp. 10-11.

Penaeus caeruleus Stebbing, 1905, p. 77. Racek, 1955, pp. 217-18.

Penaeus bubulus Kubo, 1949, pp. 296-301.

Material.—Moreton Bay and Townsville, Qld., and Exmouth Gulf, W.A., 9 specimens 100-337 mm. Australian Museum collection.

Description

Rostrum.—7-8/2-3 teeth, usually 7/3; exceeding tip of antennular peduncle, distal ventral tooth at or almost reaching joint between distal and penultimate segments of peduncle. Sigmoidal in shape in juveniles and adults, adrostral carina reaching almost to or to epigastric tooth. Postrostral carina often more or less flat with feeble indications of a sulcus, or sometimes with very shallow sulcus; carina reaching almost to or to posterior edge of carapace.

Carapace.—Length 1.6-1.7 times depth. Gastro-orbital carina occupying posterior $\frac{1}{3}$ to $\frac{1}{2}$ distance between postorbital margin of carapace and hepatic spine. Hepatic carina prominent, anterior $\frac{1}{2}$ horizontal, the posterior often diverging very slightly below horizontal axis; distinctly separated from base of antennal carina, which ends above middle of hepatic carina. Hepatic sulcus ill defined. Cervical sulcus often with upper $\frac{1}{3}$ indistinct, $\frac{1}{5}$ - $\frac{1}{4}$ length carapace.

Antennules.—Flagella subequal, equal to, or slightly longer than peduncle. Prosartema reaching to or barely exceeding tip, stylocerite attaining $\frac{1}{2}$ basal segment.

Thoracic appendages.—Endopod 3rd maxilliped reaching tip of antennular peduncle in adult ♂, reaching distal end of basal segment of antennular peduncle in ♀ and juvenile ♂. Dactyl almost length propodus in ♂, hollowed, inserted at $\frac{1}{3}$ length propodus from distal end which bears a tuft of setae as long as dactyl. Dactyl $\frac{1}{2}$ - $\frac{2}{3}$ length propodus in ♀ and inserted apically. First pereopod reaching distal end of or slightly exceeding carapocerite, 2nd reaching distal end of basal segment of antennular peduncle, 3rd reaching to or exceeding tip of peduncle by dactyl, 4th reaching as far as 1st, 5th exceeding 4th by dactyl. Ischial spine on 1st pereopod; no exopod on 5th leg.

Abdomen.—Dorsally carinated from anterior $\frac{1}{3}$ of 4th somite, carina curving downwards fairly strongly towards posterior end of 6th somite. The 4th and 5th somites each with a small cicatrice, 6th with 3 cicatrices. Telson unarmed.

Gastric mill (Fig. 5E).—Cardiac plate with 18-24 spinules, usually 20-24; zygocardiac ossicle principal + 9-12 conical teeth, usually 9-10, followed by several smaller teeth and a cluster of minute teeth; prepyloric acute with 6-8 large teeth, sometimes with 2-3 smaller teeth, on lateral margin.

Petasma (Fig. 5C).—Median anterior lobe small, separated from lateral by a shallow notch, not projecting as far as lateral lobes. Lateral lobes without distal setae, with distolateral irregular group of ossicles greatly variable in number.

Appendix masculina (Fig. 5D).—Length distal piece 1.6–1.7 width; at least basal $\frac{1}{2}$ naked.

Thelycum (Fig. 5B).—Length anterior plate twice width, anterior rounded portion concave, posterior bluntly pointed portion inserted between flaps of seminal receptacle for $\frac{2}{5}$ their length. Seminal receptacle circular, flaps forming tumid reflected lips on mid line, with smooth inner edges in impregnated females.

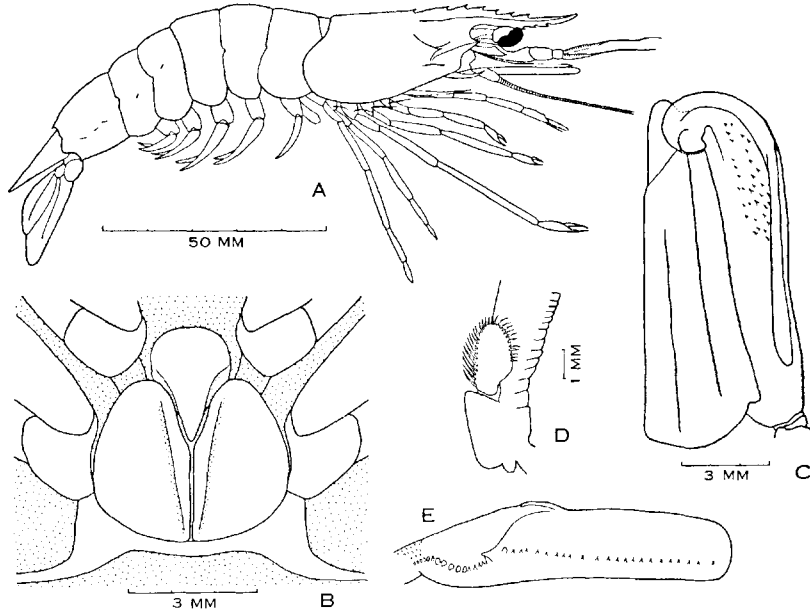


Fig. 5.—*Penaeus monodon* Fabricius. A, 140 mm ♂; B, thelycum of 227 mm ♀; C, inner aspect of petasma, 198 mm ♂; D, appendix masculina; E, cardiac plate and zygocardiac ossicle.

Colour (freshly preserved specimens).—Carapace and abdomen transversely banded, abdomen with 2 to each somite, posterior mid brown, anterior greyish brown. Rest of the body ranging from light brown to blue. Pleopods brown to blue, fringing setae red. A 126 mm ♀ from Goodna, Brisbane River, possessed (freshly preserved) a dull-red dorsal strip, width of body, running from rostrum to 6th abdominal somite, rest of animal an inky blue. Only *Metapenaeus mastersii* normally penetrates the Brisbane River to this distance, so this specimen should be regarded as abnormal. Barnard (1950) gives the general colour as “pale buff, more or less transparent, minutely speckled with blue”, except for the *caeruleus* variety which is “vivid blue”. Kubo (1949) states that *Penaeus bubulus* resembles the colour of a Japanese ox (usually a light fawn), which roughly accords with Barnard’s description. The prawns from Moreton Bay when freshly preserved ranged from vivid blue to predominantly brown, while those from Townsville were more or less buff with little or no blue.

Distribution

Moreton Bay and Townsville, Qld.; Exmouth Gulf, W.A.; East London to St. Lucia Bay, South Africa (Barnard 1950); Karachi to Mergui and the Andamans

(Alcock 1906); Tokyo Bay and Bay of Ise, Japan, Makassar, Atjeh, Singapore (de Man 1911); Yokohama, Formosa, Amoy, Celebes (Kubo 1949). Common commercial prawn of Calcutta (Alcock 1906); uncommon off southern Queensland, occasional specimens appearing in catches of *P. esculentus*, but becoming more common at Townsville.

Discussion

The above description accords with that of Barnard (1950), who states that he has "no hesitation" in making *caeruleus* a synonym; and that he "would not even regard it as a colour variety". The coloration of the Moreton Bay specimens lead the present writer to the same conclusion. There is no apparent difference in lengths of antennular flagella as noted by Anderson and Lindner (1945), and, in addition, the filamentous portions tend to be broken off in large specimens, which could easily lead to an error in this respect.

Alcock (1906) erroneously assigned *P. semisulcatus* to *P. monodon*, which has partly been responsible for confusion between these species, as indicated by Barnard (1950). Kubo (1949) has apparently followed this error, but has created *P. bubulus*, the brief description of which agrees with that of *P. monodon* except for length of 5th pereopod and armature of the prepyloric ossicle. It is thought best, therefore, to regard *P. bubulus* as a synonym. Holthuis (1949) has shown that *P. carinatus* Dana is identical with *P. monodon* Fabricius, the latter having priority. (See discussion under *P. semisulcatus* for features of difference between the 2 species.)

PENAEUS SEMISULCATUS de Haan

Fig. 6A-E

Penaeus semisulcatus de Haan, 1850, p. 191, pl. XLVI, fig. 1. De Man, 1911, pp. 97-100.

Racek, 1955, pp. 218-19.

Penaeus monodon Bato, 1888, p. 250. Kubo, 1949, pp. 291-6 (including only part synonymy).

Peneus monodon Alcock, 1906, p. 8.

Penaeus ashiaka Kishinouye, 1900, pp. 7-14. Rathbun, 1902, p. 33. Nobili, 1903, p. 2; 1906, p. 16.

Material.—QUEENSLAND: Bowen Harbour (Aust. Mus. regd. Nos. P6024-5), 2 ♂ 119, 131 mm; off Townsville, ♂ 137 mm. NEW GUINEA: Milne Bay, ♀ 190 mm, coll. A. M. Rapson.

Description

Rostrum.—Teeth 6-7/2-3, almost straight, blade uniformly convex, its highest point at 2nd to 3rd teeth; reaching tip of antennular peduncle. Postrostral carina distinctly sulcate, the sulcus slightly less or equal to $\frac{1}{3}$ length carapace. Adrostral carina and sulcus reaching $\frac{2}{3}$ length carapace from posterior edge. Postrostral carina almost reaching posterior border of carapace.

Carapace.—Gastro-orbital carina occupying posterior $\frac{2}{3}$ distance between cervical sulcus and anterior margin carapace. Orbito-antennal sulcus with parallel sides, posteriorly deep; antennal carina $\frac{2}{3}$ length carapace, exceeding orbito-antennal sulcus posteriorly, meeting hepatic sulcus $\frac{1}{3}$ its length from posterior end. Hepatic

carina inclined downwards to horizontal at angle of about 15° , $\frac{1}{2}$ length carapace. Cervical sulcus upcurved, shallow, $\frac{1}{4}$ length carapace.

Antennules.—Upper flagellum longer than lower, and 0.55 length peduncle in ♂, 0.7 in ♀. Prosartema reaching about $\frac{1}{4}$ 2nd segment of antennular peduncle; stylocerite attaining $\frac{1}{2}$ 1st segment.

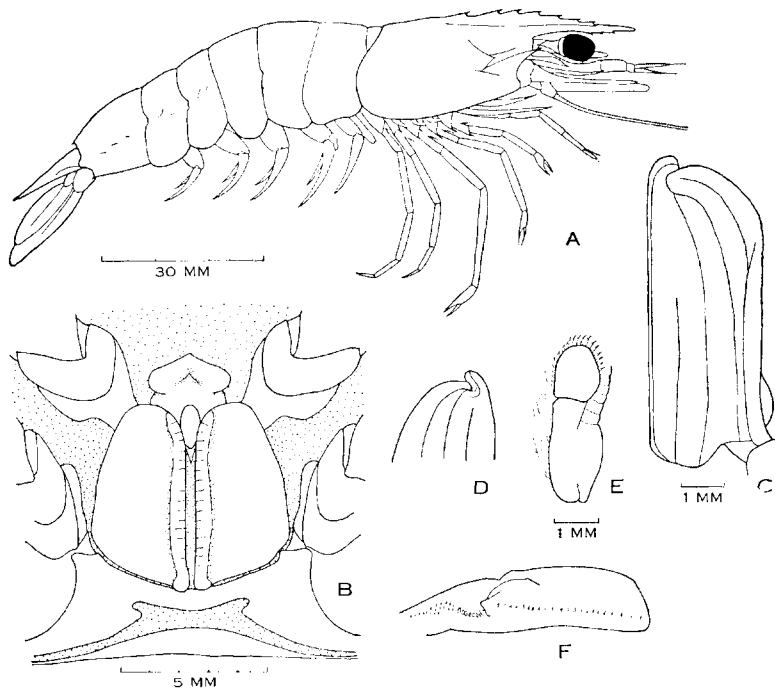


Fig. 6.—*Penaeus semisulcatus* de Haan. *A*, 137 mm ♂; *B*, thelyceum 190 mm ♀; *C*, inner aspect of left half of petasma, 137 mm ♂; *D*, outer lateral distal portion of petasma (same scale); *E*, appendix masculina; *F*, cardiac plate and zygo-cardiac ossicle.

Thoracic appendages.—Dactyl 3rd maxilliped ♂ $\frac{2}{3}$ length propodus which bears an apical tuft of setae as long as dactyl. Third maxilliped reaching as far as or slightly exceeding tip of 1st segment of antennular peduncle; 1st pereiopod exceeding carpocerite by $\frac{1}{2}$ to entire dactyl; 2nd reaching or exceeding tip of 1st, 3rd exceeding 3rd segment of antennular peduncle; 4th exceeding carpocerite by $\frac{1}{2}$ to entire dactyl; 5th very slightly exceeding 4th. Exopods on all pereiopods; an ischial spine, smaller than basal, on 1st.

Abdomen.—Dorsally carinated from anterior 4th somite. Fourth and 5th somites each with 2, 6th with 3 lateral cicatrices. Telson unarmed.

Gastric mill (Fig. 6*F*).—Cardiac plate with 18–23 spinules. Zygo-cardiac ossicle with principal tubercle + 8–9 smaller tubercles of uniform size, and a long row of irregular spinous tubercles; prepyloric with 9–10 lateral teeth.

Petasma (Fig. 6*C*, *D*).—Median projections flattened dorsoventrally, slightly overhanging lateral lobes; latter with minute apical spines; minutely tuberculate internally and externally but without distinct rows or areas of spines.

Appendix masculina (Fig. 6E).—Length distal piece $1\frac{1}{4}$ width, $\frac{1}{2}$ length basal piece.

Thelycum (Fig. 6B).—Anterior plate obtusely angled apically, with deep V-shaped excavation; a posterior tongue inserted between flaps of seminal receptacle for $\frac{1}{3}$ their length. Width of anterior plate $\frac{1}{3}$ seminal receptacle at its widest point. Seminal receptacle as wide as long, flaps strongly reflected with transverse striae on everted lips and almost angular at their lateral extremities.

Colour in life.—Dark green with indistinct darker crossbands on the abdomen; antennal scales, eyestalks, pleopods, and uropods dull red, the latter with a brownish fringe; pereopods with yellow and reddish bands, antennae banded (Racek 1955).

Distribution

Ranging from south-eastern Queensland through Indonesia and Philippine Is. to Japan; and from Singapore through Indus Delta, Madras, and Red Sea to Suez (various authors). This species seems at present to be uncommon in Australian waters, though common in Japanese and Indian markets, sometimes commercially important.

Discussion

P. semisulcatus resembles *P. esculentus* in general facies, but is readily distinguished by the following features:

Feature	<i>P. semisulcatus</i>	<i>P. esculentus</i>
Postrostral carina	Sulcate	Non-sulcate
Adrostral carina	Extending well beyond epigastric tooth	Reaching epigastric tooth
Hepatic carina	Extending posteriorly for $\frac{1}{3}$ its length beyond junction with antennal carina	Ending at the junction with antennal carina
Fourth and 5th abdominal somites	Each somite with 2 pairs of lateral cicatrices	4th with none, 5th with 1 pair of lateral cicatrices
Petasma	No external spinules on the lateral lobe	An external row of about 20 prominent spinules on lateral lobe

P. semisulcatus has been confused with *P. monodon* (see discussion under this species), but may be separated from it by the following features:

Feature	<i>P. semisulcatus</i>	<i>P. monodon</i>
Postrostral carina	Fully sulcate	Feebly, or partially sulcate
Rostrum	More or less straight with convex blade	Strongly sigmoidal

Feature	<i>P. semisulcatus</i>	<i>P. monodon</i>
Adrostral carina	Reaching well beyond epigastric tooth	Reaching to epigastric tooth
Hepatic carina	Distinct, but not strongly elevated, inclined at an angle of 15° to horizontal	Strongly elevated, horizontal
Exopod of 5th pereopod	Present	Absent

The foregoing description differs from that of Kubo (1949) (for "*P. monodon*") in that the 3rd pereopod is slightly longer and prepyloric ossicle has 9–10 teeth on each side, the latter being described by Kubo as having but 3 pairs of teeth. It is probable that Kubo has erred in describing the ischial spine as being "on the second limb only", as this does not seem to be a feature characteristic of any *Penaeus* spp. Apart from these features, agreement with Kubo's description is good. Further, this description is not applicable to *P. monodon*, and it seems likely that the 2 species have been confused.

PENAEUS ESCULENTUS Haswell

Tiger Prawn

Fig. 7A–E

Penaeus esculentus Haswell, 1879, p. 38; 1882, p. 200. Kubo, 1949, pp. 315–17. Racek, 1955, pp. 219–20.

Peneus esculentus Schmitt, 1926, pp. 362–5.

Penaeus monodon Whiteleggo, 1900, p. 224.

Material.—Wallis Lake, N.S.W., to Townsville, Qld., 14 specimens 60–237 mm; Noosa River, Qld., juveniles 20–60 mm. Material from Exmouth Gulf, Hampton Harbour, and Shark Bay, W.A., and the Australian Museum collection has also been examined.

Description

Rostrum.—5–7/3–4 teeth, usually 6/3; exceeding tip of antennular peduncle in specimens below 5 cm, becoming shorter with age, reaching middle of 2nd segment of antennular peduncle in 23 cm ♀♀; sigmoidal with low blade in juveniles, becoming almost straight with high blade in large specimens. Adrostral carina reaching epigastric tooth, postrostral carina non-sulcate ending $\frac{1}{3}$ length carapace from posterior edge.

Carapace.—Length 1.5 times depth; gastro-orbital carina occupying posterior $\frac{2}{3}$ distance between postorbital margin of carapace and hepatic spine. Hepatic carina distinct but not prominent, very slightly inclined downwards from horizontal axis, barely reaching posterior end of antennal carina. Hepatic and cervical sulci shallow, latter curving upwards posteriorly, ending below epigastric spine and ranging from $\frac{1}{6}$ (Wallis Lake prawns) to $\frac{1}{4}$ length carapace. Cervical carina well defined and extending almost as far as sulcus.

Antennules.—Flagella subequal, $\frac{2}{3}$ length peduncle. Prosartema reaching basal $\frac{1}{3}$ to $\frac{1}{2}$ 2nd segment; stylocerite attaining $\frac{1}{2}$ basal segment.

Thoracic appendages.—Third maxilliped exceeding basal segment of antennular peduncle by dactyl, ♂ with apical tuft of setae on propodus, extending as far as slightly hollowed dactyl which is inserted subapically, with a large subapical tuft of setae on carpus. Dactyl $\frac{2}{3}$ length propodus in ♂ and ♀. First pereiopod exceeding carpocerite by dactyl, 2nd reaching end of basal segment of antennular peduncle, 3rd reaching tip of peduncle, 4th and 5th exceeding carpocerite by $\frac{1}{2}$ dactyl. An ischial spine on 1st pereiopod; 5th with a small exopod.

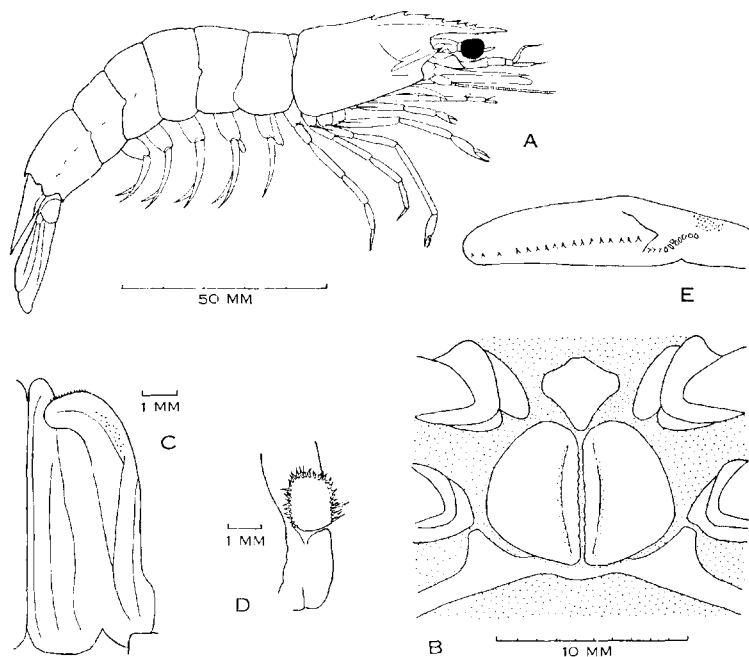


Fig. 7.—*Penaeus esculentus* Haswell. A, 141 mm ♂; B, thelycum of 230 mm ♀; C, inner aspect of left half of petasma, 141 mm ♂; D, appendix masculina of same; E, cardiac plate and zygocardiac ossicle.

Abdomen.—Dorsally carinated from $\frac{1}{2}$ 4th somite, carina curving downwards strongly towards end of 6th somite; 5th with a small, barely perceptible cicatrice, 6th with 3 ill-defined cicatrices. Telson unarmed.

Gastric mill (Fig. 7E). Cardiac plate with 16–18 spinules; zygocardiac ossicle with principal + 9–12 conical teeth and a cluster of minute teeth; prepyloric with 8–9 lateral teeth.

Petasma (Fig. 7C).—Lateral lobes with a number of minute distal setae and an irregular lateral external row of about 20 spinules.

Thelycum (Fig. 7B).—Length of anterior plate $1\frac{1}{2}$ width, concave and pear-shaped, apex barely inserted between flaps of seminal receptacle. Seminal

receptacle more or less circular, flaps forming tumid lips on mid line, inner edges tending to be serrated in large impregnated females.

Appendix masculina (Fig. 7D).—Length distal piece $1\frac{1}{2}$ width.

Colour in life (mature prawns living in open waters).—Carapace and abdomen transversely banded, those of abdomen mid brown, 2 to each somite, the anterior much lighter; spaces between bands buff to yellow. Rostrum with red and brown alternating bands. Antennae with alternating mid-brown and white bands. Bases of pleopods yellow with tinge of blue. Uropods brown changing distally to yellow. Fringing setae of uropods and tips of other appendages dark red. *Juvenile prawns in estuaries* (usually in *Zostera* beds) tend to be irregularly mottled with dark and light brown with intervening light-coloured patches.

Distribution

Wallis Lake, N.S.W., to Shark Bay, W.A.; Borneo (Kubo 1949). Trawled commercially in Queensland, and appearing sporadically in commercial quantities off Evans Head, N.S.W. Average size at sexual maturity in tropical waters (Exmouth Gulf), ♂ 145 mm, ♀ 155 mm.

Discussion

The above description differs from that of Haswell regarding length of the antennular flagella. Schmitt (1926), who examined a cotype, stated that the filamentous portions of all 4 flagella were missing and that the basal portion equalled the last 2 segments of the peduncle in length. In Schmitt's figure length of the flagella corresponds with that in Moreton Bay and Townsville specimens. Only among the larger of these prawns do rostra correspond with Schmitt's description. In immature prawns as noted, the general shape resembles that of *P. monodon*. The following features are useful for distinguishing *P. esculentus* and *P. monodon*:

Feature	<i>P. esculentus</i>	<i>P. monodon</i>
Postrostral carina	Non-sulcate	Usually sulcate or indications thereof
Gastro-orbital carina	Occupying the posterior $\frac{2}{3}$ distance between postorbital margin of carapace and hepatic spine	Occupying posterior $\frac{1}{3}$ distance between post-orbital margin carapace and hepatic spine
Hepatic carina	Barely reaching posterior end of antennal carina	Extending posteriorly past end antennal carina by $\frac{1}{3}$ its length
Fifth pereopod	Exopod present	Exopod absent
Colour	Without any trace of blue	Blue coloration usually present

PENAEUS MERGUIENSIS de Man

White or Banana Prawn

Fig. 8A-I

Penaeus merguiensis de Man, 1888, pp. 287-90; 1911, pp. 104-5. Kubo, 1949, pp. 308-11.

Racek, 1955, pp. 221-2.

Penaeus merguiensis Schmitt, 1926, pp. 360-1. Boone, 1935, pp. 96-101.

Penaeus indicus var. *merguiensis* Alecock, 1905, p. 515; 1906, p. 13.

Penaeus indicus Bate, 1888, p. 218. De Man, 1892, p. 511; 1898, p. 680.

Material.—QUEENSLAND: Brisbane River to Norman River, Gulf of Carpentaria, 38 specimens, 10-223 mm. WESTERN AUSTRALIA: Exmouth Gulf, 6 specimens, 152-166 mm. Australian Museum collection.

Description

Rostrum (Fig. 8A-D).—Teeth, $5\frac{1}{2}$ -5, usually $6\frac{1}{4}$ -5. Long, slender, upcurving, $1\frac{1}{2}$ to twice length carapace in postlarvae; 1st 5 dorsal teeth close together, penultimate and distal tooth widely separated; position of latter variable, at $\frac{1}{2}$ length of rostrum when there are 6, and $\frac{1}{3}$ from tip when there are 7, but sometimes varying regardless of number of teeth. Becoming shorter with increasing size, equalling length carapace in prawns of 80 mm, almost straight and with higher blade. Rostrum not exceeding 2nd segment of antennular peduncle in large prawns, blade high of broad triangular form. Adrostral carina usually ending between 1st and 2nd teeth, sometimes reaching 1st. Postrostral carina ending at posterior $\frac{1}{3}$ carapace.

Carapace.—Glabrous, thin, sulci and carinae feebly defined. Gastro-orbital carina absent or feeble, occupying middle $\frac{1}{3}$ distance between hepatic spine and postorbital margin; orbito-antennal sulcus wide and ill defined; antennal carina ending in front of hepatic spine, hepatic carina absent. Cervical sulcus $\frac{1}{6}$ - $\frac{1}{7}$ length carapace.

Antennules.—Outer flagellum $1\frac{1}{2}$ to twice length inner, longer than peduncle. Prosartema exceeding tip, stylocerite barely reaching $\frac{1}{2}$ basal segment.

Thoracic appendages.—Endopod 3rd maxilliped reaching tip of antennular peduncle in adult ♂, usually not exceeding basal segment in ♀; dactyl $\frac{1}{2}$ propodus, inserted subapically in ♂ with apical tuft of setae reaching $\frac{1}{2}$ dactyl. First pereopod exceeding carpocerite by dactyl, 2nd reaching tip of 2nd segment antennular peduncle, 3rd exceeding 3rd antennular segment by at least dactyl, 4th and 5th exceeding carpocerite by dactyl. Ischial spine on 1st pereopod.

Abdomen.—Dorsally carinated from middle of 4th somite in larger prawns, on 5th and 6th only in specimens below 80 mm. Fifth somite with 1, 6th with 3 small lateral cicatrices. Telson unarmed.

Gastric mill (Fig. 8I).—Cardiac plate with 22-28, usually 24 spinules. Zygocardiac ossicle with principal + 7-10 smaller teeth and longitudinal row of very small teeth. Prepyloric acute with 7-9 separated lateral teeth.

Petasma (Fig. 8F, G).—Median distal projections not overhanging lateral lobes when seen from side. Distal tip of lateral lobe minutely serrate, outer surface of lobe with large number of minute conical teeth.

Appendix masculina (Fig. 8H).—Length distal piece $1-1\frac{1}{4}$ times width, $\frac{3}{4}$ length basal piece.

Thelycum (Fig. 8E).—Anterior plate slightly concave, $\frac{1}{4}$ length seminal receptacle, with posterior convex projection, inserted between flaps of seminal receptacle for $\frac{1}{3}$ length. Seminal receptacle round with two flaps forming tumid lips on mid line.

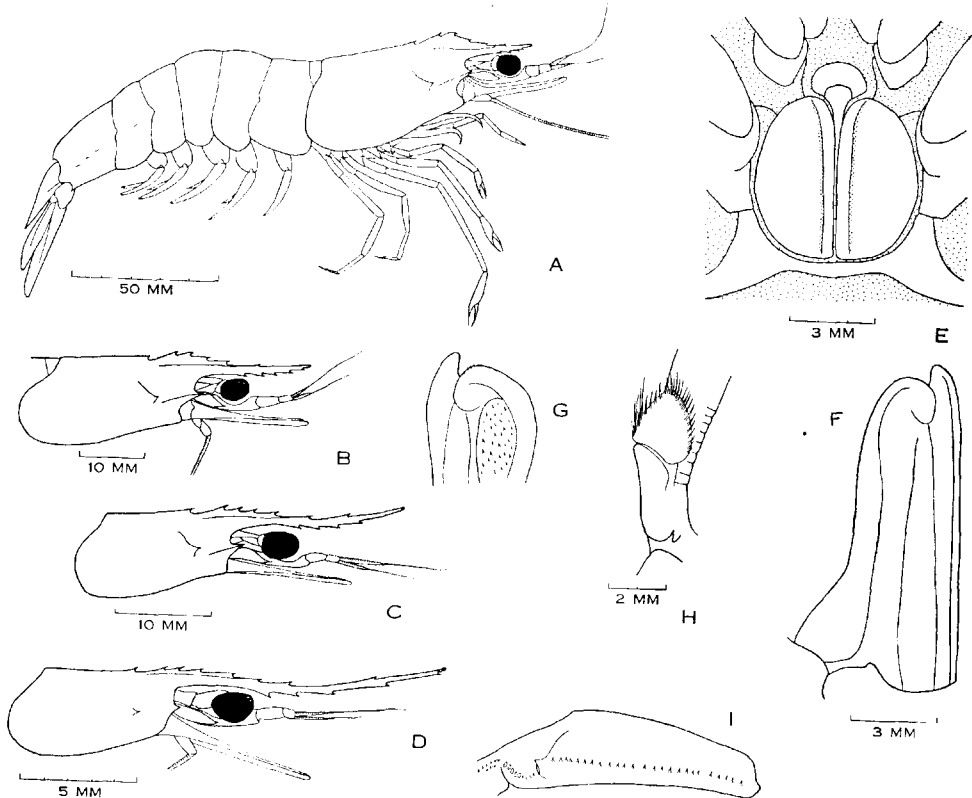


Fig. 8.—*Penaeus merguinensis* de Man. A, 156 mm ♂; B, cephalothorax, 118 mm ♂; C, cephalothorax, 74 mm ♂; D, cephalothorax, 35 mm ♀; E, thelycum, 180 mm ♀; F, inner aspect of right half of petasma, 179 mm ♂; G, outer lateral distal half of petasma, 179 mm ♂ (same scale); H, appendix masculina; I, cardiac plate and zygocardiac ossicle.

Colour in life (mature prawns living in open waters).—Body cream to yellow, sometimes minutely speckled with blue; rostral blade often blue; antennules banded with brown; antennae red; legs and pleopods yellowish, sometimes with brown or pink tinge; abdominal carina brownish red, sometimes blue; uropods brown tipped with yellow, sometimes with blue. Body sometimes pink to red, especially when coming from deeper waters. *Juveniles in muddy estuaries.*—Body cream, speckled with blue, rostral tip dark brown, outer edges of antennal scales, abdominal carina, telson, and uropods often more or less brown. *Postlarvae.*—Body white to cream, tip of rostrum dark brown.

Distribution

Australia, Ballina, N.S.W., to Exmouth Gulf, W.A., Philippine Is., Makassar, Java Sea, Mergui Archipelago, Karachi, Bombay, Palk Strait, Orissa and Ganjam, Hooghly Delta (de Man 1911); Batavia, Singapore (Kubo 1949). Trawled commercially, Queensland and Western Australia. Juveniles found up to 24 miles from mouth of Brisbane River, with juveniles of *Metapenaeus mastersii*. Average size at sexual maturity in tropical waters (Exmouth Gulf) ♂ 150 mm, ♀ 160 mm.

Discussion

This species is similar to *Penaeus indicus* Milne Edwards, but though adults have distinctive rostra, the progressive relative shortening of the rostrum during development makes immature specimens of these 2 species difficult to distinguish. De Man (1911) uses the position of the last rostral tooth to separate the juveniles, but de Man's 2 criteria are included in the range found within *P. merguensis*. *P. indicus* var. *longirostris* de Man (1892, 1911) is likely to be juvenile *P. indicus*, possibly with a longer rostrum than is usual for specimens of this size (125–165 mm). In some juvenile *P. indicus* from Ceylon, about 100 mm long, the rostrum is longer than the carapace, with distinct sigmoidal curve and low upper blade. *P. merguensis* of comparable size has a relatively straight rostrum with a higher upper blade. In some specimens in the Australian Museum, labelled "Dr. Day collection Karachi", the adrostral carina reaches 1st rostral tooth, and there is a distinct though feeble gastro-orbital carina, occupying middle $\frac{1}{3}$ between rim of the carapace and hepatic spine. The latter feature was not present in any Australian material examined.

The following features seem the most reliable for separating the 2 species:

Feature	<i>P. merguensis</i>	<i>P. indicus</i>
Adrostral carina	Not reaching 1st rostral tooth in Australian specimens	Reaches 1st rostral tooth
Gastro-orbital carina	Absent in Australian specimens (see discussion above for exception)	Well defined, occupying posterior $\frac{2}{3}$ distance between hepatic spine and margin of carapace
Outer antennular flagellum	Shorter than carapace	Longer than carapace
Dactyl of 3rd maxilliped in adult ♂	Half length of propodus	As long as propodus

Racek (1955) records *P. indicus* on the east coast of Australia. The writer has not yet examined any of this species collected from Australian waters. It is probably not common, though its presence is to be expected, especially on the north coast of Australia.

Genus *FUNCHALIA* Johnson

Punchalia Johnson, 1867, p. 895. Bouvier, 1908, p. 91. Lenz and Strunck, 1914. Calman, 1925, pp. 10-11. Burkenroad, 1934b, pp. 76-7; 1936, pp. 126-9; 1940, p. 36. Barnard, 1950, pp. 608-9.

Aristeus Bate, 1888 (part), p. 309.

Penaeus Faxon, 1895 (part). Lenz and Strunck, 1914 (part).

Hemipenaeopsis Bouvier, 1905, p. 981.

Grimabliella Bouvier, 1905, p. 982.

Rostrum with or without ventral rostral teeth; no orbital angle; antennal spine present or absent; branchiostegal spine present; hepatic spine sometimes absent; branchiocardiac and inferior carinae prominent; cervical and orbito-antennal sulci feeble or absent. Fifth and 6th abdominal somites with prominent lateral carinae; terga of 1st to 4th often with carinae; telson with 3 pairs of fixed subapical spines. Upper antennular flagellum longer than the carapace; no spine on ventral disto-median edge of 1st segment. Incisor process of mandible elongate, scimitar-like, and lying transversely behind labrum. Second maxilla with 3 endites; spines on basis and ischium of 1st and 2nd legs; small exopods on all pereopods. Exopod of uropod with large external spine. Petasma simple, open, often asymmetrical. Thelycum simple, with deep seminal receptacle, open or closed by paired flaps.

KEY TO THE SPECIES OF *FUNCHALIA*

1. Rostrum with ventral teeth; antennal spine absent *P. balboae* (Faxon)
- Rostrum without ventral teeth; antennal spine present 2
- 2(1). Hepatic spine present in adults; with more than 10 rostral teeth 3
- Hepatic spine absent in adults; with fewer than 10 rostral teeth 4
- 3(2). Sixth abdominal somite with a short carina below and parallel to the long mid-lateral carina; seminal receptacle open *P. woodwardi* Johnson
- Sixth abdominal somite with a long mid-lateral carina only; seminal receptacle closed by a pair of flaps *P. danae* Burkenroad
- 4(2). Petasma with small triangular projection on ventral surface of free distal part of larger endopod; thelycum with small median ridge behind seminal receptacle *P. villosa* (Bouvier)
- Petasma without projection on ventral surface of free distal part of larger endopod; thelycum with large median tooth-like tubercle behind seminal receptacle *P. taaningi* Burkenroad

FUNCHALIA *VILLOSA* (Bouvier)Fig. 9.4 *E*

Hemipenaeopsis villosus Bouvier, 1905 (part).

Grimabliella richardi Bouvier, 1905 (part).

Funchalia woodwardi Bouvier, 1908 (part), p. 93. Lenz and Strunck, 1914.

Funchalia runhöffeni Lenz and Strunck, 1914.

? *Funchalia* Gurney, 1924.

Material.—LORD HOWE I.: Aust. Mus. regd. No. P6762, 7 ♂, 59-74 mm (carapaces 12.5-15.5 mm), 8 ♀, 58-86 mm (carapaces 12.5-19 mm).

Description

Rostrum.—Teeth 4-5 + epigastric; not reaching as far as or slightly exceeding cornea, free part slightly depressed; adrostral carina feeble, ending below 1st tooth,

the shallow sulcus ending just behind epigastric; postrostral carina ending at $\frac{1}{5}$ carapace; 2nd tooth above postorbital rim of carapace.

Carapace.—Gastrofrontal sulcus feeble, indistinct anteriorly, reaching $\frac{1}{2}$ carapace; antennal spine small, carina and orbito-antennal sulcus reaching $\frac{1}{4}$ carapace; branchiostegal spine slightly above the barely acute pterygostomial angle; carina behind branchiostegal reaching $\frac{1}{3}$ distance between spine and inferior carina. Hepatic spine absent, sulcus running from margin of carapace becoming confluent with inferior sulcus, latter reaching branchiostegal margin. A feeble carina and sulcus arising vertically from branchiocardiac carina just behind $\frac{1}{2}$ carapace, curving forward, sulcus becoming confluent with feeble cervical sulcus; a short feeble sulcus parallel and anterodorsal to latter. A short oblique carina and sulcus on postero-dorsal surface carapace.

Antennules.—Upper flagellum as long as carapace + rostrum, lower $\frac{3}{5}$ upper. Prosartema reaching 0.7 basal segment; stylocerite a triangular flat plate reaching $\frac{1}{2}$ cornea.

Mandible.—Incisor process reaching the opposite branchiostegite, almost as long as palp.

Thoracic appendages.—Third maxilliped reaching as far as carpocerite; 1st pereopod exceeding pterygostomial angle by dactyl; 2nd reaching $\frac{1}{2}$ carpocerite; 3rd exceeding it by dactyl; 4th reaching base, 5th reaching $\frac{3}{4}$ carpocerite, dactyls of both curved and slender.

Abdomen.—First somite with downcurving continuation of branchiocardiac carina; pleura of 1st to 4th somites with vertical carinae; lateral carina of 5th and 6th continuing on 4th, sloping obliquely towards dorsum; carina and sulcus on ventral margin of 6th pronounced. A small elongate tubercle on dorsum of 2nd and 3rd somites, 4th to 6th with a carina ending in a small tooth. Telson with 2 lobes on either side of base, the more proximal partly cleft. Inner uropod exceeding telson, which reaches $\frac{2}{3}$ outer. Prominent sternal keels between 1st and 2nd pleopods.

Gastric mill (Fig. 9E).—Cardiac plate long, narrow, with dense ventral fringing setae, without row of median teeth; zygocardiac ossicle a flattened tooth with minute lateral spinules; immediately behind zygocardiac, a rounded process densely covered with spinules; prepyloric ossicle with slightly concave edge bearing a double row of spinules; urocardiac suboval, deeply concave; cardiac and pterocardiac ossicles absent.

Petasma (Fig. 9B).—Asymmetrical, reaching bases of 4th pereopods; either right or left endopod larger than other; the smaller with simple grooved spatulate apex; apex of the larger deeply grooved, curving dorsally, with paired blunt lateral lobes, with proximal triangular projection on outer edge. A pair of hoof-like projections on pleopods proximal to articulation with petasma.

Appendix masculina (Fig. 9C).—Distal segment with oval, flattened, expanded apex, slightly excavate with small anterior tubercle and with marginal row of short setae.

Thelycum (Fig. 9D).—Anterior plate between and above coxae of 4th pereopods, cordiform with sharp apex and medially grooved, the lateral edges curving ventrally.

Sternal plate of 5th pereopods large, flat, quadrangular with 2 anterior extensions fusing with anterior plate to form the deep seminal receptacle; extensions continuing backwards as carinae curving laterally behind 5th coxae along edges of sternite. A small elongate median tubercle between 5th coxae.

Distribution

Tropical Atlantic (Burkenroad 1936). The larva from New Zealand described by Gurney (1924) may be *F. villosa*, but excepting this, the Lord Howe I. specimens are the first Indo-Pacific record of this species.

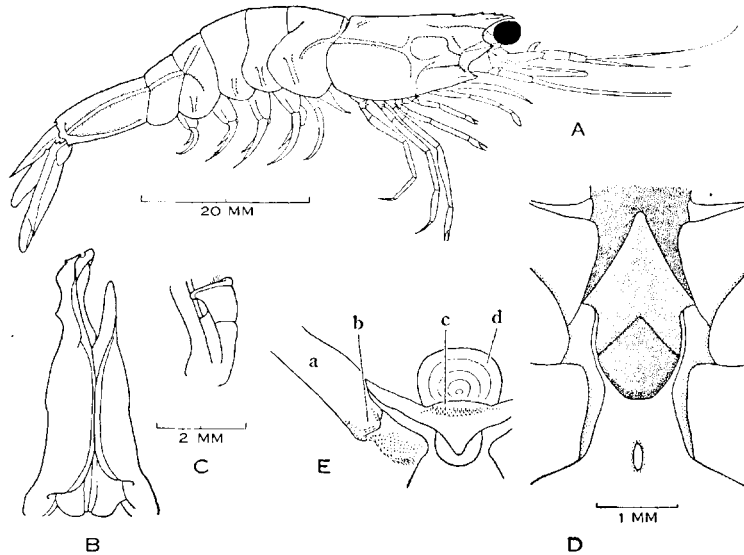


Fig. 9. *Funchalia villosa* (Bouvier). A, 74 mm ♂; B, petasma, 74 mm ♂; C, appendix masculina, 74 mm ♂; D, thelycum, 76 mm ♀; E, ossicles of gastric mill (a, cardiac plate; b, zygocardiac ossicle; c, prepyloric ossicle; d, urocardiac ossicle).

Discussion

The present specimens agree with Burkenroad's (1936) description, except that some have only 4 rostral teeth, and all have the dorsal abdominal carina ending in a small tooth, whereas Burkenroad's specimens had a "long tooth." *F. taaningi* Burkenroad (1940) differs in only minor features of petasma, thelycum, and in position of branchiostegal spine from *F. villosa*.

All *Funchalia* spp. have so far been collected in the open ocean, often from considerable depths. The greatly elongate incisor processes of the mandibles and sculpturing of the integument set *Funchalia* spp. apart from other Penaeinae. In *F. villosa* these incisor processes, together with the talon-like dactyls of 4th and 5th pereopods, and absence of teeth in the gastric mill, suggest that the species may feed by piercing and sucking the body fluids of some pelagic animal. Whether *F. villosa* is predatory, as the large hemispherical corneas seem to indicate, or merely attaches to some relatively passive organism has yet to be discovered.

Genus METAPENAEOPSIS Bouvier

Metapenaeopsis Bouvier, 1905. Kubo, 1949, pp. 408-11.

Penaeopsis de Man, 1911 (part), pp. 53-5, 61. Balss, 1914 (part), pp. 6-7. Kemp, 1915 (part), p. 321. Schmitt, 1926 (part), pp. 319-23. Burkenroad, 1934a (part), pp. 4-12. Barnard, 1950, p. 592.

Leptopenaeus Kishinouye, 1929, p. 282.

Ceratopenaeus Kishinouye, 1929, p. 282.

Erthyropenaeus Kishinouye, 1929, p. 283.

Metapeneus Alcock, 1906 (part), p. 16.

Rostrum dorsally toothed only. Carapace without longitudinal or transverse sutures. Cervical, hepatic, and orbito-antennal sulci usually ill defined. Orbital, antennal, hepatic, and pterygostomial spines well developed. Telson with a pair of fixed subapical spines followed by several pairs of large movable spines. Cornea often large. First antennular segment with a spine, which may be vestigial, on ventral distomedian border. Antennular flagella variable in length, sometimes longer than carapace. Maxillulary palp unsegmented. Basal spines on 3rd maxilliped and 1st and 2nd pereopods. Exopods on all pereopods. Petasma asymmetrical, divided transversely at about $\frac{1}{2}$ its length into proximal and distal portions, the latter complex and further divided into lobules and projections (Fig. 11B, C). Appendix masculina usually consisting of basal piece only, distal piece if present small. Thelycum consisting of a transverse plate between coxae of 4th pereopods, and variable structures between this plate and posterior transverse elevation of last thoracic sternite. Zygocardiac ossicle consisting of 2 large teeth, sometimes with smaller teeth and a patch of minute teeth. Pleurobranchiae on 3rd to 7th thoracic somites; a rudimentary arthrobranch on 1st, anterior and posterior arthrobranchiae on 2nd to 6th, and a rudimentary anterior and a posterior arthrobranch on 7th thoracic somites; mastigobranchiae on 1st, 2nd, and 4th to 6th thoracic somites; carapace usually pubescent.

Kubo (1949) elevates subgenus *Metapenaeopsis* as defined by Burkenroad (1934a) to generic rank, to separate species with an asymmetrical petasma from those included in *Penaeopsis* Bate (restricted).

Metapenaeopsis is a large genus, and contains a number of obscure and doubtful species. Many are small and uncommon and this possibly accounts for the fact that many species are little known. The type species, *M. pubescens* Bouvier, is from the tropical Atlantic, and 4 additional species, 2 from America, are described from the Atlantic. (For key to Atlantic and Pacific American spp. see Anderson and Lindner (1945).) The majority (19) of Indo-West Pacific *Metapenaeopsis* spp. are keyed below. The following little-known or doubtful species have not been included: *M. assimilis* (de Man), 1920; *M. batei* (Miers), 1884; *M. commensalis* (Borradaile), 1898 (de Man (1911) states that the single type of this species, of which only ♂ is known, has been lost); *M. gallensis* (Pearson), 1905. *M. longipes* (Paulson), 1875, *M. consobrinus* (Nobili), 1904, *M. perlaram* (Nobili), and *M. vaillanti* (Nobili) are from the Red Sea, the last 3 very possibly being *Metapeneus* spp. and synonymous with well-known species.

According to the rules of grammar, *Metapenaeopsis* should be of feminine gender. Most authors have treated it as of masculine gender, and as there is a possibility

of the gender being decided by the International Commission of Zoological Nomenclature (Dr. L. B. Holthuis, personal communication), *Metapenaeopsis* has been treated as of masculine gender in the present paper.

KEY TO THE INDO-WEST PACIFIC SPECIES OF METAPENAEOPSIS

1. Length 6th pleonic somite less than twice depth near posterior end; spine on distoventral border of basal segment of antennular peduncle vestigial 2
 Length 6th pleonic somite more than twice depth near posterior end; spine on the distoventral border of basal segment of antennular peduncle usually well developed 14
- 2(1). Stridulating organ present on posterior branchiostegite 3
 Stridulating organ absent from posterior branchiostegite 6
- 3(2). Dorsal carina of 3rd abdominal somite with well-defined sulcus *M. durus* Kubo
 Dorsal carina of 3rd abdominal somite flat or feebly sulcate at posterior end only 4
- 4(3). Rostrum reaching to or almost to tip of antennular peduncle; plate of thelycum between 4th pereopods wider than long, and much larger than coxal projections 5
 Rostrum reaching to distal end of 1st segment of antennular peduncle; plate of thelycum between 4th pereopods as long as wide and about as large as coxal projections
 *M. acclieis* (Rathbun)
- 5(4). Stridulating organ with 13–25 (usually 18–22) ridges; inner intermediate strip of petasma exceeding outer; rim of posterior transverse sternal ridge thelycum with median protuberance *M. barbatus* (de Haan) (= *P. akagebi* Rathbun)
 Stridulating ridge with 7–12 ridges; inner intermediate strip of petasma as long as or shorter than the outer; rim of posterior transverse sternal ridge thelycum without median protuberance *M. norae-guineae* (Haswell)
- 6(2). Epigastric tooth at $\frac{1}{4}$ carapace; antennal scale more than twice as long as broad 7
 Epigastric tooth a little posterior to middle of carapace; antennal scale twice as long as wide *M. lamellatus* (de Haan)
- 7(6). With transverse plates only between coxae of ♀ 4th and 5th legs 8
 With 2 median spines situated one behind the other between coxae of ♀ 4th and 5th legs *M. cecronanni* (Rathbun)
- 8(7). A pair of long spinous processes on sternum between coxae of ♀ 2nd pereopods 9
 No spinous processes on sternum between coxae of ♀ 2nd pereopods *M. velutinus* (Dana)
- 9(8). Hepatic sulcus descending almost vertically to ventral edge of branchiostegite
 *M. borradalei* (de Man)
 Hepatic sulcus absent or not reaching to ventral edge of branchiostegite 10
- 10(9). Anterior transverse plate between ♀ 4th legs with 1 or more pairs of median prominent teeth-like processes immediately posterior to it 13
 Anterior transverse plate between ♀ 4th legs without 1 or more pairs of median teeth-like processes immediately posterior to it 11
- 11(10). Anterior transverse sternal ridge between ♀ 5th pereopods with pair of spinous anterolateral processes; process between 3rd legs either double or absent 12
 Anterior transverse sternal ridge between ♀ 5th pereopods without pair of spinous anterolateral processes; a single spinous process between 3rd legs
 *M. quinquidentatus* (de Man)
- 12(11). Posterior transverse sternal ridge between ♀ 5th pereopods with large median triangular process; no processes between 3rd legs *M. dalci* (Rathbun)
 Posterior transverse sternal ridge between ♀ 5th pereopods with small median tubercle; a pair of bluntly pointed processes between 3rd legs *M. incomptus* Kubo
- 13(10). Thelycum with a pair of small pointed processes immediately behind plate between 4th pereopods, and arising from posterior base of these processes, a pair of acute dentiform tubercles *M. distinctus* (de Man)
 Thelycum with a pair of more or less diverging processes immediately behind plate between 4th pereopods, and with no acute tubercles at posterior base
 *M. mogiensis* (Rathbun) (= *Penaeopsis hilarulus* de Man)

- 14(1). Anterior plate of thelycum with posterior extension15
 Anterior plate of thelycum without posterior extension*M. sinuosus*, sp. nov.
 15(14). Posterior extension of anterior plate of thelycum bilobed16
 Posterior extension of anterior plate of thelycum single and pointed18
 16(15). Rostrum as long as or longer than antennular peduncle17
 Rostrum not reaching tip of antennular peduncle*M. coniger* (Wood-Mason)
 17(16). Right apex of petasma slightly exceeding the left*M. sibogae* (de Man)
 Left apex of petasma slightly exceeding the right
M. philippii (Bate) (= *Penaeus philippinensis* (Bato 1888) (= *Penaeopsis coniger*
andamanensis (Wood-Mason & Alcock))
 18(15). Abdomen dorsally carinated posterior to 1st somite*M. latus* Kubo
 Abdomen dorsally carinated posterior to 2nd somite*M. kyushuensis* (Yokoya)

METAPENAEOPSIS DURUS Kubo

Fig. 10A, B

Metapenaeopsis durus Kubo, 1949, pp. 421-4, figs. 8A, 18G-L, 22O, 46D, 64C, 76E, J, 80L, 148C, 149.

Material.—WESTERN AUSTRALIA: Near entrance Roebuck Bay, Broome, ♀ 59 mm; between C. Bossuet and Broome, ♀ 61 mm.

Description

Rostrum.—Teeth 8-9 + epigastric; almost reaching tip of antennular peduncle, slightly upcurved. Adrostral carina reaching postorbital rim of carapace and following it for a short distance. Epigastric tooth at $\frac{1}{3}$ carapace; postrostral carina absent.

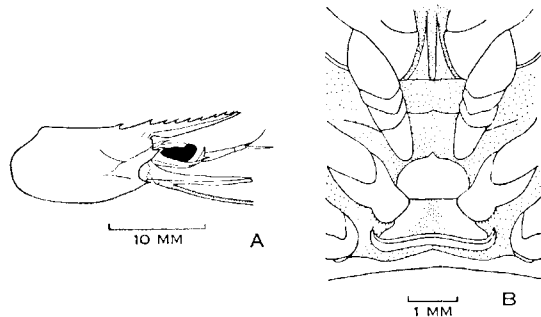


Fig. 10.—*Metapenaeopsis durus* Kubo. A, cephalothorax, 59 mm ♀; B, thelycum, 59 mm ♀.

Carapace.—Orbital spine small; orbito-antennal sulcus shallow. A postocular depression present. Antennal spine large, reaching cornea; carina short, reaching barely $\frac{1}{3}$ distance between tip of spine and hepatic spine. Cervical and hepatic sulci indistinct owing to presence of dense pubescence; when this is removed sulci are distinct and deep. Cervical sulcus straight, reaching $\frac{1}{3}$ carapace; hepatic sulcus horizontal below spine turning towards pterygostomial spine in front of hepatic, reaching $\frac{2}{3}$ distance between hepatic and pterygostomial spines. Pterygostomial spine reaching almost as far as spine of basicerite. Stridulating ridges on branchiostegite 14-18.

Antennules.—Flagella $\frac{1}{3}$ length peduncle, slightly more than $\frac{1}{4}$ length carapace. Prosartema not reaching as far as eye; stylocerite as long as 1st segment.

Thoracic appendages.—Third maxillipeds reaching from base to $\frac{1}{3}$ 2nd antennular segment. First pereiopod reaching $\frac{1}{2}$ carapocerite, 2nd exceeding it by dactyl; 3rd exceeding 1st antennular segment by dactyl; 4th reaching as far as 1st, 5th exceeding carapocerite by $\frac{1}{2}$ dactyl. Exopod 3rd maxilliped reaching $\frac{2}{3}$ merus; exopods on all pereiopods exceeding ischia. Ischial spine on 1st pereiopod.

Abdomen.—Dorsal carina beginning on posterior $\frac{1}{2}$ 2nd somite, bearing a well-defined sulcus on 3rd somite; carina prominent on 4th to 6th somites; 6th somite 1.7 times as long as deep. Telson as long as inner and outer uropods, with 3 pairs of long lateral spines.

Gastric mill.—Cardiac plate with 32 teeth; zygocardiac ossicle with principal teeth + 3 blunt tubercles. Prepyloric with 7–8 long blunt teeth subequal to median tooth.

Thelycum (Fig. 10B).—A pair of long spines between coxae of 2nd pereiopods; no appreciable projections between 3rd. Transverse plate between 4th pereiopods suboval with mucronate anterior edge and as long as broad. Coxal projections of 4th pereiopods rounded, smaller than transverse plate, bounding and slightly overlying a quadrangular plate with broad median depression; posterior sternal plate between 5th pereiopods with a median, broadly triangular, and 2 lateral rounded projections.

Distribution

Tokyo, Miya, Aichi Prefecture (Kubo 1949). Vicinity of Broome, W.A.

Discussion

The present specimens differ from those described by Kubo (1949) in the following features:

Feature	Broome Specimens	Japanese Specimens
Rostrum	Almost reaching tip of antennular peduncle and slightly upturned	Hardly reaching $\frac{1}{3}$ 2nd antennular segment and strongly upturned
Antennular flagella	Barely $\frac{1}{3}$ length carapace	Half length carapace
Number of stridulating ridges	14–18	28–35

The coxal projections of 4th pereiopods are not as large as those figured by Kubo, but this may be due to the smaller size of the Broome specimens (Japanese specimens range from 76.1 to 94.5 mm). Against this the ovaries of the 61 mm female contain formed eggs indicating sexual maturity. Kubo examined only 5 specimens and it is possible that a larger number would show wide variations in rostrum etc. (cf. *M. novae-guineae*). It is possible that the present specimens belong

to a new species, but in the absence of a better series, including males, it is thought advisable, as the majority of features are in close agreement, to include them with *M. durus*.

METAPENAEOPSIS NOVAE-GUINEAE (Haswell)

Fig. 11A-F

Penaeus novae-guineae Haswell, 1879, p. 43; 1882, p. 203.

Penaeus palmensis Haswell, 1879, p. 43; 1882, p. 204.

Penaeus velutinus Bate, 1888, p. 253.

Metapeneus palmensis Alcock, 1906, p. 51.

Metapeneus stridulans Alcock, 1906, p. 27.

Penaeopsis palmensis de Man, 1911, pp. 8, 55, 73.

Penaeopsis stridulans de Man, 1911, p. 65.

Penaeopsis novae-guineae Schmitt, 1926, pp. 338-48. Racek, 1955, pp. 226-7.

Material.—Moreton Bay, Qld., to Exmouth Gulf, W.A., 33 specimens, 38-106 mm. Australian Museum collection.

Description

Rostrum.—Variable, teeth 5-8 + epigastric; usually reaching to, or almost to tip of antennular peduncle, but often much shorter. Postrostral carina often absent, but sometimes a feeble carina reaching $\frac{1}{2}$ carapace. Position of epigastric tooth varying from $\frac{1}{5}$ to $\frac{1}{4}$ carapace, 2nd tooth at frontal margin carapace. Rostral shape variable, ventral margin always upcurved, upper surface sometimes straight and horizontal, sometimes strongly upcurved.

Carapace.—Orbital spine minute; orbito-antennal sulcus sometimes clearly though feebly defined to hepatic spine, but sometimes barely defined at all. Hepatic spine small, with very feeble indication of cervical groove immediately above it. Antennal spine large, without carina. Hepatic sulcus shallow, tomentose, horizontal, slightly below and behind hepatic spine. A stridulating ridge on posterior branchiostegite, with 7-12 ridges varying greatly in size and shape.

Antennules.—Upper flagellum slightly shorter than lower which is $\frac{2}{3}$ peduncle and $\frac{1}{3}$ length carapace in ♂, $\frac{1}{4}$ peduncle and $\frac{1}{5}$ carapace in ♀. Prosartema reaching as far as eye; stylocerite reaching to or almost to tip basal segment.

Thoracic appendages.—Third maxilliped reaching from base to tip of 3rd segment of antennular peduncle; 1st pereopod reaching almost to, or exceeding, tip of carapocerite; 2nd exceeding it by dactyl to entire propodus; 3rd ranging from base to tip of 2nd segment of antennular peduncle; 4th reaching as far as carapocerite, 5th exceeding it by dactyl to $\frac{1}{2}$ propodus. Ischial spine on 1st pereopod.

Abdomen.—Second abdominal somite with short feeble dorsal carina, 3rd to 6th with a strong carina, that of 3rd dorsally flat or feebly sulcate posteriorly. Telson with 3 pairs of lateral movable spines, 1st smaller than long 2nd and 3rd and based at $\frac{1}{2}$ telson. Inner uropod as long as telson, slightly exceeded by exopod.

Gastric mill (Fig. 11F).—Cardiac teeth 26-32. Zygocardiac ossicle with principal + 2-3 smaller teeth beside upper tooth. Prepyloric with 8-11 long blunt lateral teeth, similar in size to median tooth.

Petasma (Fig. 11B, C).—Shape of various parts variable and reaching coxae of 4th pereopods; right distoventral projection (*a*) bearing few small distal processes, left distoventral projection (*e*) with 8–14 larger finger-like processes; both projections much thickened distally. Inner intermediate strip (*g*), usually finger-like and cylindrical, outer intermediate strip (*h*) with numerous minute distal setae, as long as the inner strip in Moreton Bay ♂♂, much longer in Townsville and Western Australian specimens.

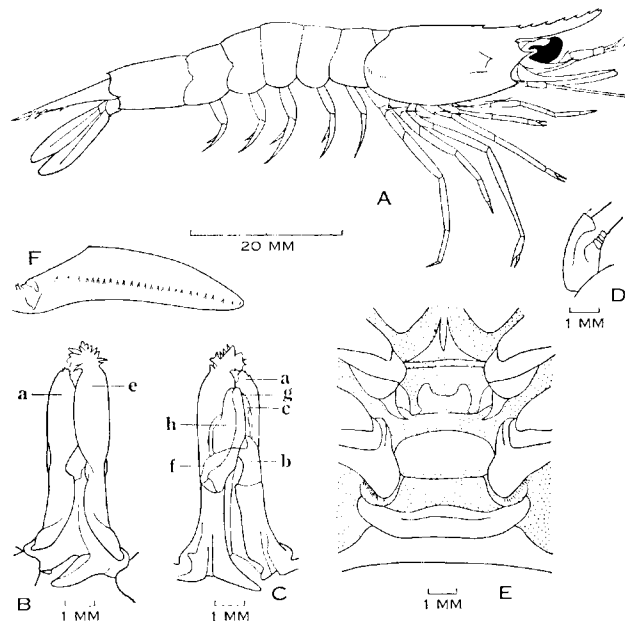


Fig. 11.—*Metapenaeopsis novae-guineae* (Haswell). *A*, 76 mm ♂, Townsville; *B*, ventral surface of petasma; *C*, dorsal surface of same (*a*, right distoventral projection; *b*, right distodorsal lobule; *c*, distomedian lobule; *e*, left distoventral projection; *f*, left distodorsal lobule; *g*, inner intermediate strip; *h*, outer intermediate strip); *D*, appendix masculina, 72 mm ♂; *E*, thelycum, 106 mm ♀; *F*, cardiac plate and zygocardiac ossicle.

Appendix masculina (Fig. 11D).—One segment, with cup-like distal expansion bearing a tuft of setae on distal edge.

Thelycum (Fig. 11E).—Sternum of 2nd pereopods with 2 long spinous processes, that of 3rd with 2 shorter blunt projections; genital openings on coxae curved and beak-like. Coxae of 4th pereopods bounding a very broad plate, ventral edge entire; coxal processes densely setose, posterior edge densely fringed with spinules. Sternum of 5th pereopods simple, without sharp processes or spines.

Colour and appearance in life.—Carapace and abdomen densely pubescent. Irregularly mottled with dark reddish brown, with transverse band across distal $\frac{1}{2}$ telson and uropods, rostrum and appendages anterior to eyes banded with same colour. Colour between mottling mid brown dorsally, becoming light brown ventrally. Rose pink (Hale 1927).

Distribution

Ranging from Port Jackson, N.S.W., through north and west Australia to south Australia (common in warmer waters). Gulfs of South Australia (Hale 1927). Indonesia, Hong Kong, Gulf of Martaban, coasts of Bay of Bengal to Ceylon (de Man 1911).

Discussion

M. novae-guineae is a variable species, especially in features of the carapace, which in other penaeids are usually constant. Other *Metapenaeopsis* spp. possessing a stridulating organ are *M. barbatus* (de Haan) (= *Penaeopsis akayebi* Rathbun), *M. acclivis* (Rathbun), and *M. durus* Kubo, the first 2 resembling *M. novae-guineae* very closely but readily distinguished by the key characters (see above).

The variability of the species, especially with regard to the petasma, often gives rise to the suspicion that more than one species is being examined, but the thelyca and gastric mills of the specimens from various localities are uniform. A similar difficulty was noted by de Man (1911). The differences between specimens from widely different localities appear greater than those between specimens from the same locality but there do not seem to be any uniform distinctive features that would justify splitting *M. novae-guineae* into 2 or more species.

Schmitt (1926) discusses differences in thelyca between *M. novae-guineae* and *M. mogiensis* (Rathbun). The identity of *Penaeus velutinus* Bate, 1888, has still to be resolved. Bate's Figure 1 (pl. XXXIII) has the stridulating ridge covered by the pleuron of 1st abdominal somite, but telson, stylocerite, petasma, and thelycum (Figs. 1'', 1''') most nearly resemble those of *M. novae-guineae*. In addition in the Australian Museum there is a specimen of "*Penaeus velutinus*" identified by Bate which is undoubtedly *M. novae-guineae*. There seems little doubt, therefore, that at least the figured specimens of "*Penaeus velutinus*" are *M. novae-guineae*.

METAPENAEOPSIS MOGIENSIS (Rathbun)

Fig. 12A, B

Parapenaeus mogiensis Rathbun, 1902, p. 39.

Metapeneus mogiensis Alcock, 1906, pp. 29-30.

Penaeopsis mogiensis Schmitt, 1926, pp. 346-8.

Penaeopsis hilarulus de Man, 1911, pp. 70-1. Barnard, 1950, pp. 595-6.

Material.—QUEENSLAND: Darnley I., Torres Strait (figd. Schmitt 1926), ♀ 32 mm; North West I., Capricorn Group, coll. M. Ward, ♀ 63 mm.

Description

Rostrum.—Teeth 7 + epigastric; rostrum deep, reaching $\frac{1}{2}$ 2nd antennular segment, tip slightly upturned; greatest depth at 2nd tooth. Adrostral carina distinct, reaching postorbital margin of carapace and becoming confluent with it. Postrostral carina absent. Epigastric tooth only on carapace.

Carapace.—Orbital spine small, antennal spine slender, carina absent; cervical sulcus feeble, straight, reaching $\frac{1}{2}$ carapace. Hepatic spine long and slender; hepatic sulcus deep, horizontal below spine, its posterior end slightly upturned; sulcus

curving downwards from base of hepatic spine towards but not reaching branchiostegal border, becoming indistinct at level of pterygostomial spine. Pterygostomial spine short, well above antero-inferior corner of carapace.

Antennules.—Flagella subequal $\frac{1}{2}$ length peduncle. Stylocerite slightly exceeding upper median edge of 1st segment; prosartema slightly exceeding eye. Distomedian spine on 1st segment small but distinct; distolateral spine long, slender, inclined slightly upwards.

Thoracic appendages.—Third maxilliped reaching tip of 2nd antennular segment; 1st pereopods reaching base, 2nd exceeding tip of carapocerite by dactyl, 3rd reaching $\frac{1}{2}$ 2nd antennular segment, 4th reaching base, 5th exceeding tip of carapocerite by dactyl. (Pereopods of smaller specimen, where present, longer than those of preceding description by about the dactyl.) Exopods of pereopods as long as or exceeding the ischia. Ischial spine on 1st pereopod.

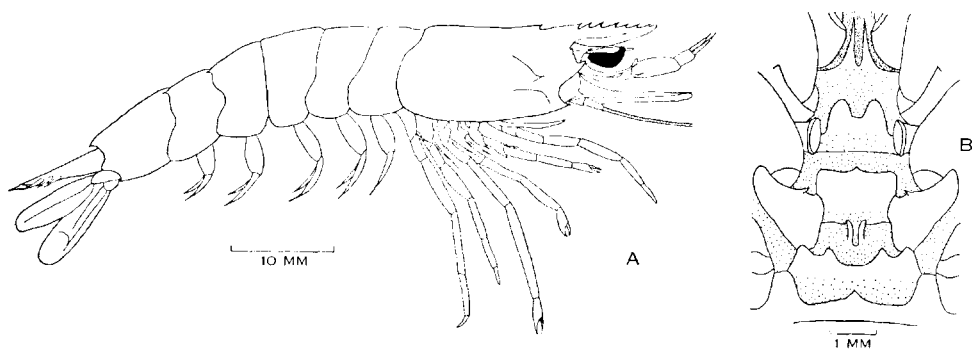


Fig. 12.—*Metapenaeopsis mogiensis* (Rathbun). A, 63 mm ♀, North West I.; B, telson, 63 mm ♀.

Abdomen.—Carina commencing on and bearing sulcus for length 3rd somite; remainder carina non-sulcate and high. Depth 6th somite $\frac{2}{3}$ length. Telson non-sulcate proximally with 3 pairs long movable spines, the most distal pair almost reaching tip of telson, thrice length fixed spines.

Telson (Fig. 12B).—Sternum of 2nd pereopods with 2 long spines, 2 blunt processes on 3rd. Transverse plate between 4th pereopods with median tooth, remainder of anterior border almost straight; width plate $1\frac{1}{2}$ times length. Immediately behind anterior plate a pair of slender divergent tubercles, tending to be more lamellar and less divergent in immature specimen. Anterior 5th sternal ridge with large median and 2 semicircular excavations, the 2 median projections separating them smoothly rounded; these features ill defined in immature ♀. Posterior sternal plate with mucronate median projection.

Distribution and Size

Ranging from Mogi, Japan (type locality), to Capricorn Group, Queensland, and to South Africa (Barnard 1950). Abundant off the Malabar coast, Ceylon, and Andaman Is. (Alcock 1906). Females of 90 mm have been recorded (Alcock 1906).

Discussion

Schmitt (1926), who examined both the type material and the Darnley I. female, could see no reason for regarding de Man's (1911) *P. hilarulus* as a separate species. The only major point of difference is that Rathbun (1902) states that the spines between 2nd pereopods are rudimentary, whereas de Man shows these spines as well developed. Schmitt, however, states that the spines between 2nd legs (Darnley I. specimen) are like those of a typical *mogiensis* and previously makes reference to a specimen other than the holotype as having the more usual, and possibly less mature type of thelycum. It seems likely that Rathbun's description was taken from an abnormal or damaged specimen. The two major differences between mature and immature thelyca are configuration and size of 2 spines or platelets behind anterior plate of thelycum, and of foremost 5th sternal plate. As the present specimens agree in other features it seems undesirable to separate them. Sexual maturity is apparently reached by ♀♀ at a length of 60–75 mm and a specimen under 40 mm would not show adult secondary sexual features.

The 63 mm ♀ agrees closely with Rathbun's (1902) figures of the rostrum and thelycum, but differs slightly from those of Alcock (1906). Schmitt (1926) noted differences in Alcock's figure of the thelycum compared with Japanese specimens. It is likely there is some variation between adults from various localities.

METAPENAEOPSIS BORRADAILEI (de Man)

Fig. 13A–E

Penaeopsis borradailei de Man, 1911, pp. 73–5, pl. VIII, fig. 24a, b.

Material.—QUEENSLAND: Murray I., Torres Strait (Aust. Mus. regd. No. P7452), ♂ 34 mm.

Description

Rostrum.—Teeth 9 + epigastric, the last minute. Rostrum straight, inclined upwards, reaching tip of 2nd segment of antennular peduncle; epigastric at slightly less than $\frac{1}{4}$ carapace. Adrostral carina reaching almost to 2nd tooth, which is slightly in advance of postorbital margin of carapace; postrostral carina absent.

Carapace.—Densely and harshly pubescent; orbito-antennal sulcus absent; antennal spine large, the carina extending $\frac{1}{4}$ distance between antennal and hepatic spines. Hepatic spine prominent, with distinct but feeble cervical sulcus ascending steeply dorsad, edged with stiff setae. Hepatic sulcus a short horizontal groove immediately below hepatic spine, then turning abruptly ventrad, upper $\frac{1}{2}$ directed anteroventrally, lower $\frac{1}{2}$ descending vertically to edge of branchiostegite; descending portion of sulcus fringed posteriorly with long spinose setae. Pterygostomial spine large.

Antennules.—Upper flagellum shorter than lower, which is $\frac{1}{3}$ peduncle, and $\frac{1}{4}$ length carapace. Prosartema not reaching as far as eye, stylocerite attaining $\frac{2}{3}$ basal segment.

Thoracic appendages.—Third maxilliped reaching middle of 2nd segment of antennular peduncle; 1st pereopod slightly exceeding carapace; 2nd exceeding it by propodus; 3rd reaching tip of 2nd segment of antennular peduncle; 4th reaching

$\frac{1}{2}$ carpopacrite. Ischial spine on 1st pereopod. A pair of long slender spines between coxae of 2nd pereopods.

Abdomen.—Fifth and 6th somites dorsally carinated; depth 6th somite $\frac{2}{3}$ length. Telson with 3 pairs of lateral movable spines, 1st small, based at $\frac{1}{2}$ length telson, 2nd and 3rd large and close to subapical spine; telson $\frac{1}{5}$ length inner uropod.

Petasma (Fig. 13B, C).—Right distoventral projection (a) large, more or less flap-like; left distoventral projection (c) vestigial, its exact limits not clear. Right and left distodorsal lobules large (b, f). Distomedian lobule (e) a bifid structure with minute distal setae. Intermediate strips fused, slender and small (h). Petasma reaching basis 3rd pereopods.

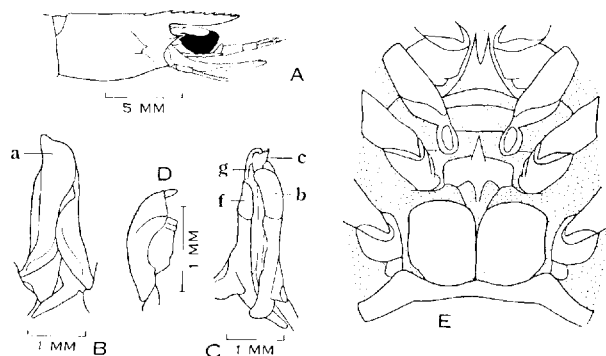


Fig. 13. —*Metapenaeopsis borradalei* (de Man). A, cephalothorax, 34 mm ♂; B, ventral surface of petasma; C, dorsal surface of petasma (a, right distoventral projection; b, right distodorsal lobule; c, distomedian lobule; f, left distodorsal lobule; g, inner intermediate strip); D, appendix masculina (lateral view); E, thelycum (after de Man 1911).

Appendix masculina (Fig. 13D).—Two-segmented, the distal segment minute, $\frac{1}{8}$ length proximal segment.

Thelycum (Fig. 13E; after de Man (1911)).—A single median acute spine situated on transverse plate between coxae 4th pereopods, this plate united with the posterior thelycum by short median longitudinal ridge. Posterior part with deep median groove, consisting of 2 subrectangular plates, rounded anteriorly with outer surface of each slightly convex. Posterior transverse sternal ridge with 5 or 6 median setae.

Distribution

Murray I., Torres Strait; otherwise known only from the "Siboga" Expedition type localities.

Discussion

The Murray I. specimen is the first record of ♂ of this species, which apart from the distinctive petasma, is readily distinguished from similar species by short stylocerite, hepatic sulcus descending to ventral edge of branchiostegite, and lack of dorsal carination on abdomen anterior to 5th somite. The above description is in

close agreement with that of de Man (1911). It is a small species, the largest specimen recorded by this author measuring "nearly 56 mm". *M. borradalei* is the only species within the genus so far described as possessing a distal segment on appendix masculina.

METAPENAEOPSIS SINUOSUS, sp. nov.

Fig. 14A-F

Material.—QUEENSLAND: Off Shore I. (Kennedy Sound), Cumberland Group, trawled 10 fm at night, G. P. Whitley, 5.ix.1935: holotype ♂, 41 mm, carapace 8 mm, Aust. Mus. regd. No. P12223; allotype ♀, 37 mm, carapace 7.8 mm, Aust. Mus. regd. No. P12223.

Diagnosis

Rostrum slender, sigmoidal, and as long as antennular peduncle, with 7 teeth + epigastric; small notch on edge of carapace just above antennal spine; abdomen well developed, length 6th somite more than twice depth measured at posterior end; right lobe of petasma exceeding left; anterior plate of thelycum simple, behind which is a large centrally depressed plate.

Description

Rostrum.—Teeth 7 + epigastric; reaching as far as or slightly exceeding tip of antennular peduncle, slender and sigmoidal, 1st 4-5 teeth long and borne on proximal $\frac{1}{2}$ free portion, remaining 2-3 minute and more widely spaced along distal $\frac{1}{2}$. Epigastric tooth at $\frac{1}{4}$ carapace, 1st tooth in advance of postorbital margin of carapace. Adrostral carina ending at postorbital margin; postrostral carina ending at $\frac{1}{2}$ carapace.

Carapace.—Orbital angle close to rostral base and separated from it by a small depression; a small notch on frontal margin of carapace just above long antennal spine. Orbito-antennal sulcus ill defined; antennal carina absent; cervical sulcus short, not quite reaching $\frac{1}{2}$ carapace. Antennal spine long and slender; hepatic sulcus horizontal, situated immediately below the spine, anterior end level with tip of spine. Pterygostomial spine long.

Eye.—Cornea $\frac{1}{4}$ length carapace; peduncle with triangular scale.

Antennules.—Flagella subequal, $\frac{2}{5}$ length, peduncle, $\frac{1}{3}$ length carapace. Prosartema slender, not quite reaching as far as eye; stylocerite reaching $\frac{3}{4}$ basal segment. Spine on inner margin of basal segment small, but fully developed.

Antennae.—Scaphocerite reaching as far as or slightly exceeding antennular peduncle, the spine very slightly exceeding the lamina.

Mandible.—Palp reaching base of carapocrite, distal segment widest at $\frac{1}{2}$ its length, distolateral edge barely concave, making an obtuse angle with the short mediodistal edge. Incisor process a blunt distal tooth separated by a shallow notch from remainder of process. Molar process subrectangular, and flat except for a ridge along the posterior edge.

Maxillule.—Inner margin with basal $\frac{1}{2}$ convex, bearing 4-5 long setae; distal $\frac{1}{2}$ convex, bearing a small spine directed distomedially; apex with small cluster of setae.

Thoracic appendages.—Third maxilliped reaching $\frac{1}{2}$ 2nd segment of antennular peduncle; 1st pereopod reaching $\frac{1}{2}$ carapocerite, 2nd exceeding it by dactyl, 3rd reaching as far as 3rd maxilliped, 4th almost reaching tip of carapocerite, 5th exceeding it by $\frac{1}{2}$ dactyl. Ischial spine on 1st pereopod, all exopods minute.

Abdomen.—Dorsally carinated from anterior 3rd somite; carina 6th somite ending in blunt tooth. Length 6th somite $2\frac{1}{2}$ times depth measured at the posterior edge. Telson with 3 pairs lateral movable spines, and slightly shorter than endopod uropod.

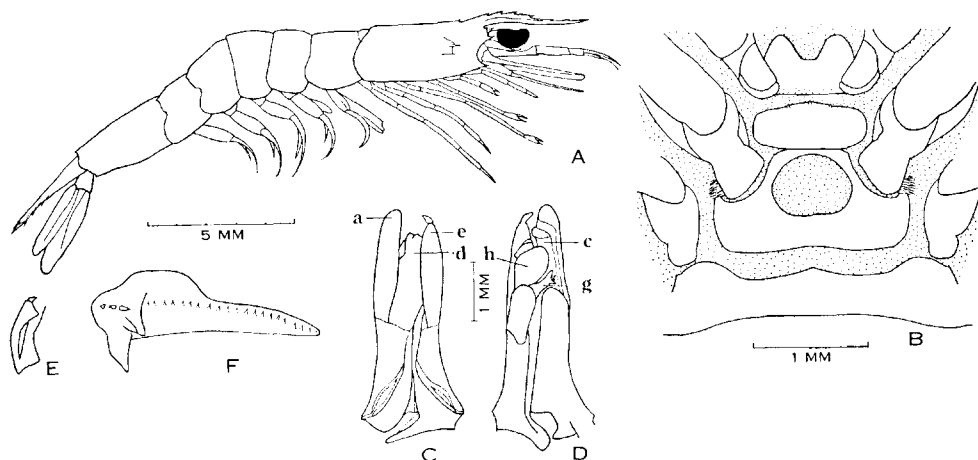


Fig. 14.—*Metapenaeopsis sinuosus*, sp. nov. A, 41 mm ♂ (holotype); B, thelycum, 37 mm allotype; C, ventral surface of petasma of holotype; D, dorsal surface of petasma of holotype (a, right distoventral projection; c, distomedian lobule; d, distoventral flap; e, left distoventral projection; g, inner intermediate strip; h, outer intermediate strip); E, appendix masculina; F, cardiac plate and zygocardiac ossicle of allotype.

Gastric mill (Fig. 14F).—Cardiac plate with about 21 spinules. Uppermost tubercle of zygocardiac ossicle with 3–4 teeth on posterior edge, lower with rounded projection on posterior edge. Cardiac ossicle subrectangular; urocardiac bluntly pointed; pterocardiac sigmoidal. Prepyloric with large median tooth, with a smaller tooth on either side $\frac{1}{2}$ length and partially fused with it; distolateral teeth long, spinous, slightly curved, and well separated.

Petasma (Fig. 14C, D).—Right lobe slightly exceeding left and reaching bases of 2nd pereopods. Right distoventral projection (a), thickened distally and smoothly rounded; left distoventral projection (e), with distal inwardly projecting process of irregular shape. Distoventral flap (d) large, cylindrical, the apex irregularly truncate; distomedian lobule (c) slender, proximally widening towards apex, which is very minutely and densely setose. Inner intermediate strip (g) very slender with 3 lateral digitiform processes, outer intermediate strip (h) large, lamellar, and sub-rhomboidal. Posteromedian projection of left proximal piece of petasma much larger than that of right, wide for most of its length, ending in blunt point.

Appendix masculina (Fig. 14E).—One-segmented with posterodistal surface oval and excavate, with a small soft process just inside most distal part of rim.

Thelycum (Fig. 14B).—A pair of spines on sternum of 2nd pereopods (absent in ♂); a pair of blunt processes, fringed with setae, on sternum of 3rd pereopods; a suboval plate, twice as wide as long, with 3 minute spinules on ventral margin, between coxae of 4th pereopods; behind this plate is a large, centrally depressed plate, widening posteriorly, with posterior edges of 4th coxae each resting in concave anterolateral margin. Posterior transverse sternal plate with obtusely angular median ventral prominence, and 2 convex projections; distolateral corner of the plate sharply angular. Coxae of 4th pereopods with row of articulate spinules on posterolateral margins.

Discussion

M. sinuosus falls within the group of small slender *Metapenaeopsis* spp. with well-developed abdomen, viz. *M. coniger*, *M. sibogae*, *M. phillippii*, *M. latus*, and *M. kyushuensis*. These species have mostly been recorded at depths greater than 100 m. Apart from the fact that it has been found in relatively shallow water, *M. sinuosus* differs from the above species in having a simple anterior thelycal plate without a posterior process, a doubly recurved rostrum, and only a small spine on the inner margin of the 1st antennal segment.

Genus PARAPENAEUS Smith

Parapenaeus Smith, 1885, p. 170. De Man, 1911, pp. 77–9. Kubo, 1949, pp. 398–9. Barnard, 1950, pp. 600–1.

Parapeneus Alcock, 1901, p. 14; 1906, pp. 32–3.

Rostrum dorsally toothed only. Carapace with longitudinal sutures reaching at least as far as median posterior border of carapace, with transverse sutures just above base of 2nd pereopods. Cervical, hepatic, and orbito-antennal sulci feeble or absent. Antennal and hepatic spines present, branchiostegal spine often present. Telson with shallow median sulcus and a pair of subapical fixed spines, lateral movable spines absent. First antennular segment with spine on the ventral distomedian border. Maxillary palp unsegmented. First pereopod with ischial and basal spines. Minute, barely perceptible exopods on all pereopods. Petasma open and with apical pair of complex petaloid processes (Fig. 15B D); median lobes thick, often ending in pair of blunt processes (*c*), lateral lobes with lateral process which bifurcates, each part then ending apically in a more or less spinous process (*a* and *b* respectively), process *a* often bearing another small process *d*. Appendix masculina 2 pieces, the proximal with a prominent anterior ridge, the distal irregularly globular. Thelycum with anterior raised plate between coxae of 4th pereopods, often an intermediate plate which usually has anterior processes embracing posterior part of anterior plate, and a posterior transverse sternal plate. Zygocardiac ossicle consisting of principal tooth + several irregularly disposed smaller teeth. Pleurobranchiae on 3rd to 7th thoracic somites; a rudimentary arthrobranch on 1st, anterior and posterior arthrobranchiae on 2nd to 6th, posterior arthrobranch on 7th thoracic somites; mastigobranchiae on 1st, 2nd, 4th, 5th thoracic somites. Body glabrous.

Type species *P. longirostris* Lucas.

The genus comprises 8 species, all found in relatively deep water. The following key is modified from Kubo (1949) to include *P. australiensis*, sp. nov.

KEY TO THE SPECIES OF PARAPENAEUS

- | | | |
|-------|---|------------------------------------|
| 1. | Branchiostegal spine present; 5th pereopods not reaching tip of antennal scale | 2 |
| | Branchiostegal spine absent; 5th pereopods exceeding antennal scale by dactyl | |
| | | <i>P. longipes</i> Alcock |
| 2(1). | Branchiostegal spine on anterior margin of carapace | 3 |
| | Branchiostegal spine a little behind anterior margin of carapace | 7 |
| 3(2). | Sixth abdominal somite less than twice length 5th | 4 |
| | Sixth abdominal somite a little more than twice length 5th | <i>P. americanus</i> Rathbun |
| 4(3). | Process <i>a</i> of petasma bifurcate, directed laterally | 5 |
| | Process <i>a</i> simply pointed, directed distolaterally | 6 |
| 5(4). | Process <i>b</i> of petasma long, sharply pointed; process <i>d</i> present; thelycum consisting of anterior, intermediate, and posterior plates | <i>P. fissurus</i> (Bate) |
| | Process <i>b</i> short, bluntly pointed; process <i>d</i> absent; thelycum consisting of anterior and posterior median bosses and 2 pairs anterior and posterior lateral bosses | <i>P. sextuberculatus</i> Kubo |
| 6(4). | Process <i>d</i> of petasma well developed; adrostral carina ending just behind 2nd rostral tooth; principal tubercle of zygoecardiac ossicle cup-shaped with large number of minute teeth on margin of cardiac plate; longer antennular flagellum shorter than peduncle .. | |
| | | <i>P. australiensis</i> , sp. nov. |
| | Process <i>d</i> minute, tooth-like; adrostral carina reaching almost to epigastric tooth; principal tubercle of zygoecardiac ossicle simple, without minute teeth on margin of cardiac plate; longer antennular flagellum longer than peduncle | <i>P. lunceolatus</i> Kubo |
| 7(2). | Rostrum reaching distal end of 1st segment of antennular peduncle; 6th abdominal somite more than twice length 5th | <i>P. investigatoris</i> Alcock |
| | Rostrum reaching distal end of 2nd segment of antennular peduncle; 6th abdominal somite a little less than twice length 5th | <i>P. longirostris</i> (Lucas) |

PARAPENAEUS AUSTRALIENSIS, sp. nov.

Fig. 15A-F

Material.—NEW SOUTH WALES: Off Newcastle, Dec. 1953, holotype (Aust. Mus. regd. No. P12329) ♂ 112 mm, carapace 26 mm, and allotype (Aust. Mus. regd. No. P12328) ♀ 114 mm, carapace 29 mm; off Wata Mooli, 68 fm, Apr. 1919, paratypes (Aust. Mus. regd. Nos. P4444-5) 2 ♀ 101, 124 mm.

Diagnosis

Rostrum sigmoidal, teeth 6 + epigastric; postrostral carina sharp, reaching almost to posterior border of carapace. A shallow postocular depression present, branchiostegal spine on anterior margin of carapace. Petasma with 3 processes of lateral lobes (when viewed laterally) each simple and pointed. Thelycum with pear-shaped anterior plate, pointed anteriorly, with intermediate plate with 2 subquadrate lateral processes, and posterior plate with 2 ovoid processes.

Description

Rostrum.—Teeth 6 + epigastric; sigmoidal, in ♂ reaching $\frac{1}{2}$, in ♀ reaching tip of 2nd segment of antennular peduncle. Epigastric at $\frac{1}{3}$ carapace, 2nd tooth just behind anterior margin of carapace; 2nd to 4th teeth fairly widely but evenly spaced, remainder closer together. Adrostral carina ending just behind 2nd rostral tooth. Postrostral carina sharp, ending almost at posterior margin of carapace.

Carapace.—A shallow oval postocular depression at end of adrostral carina; orbital angle sharp. Longitudinal suture ending below posteromedian margin of carapace. Orbito-antennal sulcus distinct for anterior $\frac{1}{3}$ distance between hepatic spine and margin of carapace, a very shallow, barely defined depression marking remainder of distance. Antennal carina occupying $\frac{5}{8}$ distance between hepatic and antennal spines, cervical sulcus short; hepatic sulcus with horizontal, wide, shallow, posterior part, below and behind spine, and anterior part confluent with carina, 2 parts not continuous; hepatic carina curved, commencing well in front of hepatic spine, ending in branchiostegal spine on anterior margin of carapace.

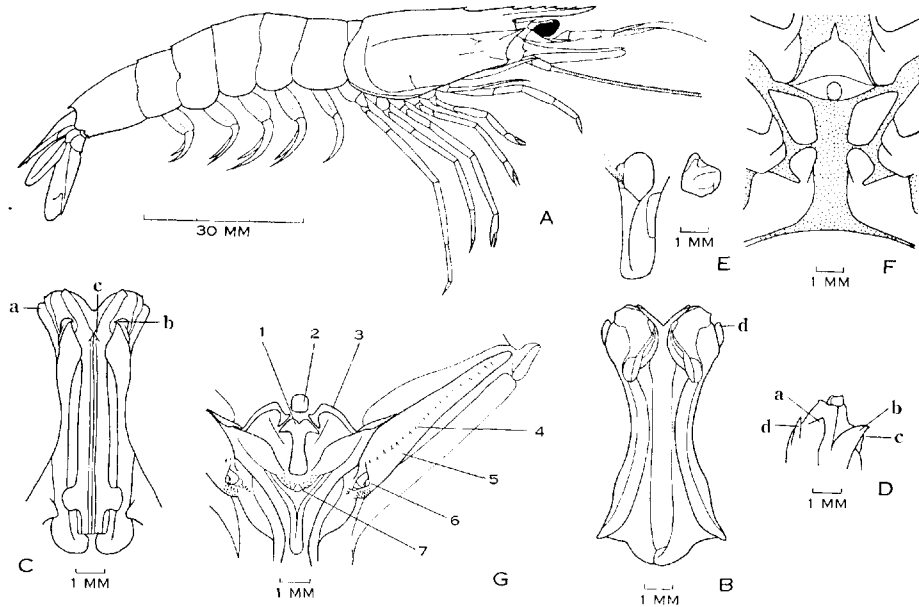


Fig. 15. *Parapenaeus australiensis*, sp. nov. *A*, allotype; *B*, ventral surface of petasma of holotype; *C*, dorsal surface of petasma; *D*, left lateral distal portion of petasma (*a-c*, spinous processes); *E*, appendix masculina and end view of distal piece; *F*, thelycum of allotype; *G*, inner aspect of gastric mill, cut ventromedially and spread to display the parts: 1, urocardiac ossicle; 2, cardiac ossicle; 3, pterocardiac ossicle; 4, teeth or spinules of cardiac plate; 5, cardiac plate; 6, zygocardiac ossicle; 7, prepyloric ossicle.

Eye.—Proximal segment of ophthalmopod with large acute dorsal scale overlying 2nd segment; longitudinal diameter of cornea equal to $\frac{1}{3}$ carapace.

Antennules.—Second segment of peduncle 0.7 length 1st, 3rd $\frac{1}{2}$ length 2nd. Upper flagellum $\frac{2}{3}$ length lower, which is 0.7 length peduncle. Prosartema reaching as far as eye, stylocerite attaining $\frac{2}{3}$ basal segment.

Antennae.—Basicerite with distolateral spine; scaphocerite slightly exceeding antennular peduncle ♀, reaching $\frac{1}{2}$ 3rd segment in ♂, spine reaching almost as far as lamella; carpocerite reaching below middle cornea.

Mandible.—Palp reaching as far as basicerite, distal segment twice width, with parallel sides, blunt apex, deep but small distolateral excavation; basal segment triangular, length $\frac{1}{2}$ distal segment. Incisor process with deep notch separating distal

and proximal tooth, molar process with large posterior flattened tooth, otherwise flat and of rectangular shape.

Maxillule.—Palp with 2 inner convex flattened setose processes of about equal size, one at $\frac{1}{2}$ segment, the other apical; a proximal rounded densely setose projection on outer side. Anterior face of palp with diagonal row of long setae commencing at outer base and running to apex.

Thoracic appendages.—Third maxilliped reaching $\frac{2}{3}$ 2nd segment of antennular peduncle; 1st pereopod reaching $\frac{1}{2}$ carpocerite; 2nd reaching tip of carpocerite; 3rd reaching 2nd segment of antennular peduncle; 4th and 5th reaching as far as 1st segment of peduncle.

Abdomen.—Third somite bluntly angular dorsally, sharp dorsal carina beginning at anterior 4th somite, ending on each of 4th, 5th, 6th somites in a horizontal tooth, that of 5th larger than 4th, that of 6th larger than 5th. Spines of telson with bases at $\frac{1}{3}$ length telson. Median sulcus of telson shallow posteriorly, fading out at level of subapical spines. Basis and exopod uropods each with minute distolateral spine.

Gastric mill (Fig. 15G).—Cardiac plate with 20–25 spinules. Zygocardiac ossicle a large complex principal tubercle, an irregular row of 3–5 long teeth, and on lower edge of cardiac plate a series of irregular rows of minute teeth; principal tubercle cup-shaped, formed by incomplete fusion of 4 teeth. Cardiac ossicle ovoid; urocardiac with 2 lateral, slightly recurved, wing-like processes; pterocardiac strongly arched. Prepyloric ossicle with rounded rim, median tooth, 4–6 long rounded lateral teeth projecting at right angles to flat surface of ossicle.

Petasma (Fig. 15B, C).—Apical lobes rosebud-like. Lateral processes dividing near base of petasma, dorsal process ending in a slightly recurved distal spine (*b*); ventral process divides into mediodistal spinous process (*a*), and ventral spinous process (*d*). Median lobe with 2 blunt distal tubercles (*c*), and 2 expanded wing-like processes towards proximal end. Apex petasma reaching coxae of 4th pereopods, maximum width $\frac{1}{2}$ total length.

Appendix masculina (Fig. 15E).—Distal piece rounded, $\frac{1}{2}$ length basal piece and with median groove bearing a small tuft of setae. Posterodistal surface convoluted.

Thelycum (Fig. 15F).—Anterior plate pear-shaped, anterior end sharp, posterior with small depression. Intermediate plate with 2 raised processes on either side of wide median groove; posterior sternal plate continuous with this groove, and with 2 ovoid anterior processes on either side of groove.

Discussion

P. australiensis belongs to the closely related group of *Parapenaeus* spp. with a branchiostegal spine on the anterior border of the carapace. *P. fissurus* (Bate) and *P. sextuberculatus* Kubo both possess a bifurcate median lateral process of the petasma, and the anterior plate of the thelycum is not sharp anteriorly. *P. lanceolatus* Kubo, of which the female is unknown, is the most closely similar to the present sp. As Kubo's description is sketchy and relies mainly on petasmas features, the key characters are the best available for separation of the 2 species. In addition *P. australiensis* is almost twice the length of *P. lanceolatus* at maturity.

Genus *METAPENAEUS* Wood-Mason & Alcock

Metapenaeus Wood-Mason and Alcock, 1891, p. 271. Burkenroad, 1934*b*, pp. 4, 29. Kubo, 1949, pp. 327-8. Barnard, 1950, pp. 596-7.

Metapeneus Alcock, 1906 (part), p. 16.

Penaeopsis de Man, 1911 (part), pp. 53-5, 61. Schmitt, 1926 (part), pp. 319-23.

Rostrum dorsally toothed only. Carapace without longitudinal or transverse sutures, orbital angle usually sharp. Postocular sulcus present, cervical sulcus well defined. Hepatic sulcus not well defined or absent behind level of hepatic spine, but pronounced in front with a well-defined postero-inferior border, usually descending vertically from hepatic spine, then turning towards the pterygostomial angle. Antennal and hepatic spines pronounced. Pterygostomial angle blunt. Telson with deep dorsomedian sulcus, without fixed subapical spines, and with movable dorso-lateral spines which may be microscopic and very numerous. First antennular segment without spine on ventral distomedian border. Antennular flagella shorter than carapace. Maxillary palp with 2 segments, distal small, basal with convex, foliaceous projections on inner and outer edges, and a long spine on inner edge. First to 3rd pereopods with basal spines, no exopod on 5th. Ischium and merus of 5th pereopod often modified in adult ♂. Petasma tubular with thickened median lobes; lateral lobes thicker than median, forming distolateral spout-like projections, each with a dorsal lobule produced posteriorly into an expanded, plate-like projection; median lobes with dorsal lobule produced into a thin recurved, plate-like, or hood-like structure. Appendix masculina with a knob-like distal piece which bears either a deep posterodistal depression or is sculptured in some way. Thelycum composed of anterior median plate and 2 posterior lateral plates more or less enclosing posterior end of median plate; posterior plates often continuous across sternite. Zygocardiac ossicle with 2 rows of teeth which get progressively smaller. Pleurobranchiae on 3rd to 7th thoracic somites, a rudimentary arthrobranch on 1st, anterior and posterior arthrobranchiae on 2nd to 6th, and an anterior vestigial and a posterior fully developed arthrobranch on 7th thoracic somites; mastigobranchiae on 1st, 2nd, 4th-6th thoracic somites. Body usually with at least a few dorsal setose depressed areas, remainder of body surface varying from being completely glabrous to covered with close irregular setose depressed areas.

Burkenroad (1934*a*) restricted the definition of the genus to separate the species enumerated below from those with a branchiostegal spine and fixed subapical spines on the telson, which he included in the genus *Penaeopsis* Bate. Hitherto, *Metapenaeus* and *Penaeopsis* had been regarded as synonymous (*Penaeopsis* has been further restricted by Kubo (1949); see *Metapenaeopsis*).

The following well-established species are included in the genus *Metapenaeus*: type species *M. affinis* (Milne Edwards); *M. monoceros* (Fabricius); *M. intermedius* (Kishinouye); *M. endeavouri* (Schmitt); *M. mastersii* (Haswell); *M. burkenroadi* Kubo; *M. eboracensis*, sp. nov.; *M. demani* (Roux); *M. dobsoni* (Miers); *M. joyneri* (Miers); *M. tenuipes* Kubo; *M. lysianassa* (de Man); *M. stebbingi* (Nobili); *M. brevicornis* (Milne Edwards); *M. spinulatus* Kubo; *M. macleayi* (Haswell).

Burkenroad (1934*a*) regards *Penaeopsis elegans* de Man, 1911, *Penaeus incisipes* Bate, 1888, *Metapenaeus deschampii* Nobili, 1903, *M. cognatus* Nobili, 1906, and

Penaeopsis spinulicauda Stebbing, 1914, as being immature specimens of *M. monoceros*, but for the present they are better regarded as doubtful species. It is likely that *Penaeus mutatus* Lanchester, 1901, is synonymous with *Metapenaeus affinis* as Burkenroad (1934a) suggests. *M. ensis* (de Haan) is a nomen nudum, the cephalothorax being that of *M. monoceros* and the abdomen that of a *Metapenaeopsis* sp. (L. B. Holthuis, personal communication).

Many members of this genus, especially the more pubescent species with minute spinules on the telson, are closely similar in general appearance and have been confused in the past. The following key to the genus as defined by Burkenroad (1934a) does not include the above doubtful species.

KEY TO THE SPECIES OF METAPENAEUS

1. Abdomen with a number of pubescent depressed areas2
Abdomen uniformly glabrous14
- 2(1). Ischial spine on 1st pereopod3
Ischial spine absent on 1st pereopod5
- 3(2). Ischial spine much smaller than basal spine; branchiocardiac carina present; 2nd and 3rd abdominal somites with dorsal carina
..... *M. monoceros* (Fabricius) (= *M. incisipes* (Bato))
Ischial spine subequal to basal spine; branchiocardiac carina absent or merely a flat glabrous strip marking its position; 2nd and 3rd abdominal somites without distinct dorsal carina4
- 4(3). Branchial region with small pubescent areas; thelycum with median boss close to posterior edge of last thoracic sternite *M. intermedius* (Kishinouye)
Branchial region with 2 large pubescent areas; no median boss on last thoracic sternite in ♀ *M. endeavouri* (Schmitt)
- 5(2). Rostrum exceeding distal end of basal segment of antennular peduncle6
Rostrum short, not reaching distal end of basal segment of antennular peduncle
..... *M. lysianassa* (de Man)
- 6(5). Carapocerite reaching below middle cornea; petasma with hood- or spout-like distomedian projections7
Carapocerite reaching at least as far as the eye; petasma with slender or with simple flap-like median projections8
- 7(6). Gastrofrontal sulcus well defined and glabrous; cardiac plate with 26–32 spinules; distomedian projections of petasma retort-shaped *M. mastersii* (Haswell)
Gastrofrontal sulcus not a well-defined glabrous region; cardiac plate with 32–35 spinules; distomedian projections of petasma hood-like *M. burkenroadi* Kubo
- 8(6). Distomedian projections of petasma simple, flap-like9
Distomedian projections of petasma slender12
- 9(8). Basal spine of 3rd pereopods in adult ♂ long, barbed; 2 tubercles on merus of ♂ 5th pereopod *M. dobsoni* (Miers)
Basal spine of 3rd pereopods in adult ♂ simple; 1 tubercle on merus of ♂ 5th pereopod10
- 10(9). Thelycum with flat leaf-like anterior plate11
Thelycum with tongue-like anterior plate, grooved longitudinally and with 2 rounded anterior projections *M. affinis* (Milne Edwards)
- 11(10). Anterior plate of thelycum with blunt point directed forwards; posterior plate flat except for median fissure *M. eboracensis*, sp. nov.
Anterior plate of thelycum broad and with smoothly rounded anterior margin; posterior plate forming a cup-shaped depression *M. demani* (Roux)

- 12(8). Postrostral carina absent or very feeble; distomedian projections of petasma straight, each with serrate border *M. stebbingi* (Nobili)
 Postrostral carina well defined; distomedian projections of petasma recurved posteriorly, borders not serrate 13
- 13(12). Postrostral carina reaching $\frac{5}{8}$ carapace; 1st-6th abdominal somites dorsally carinated *M. joyneri* (Miers)
 Postrostral carina reaching middle of carapace; 1st-3rd abdominal somites without dorsal carina *M. tenuipes* Kubo
- 14(1). Telson with large mobile lateral spinules; median plate of thelycum smaller than posterior plates 15
 Telson not conspicuously armed; median plate of thelycum larger than posterior plates *M. brevicornis* (Milne Edwards)
- 15(14). Telson with 2 pairs lateral spines; posterior plate of thelycum not enclosing prominent rounded tubercles *M. spinulatus* Kubo
 Telson with 4 pairs lateral spines; posterior plate of thelycum enclosing 2 prominent rounded tubercles *M. macleayi* (Haswell)

METAPENAEUS MONOCEROS (Fabricius)

Fig. 16A-H

Penaeus monoceros Fabricius, 1798, p. 409.

Metapencus monoceros Alecock, 1906, pp. 18-20.

Metapenaeus monoceros Burkenroad, 1934a, pp. 32-3. Kubo, 1949, pp. 329-33. Barnard, 1950, pp. 597-9.

Penaeopsis monoceros de Man, 1914, pp. 55-7. Schmitt, 1926, pp. 325-9 (not incl. "*Penaeus mastersii*").

Penaeus incisipes Bate, 1888, pp. 257-8, pl. 34, figs. 2, 2" (not including female). Kishinouye, 1900, pp. 18-19.

Metapenaeus incisipes Racek, 1955, pp. 230-2.

Material.—QUEENSLAND: F.I.S. *Endeavour* specimens (Aust. Mus. coll.); Moreton Bay, Townsville, 12 specimens, 68-149 mm. NEW SOUTH WALES: Broadwater (coll. A. A. Racek), ♂ 139 mm. WESTERN AUSTRALIA: Exmouth Gulf, ♂ 105 mm; Australian Museum collection.

Description

Rostrum.—Teeth 8-10 + epigastric; varying in shape, sometimes slightly depressed apically but usually projecting upwards slightly with ventral upward curve reaching to or almost to tip of antennular peduncle. Adrostral carina ending between epigastric and 1st tooth, sulcus extending behind epigastric, reaching $\frac{1}{3}$ - $\frac{1}{2}$ carapace. Postrostral carina distinct, continuing to posterior border of carapace.

Carapace.—Postocular sulcus at angle of about 40° to rostrum. Orbito-antennal sulcus wide, shallow, meeting hepatic below hepatic spine. Hepatic sulcus descending vertically for upper $\frac{1}{3}$, then curving towards pterygostomial angle. Cervical sulcus straight, ending at 0.3-0.4 length carapace. Epigastric spine at $\frac{1}{4}$ carapace. Branchiocardiac sulcus indistinct, carina distinct and meeting glabrous posterior extension of hepatic spine.

Antennules.—Flagella subequal $\frac{1}{2}$ length peduncle. Prosartema exceeding eye, but not reaching tip of basal segment, stylocerite attaining $\frac{1}{2}$ basal segment.

Thoracic appendages.—Third maxilliped and 1st pereopod reaching $\frac{3}{4}$ carpo-cerite; 2nd pereopod reaching tip of 1st segment, 3rd reaching to or beyond tip of

2nd segment of antennular peduncle; 4th reaching tip of carpopodite; 5th reaching at least middle 2nd segment of antennular peduncle in ♂, and reaching its base in ♀. A small blunt ischial spine on 1st pereopod. A large triangular distoventral keel on ischium of 5th pereopod in mature ♂, followed by a deep notch on merus, bounded by a prominent spinous process twisted ventrally at angle 90° to axis of merus, usually followed by a ventral row of conical tubercles, which end in a small keel at distal $\frac{1}{4}$ merus; tubercles sometimes reduced or absent.

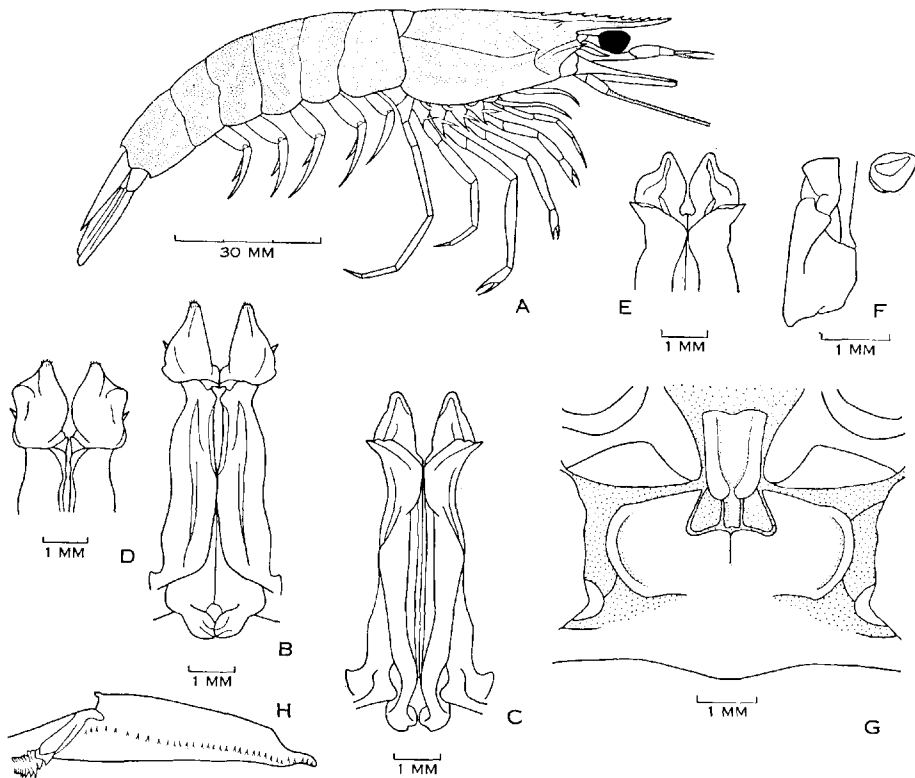


Fig. 16.—*Metapenaeus monoceros* (Fabricius). A, 138 mm ♀; B, ventral surface of petasma, 138 mm ♂; C, dorsal surface of petasma; D, E, distal ventral and dorsal surfaces respectively of petasma, 130 mm ♂; F, appendix masculina and end view of distal piece, 138 mm ♂; G, thelycum, 138 mm ♀; H, cardiac plate and zygocardiac ossicle.

Abdomen.—Traces of dorsal carina usually present on 1st somite, becoming progressively more prominent to 6th. Telson with 3 or 4 rows minute dorsolateral spinules on distal $\frac{1}{2}$. Exopod uropod with outer proximal depression in ♂.

Gastric mill (Fig. 16H).—Cardiac plate with 28–36 spinules. Zygocardiac ossicle with upper row of 8–9 short tubercles of which 1st 3 are usually blunt, remainder more spinous, and a lower row of 9–12 longer tubercles, 1st 2 relatively blunt, remainder spinous. Prepyloric ossicle with rounded median tubercle with 4–5 blunt lateral tubercles and 1 or 2 small spines, usually at an angle to tubercles.

Petasma (Fig. 16B-E).—Apex of petasma barely reaching bases of 2nd pereopods. Distomedian projections $\frac{1}{4}$ total length petasma, overlying distolateral projections, with openings facing dorsolaterally; openings closed by convex flap on distoventral edge of opening; this flap sometimes flat and projecting laterally, when distomedian projections appear quadrangular, sometimes reflected back, when projections appear triangular. Apices of projections with 1 or 2 rows minute setae. Distolateral projections spout-like with large distal openings; distance between projections $\frac{1}{3}$ total length petasma.

Appendix masculina (Fig. 16F).—Distal piece with flattened apex 0.7–0.8 length basal piece, posterior depression a very elongate pear shape with narrow part at obtuse angle to broad part.

Thelycum (Fig. 16G).—Anterior plate level with and bounded on either side by expanded coxal projections of 4th pereopods; with median groove deepening posteriorly, between 2 projecting carinae (rounded when viewed laterally). Posterior plates strongly concave, middle part much above ventral surface of anterior plate, lateral edge level with it; anterior part with angular projections facing inwards under anterior plate, enclosing 2 flat plates lying on either side of posterior tongue-like extension of anterior plate; the whole having a cup-shaped appearance, but open posteriorly.

Colour in life.—Body irregularly pubescent. Light tan or pink to brown; pleopods, uropods, and antennae red; peduncles of pleopods and tips of uropods purple; ischia and mera of pereopods striped orange and cream. Pale, more or less semitransparent with bluish speckling, chiefly in the form of crossbands on abdominal segments, flagellum of antennae reddish, pleopods bluish (Barnard 1950).

Distribution

Ranging from northern New South Wales (Racek 1955) to Exmouth Gulf, W.A.; through Indonesia and Philippine Is. to southern Japan (Kubo 1949); through Indian seas to Red Sea and Mediterranean (by migration through Suez Canal); Mauritius and south-eastern South Africa. Mature adults are usually taken in water of at least 10 fm depth, often much deeper (cf. *M. mastersii*).

Discussion

There are a number of minor discrepancies in descriptions of specimens of this species from various localities, especially those of the median projections of the petasma. This apparently very widely ranging species may be a complex of closely related species differing only in minute characters, but at present there is not sufficient evidence to support this. All descriptions of carapaces and thelyca seem to be in agreement. The median projections of the petasma vary even in specimens collected from the same locality. Of the *Endeavour* specimens E.6612, 130 mm ♂, has a petasma with subrectangular apical projections, which lie close together (Fig. 16D, E); E.6614 (122 mm), E.6616 (123 mm), have similar apices but with a wider space between them; E.6614, 124 and 130 mm, have the distolateral flaps reflected back, giving the apices a triangular appearance. The petasmas figured by de Man (1911), and by Kubo (1949), could well be those of the Australian species. As apices of the petasmas of this species vary considerably, use of details of this structure

alone for specific identification is undesirable. The few colour descriptions in the literature are also at variance. The coloured plate of Kishinouye (1900) agrees with the above and Racek's (1955) description. Except for antennal flagellae and pleopods, Barnard's (1950) description is quite different from these. It is possible that the species is subject to more than the usual colour variations.

Racek (1955) has identified his specimens, together with those of Kishinouye (1900), as *M. incisipes* (Bate), mainly on the basis of colour and apical projections of the petasma. Mr. J. C. Yaldwyn (personal communication) compared Bate's type specimen in the British Museum with Racek's photographs, and could find no major differences. The identity of the Australian specimens and Bate's "*Penaeus incisipes*" is established, and it remains to decide whether they are identical with *M. monoceros* (Fabricius). Reasons for separation seem insufficient at present, and until further work has been done, it is best to regard the Australian specimens as *M. monoceros*.

The following features, apart from the distinctive petasmas and thelyca, are useful for distinguishing *M. monoceros* from *M. mastersii* (see discussion under the latter species):

Feature	<i>M. monoceros</i>	<i>M. mastersii</i>
Gastrofrontal sulcus	Absent	Present
Adrostral sulcus	Reaching $\frac{1}{3}$ to $\frac{1}{2}$ carapace	Barely extending behind epigastric tooth
Branchiocardiac carina	Present, extending almost to hepatic spine	Absent
Postrostral carina	Reaching posterior margin of carapace, always distinct	Ending before posterior margin of carapace, always low, and often indistinct
Ischial spine on 1st pereopod	Small blunt spine present	Spine absent, but a blunt angle persists

METAPENAEUS ENDEAVOURI (Schmitt)

Fig. 17A-F

Penaeopsis endeavouri Schmitt, 1926, pp. 329-33, pl. LIX, figs. 1-3, pl. LXVIII, fig. 4.

Metapenaeus endeavouri Kubo, 1949, pp. 339-40. Racek, 1955, pp. 229-30.

Material.—Moreton Bay, Qld., to Shark Bay, W.A., 13 specimens, 111-143 mm; numerous specimens trawled from Exmouth Gulf; Australian Museum collection.

Description

Rostrum.—9-10 teeth + epigastric; of obtuse triangular shape, free portion inclined upwards from carapace, length 4 times depth; reaching from proximal to distal end of 3rd segment of antennular peduncle. Adrostral carina ending behind 2nd tooth, sulcus ending behind epigastric. Postrostral carina distinct, ending in

a glabrous expansion $\frac{1}{5}$ length carapace from its posterior edge, 3rd spine at margin of carapace.

Carapace.—Postocular sulcus at angle of 45° to rostrum, $\frac{1}{7}$ length carapace. Orbito-antennal sulcus narrow, well defined, meeting hepatic below hepatic spine. Antennal carina distinct for $\frac{3}{4}$ distance between antennal and hepatic spines. Hepatic sulcus descending vertically for $\frac{1}{2}$ its length, then curving towards pterygostomial angle, extremity almost horizontal. Cervical sulcus straight, ending at 0.45 length carapace. A feeble accessory cervical sulcus running from below level of hepatic spine, more or less parallel to cervical sulcus but with a break in its lower $\frac{1}{3}$ and reaching further dorsally than cervical sulcus. Branchiocardiac sulcus present, bounded on either side by a glabrous strip, an appreciable carina absent. Sulcus reaching almost $\frac{1}{2}$ carapace.

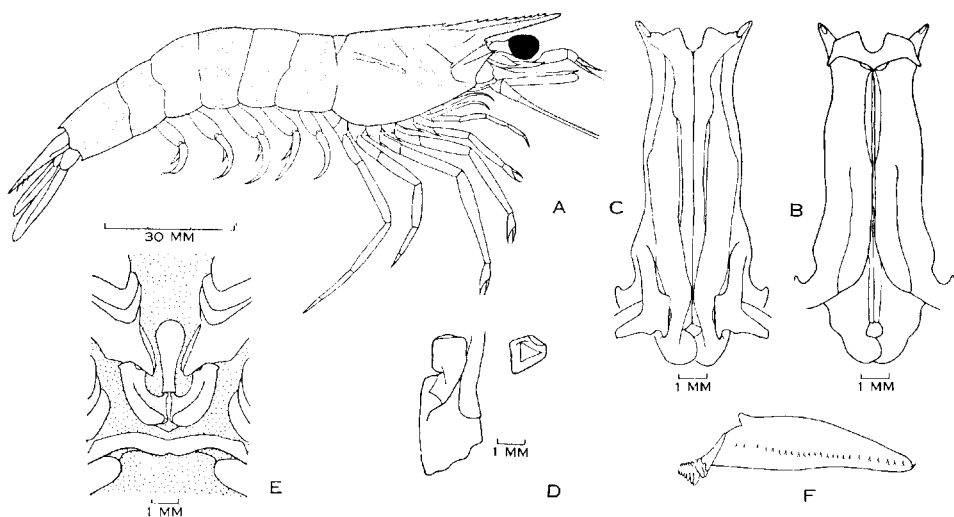


Fig. 17. *Metapenaeus endearouri* (Schmitt). A, 136 mm ♀; B, ventral surface of petasma, 121 mm ♂; C, dorsal surface of petasma; D, appendix masculina and end view of distal piece; E, thelycum, 134 mm ♀; F, cardiac plate and zygocardiac ossicle.

Antennules.—Flagella subequal, $\frac{1}{2}$ length peduncle in ♂, $\frac{2}{3}$ in ♀. Prosartema reaching as far as eye, stylocerite attaining $\frac{1}{2}$ basal segment antennular peduncle.

Thoracic appendages.—Third maxilliped and 1st pereopod reaching as far as or slightly exceeding carpocerite; 2nd pereopod reaching from base to $\frac{1}{2}$ 2nd segment of antennular peduncle; 3rd reaching tip of antennular peduncle or exceeding it by dactyl; 4th ranging from base to tip of carpocerite; 5th ranging from base to tip of 2nd segment of antennular peduncle. A large ischial spine on 1st pereopod. Ischium of 5th pereopod in adult ♂ with low ventral keel, merus with proximal notch followed by keel-shaped tubercle.

Abdomen.—First to 3rd abdominal somites with median dorsal glabrous strips, carina discernible from posterior $\frac{1}{2}$ of 4th somite. Telson with 3 pairs large movable spines, becoming progressively larger distally.

Gastric mill (Fig. 17F).—Cardiac plate with 24–30 spinules. Zygocardiac ossicle with upper row 9–11 short tubercles, and lower row 2 large rounded tubercles, at an angle and well separated from remaining 7–10 long tubercles; in advance of latter on edge of cardiac plate 2–3 small spines; prepyloric ossicle with 8–9 lateral tubercles + median rounded tubercle.

Petasma (Fig. 17B, C).—Apex reaching $\frac{1}{2}$ bases 3rd pereopods. Median projections triangular flaps closing distal end of petasma, apices of flaps almost level with distolateral projections; lateral corners flaps with tongue-like projections slightly exceeding lateral margins of petasma. Lateral lobes with pointed distolateral projections, distance between their tips $\frac{3}{8}$ length petasma.

Appendix masculina (Fig. 17D).—Distal piece 0.7 length basal piece, and with small triangular posterior depression.

Thelycum (Fig. 17E).—Anterior plate rounded anteriorly, concave, tapering posteriorly; ventral surface above coxal expansions of 4th pereopods; coxal expansions tapering posteromedially to blunt points. Seminal receptacle with deep median fissure separating 2 posterior blunt keel-like tubercles on posterior edge; anterior part on either side produced into blunt process overlying coxal projections of 4th pereopods, and enclosing 2 oval plates. Sternal plate of 5th pereopods rounded transversely, ventral edge lower than that of seminal receptacle.

Colour in life.—Body generally light brown, sometimes reddish; antennae and borders of antennal scale bright red; ophthalmopods yellowish green, corneas speckled black; rostrum, postrostrum, and abdominal carina dark brown; uropods and telson light brown proximally, changing to yellow-green and becoming brilliant blue distally; fringing setae reddish brown; pereopods yellow proximally, white distally, sometimes pink; pleopods with white areas on peduncles, rami yellow.

Distribution

Moreton Bay, Qld., to Shark Bay, W.A.

Discussion

Schmitt (1926) gives a detailed account of the differences between the present species and *M. intermedius* (Kishinouye). The following features are useful for differentiation of *M. endeavouri* from *M. intermedius*:

Feature	<i>M. endeavouri</i>	<i>M. intermedius</i>
Distomedian projections of petasma	Not reaching as far as distolateral horns	Reaching as far as distolateral horns
Appendix masculina	Triangular	Elongate pear shape
Thelycum	No median boss on posterior sternite	Median boss present on posterior sternite
Cardiac plate	24–30 spinules	40–43 spinules

METAPENAEUS MASTERSII (Haswell)

Greentail, River, or Greasy-back Prawn, eastern Australia; School Prawn,
Western Australia

Fig. 18.4-G

Penaeus mastersii Haswell, 1879, p. 42; 1882, p. 203.

Penaeus sp. Whitelegge, 1890, p. 225. Whitelegge, in Ogilby, 1893, p. 203.

Penaeopsis monoceros Schmitt, 1926, pp. 325-9, pl. LVIII, figs. 1, 2 ("Penaeus mastersii" only; not incl. *Endeavour* material).

Penaeopsis affinis de Man, 1911, pp. 57-8.

Metapenaeus, sp. nov.; Morris and Bennett, 1952, pp. 164-82 (life-history and larval development).

Metapenaeus mastersii Racols, 1955, pp. 232-5.

Material.—QUEENSLAND: Moreton Bay. Brisbane River, numerous specimens, 6-104 mm. NEW SOUTH WALES: Tuggerah Lakes, 27 specimens. WESTERN AUSTRALIA: Swan River to Exmouth Gulf, 28 specimens. Australian Museum collection.

Description

Rostrum.—Teeth 7-8 + epigastric; slender with slight upward curve, usually reaching tip of 2nd segment of antennular peduncle in ♂, reaching to or beyond tip of peduncle ♀, tip sometimes slightly malformed. Adrostral carina ending between epigastric and 1st tooth, sulcus continuing to just beyond epigastric. Postrostral carina variable, distinct but not prominent, glabrous to $\frac{1}{2}$ distance between epigastric tooth and edge of carapace, where it widens and becomes confluent with other irregular glabrous regions of carapace; posterior $\frac{1}{2}$ sometimes continuing as a relatively narrow glabrous strip to $\frac{1}{10}$ length carapace from its posterior edge, where it again becomes confluent laterally with other glabrous areas; sometimes widening and losing its identity as it approaches posterior edge of carapace (Swan River specimens).

Carapace.—Gastrofrontal sulcus present, very wide and shallow without a carina, continuous posteriorly with postocular sulcus, which runs at angle of 45° to rostrum. Orbito-antennal sulcus narrow posteriorly and ending in front of hepatic spine. Cervical sulcus straight and ending at $\frac{1}{2}$ carapace. Epigastric spine at $\frac{1}{4}$ length carapace. Hepatic sulcus descending vertically for $\frac{1}{3}$ length, remainder inclined at an angle towards pterygostomial angle. Branchiocardiac sulcus feeble, anterior end not exceeding the posterior $\frac{1}{3}$ carapace, carina absent.

Antennules.—Flagella equal in length and about $\frac{1}{2}$ length peduncle. Prosartema reaching almost as far as eye, stylocerite attaining $\frac{1}{2}$ basal segment.

Thoracic appendages.—Third maxilliped reaching tip of carapocerite; 1st pereopod reaching $\frac{1}{2}$ carapocerite; 2nd reaching as far as eye; 3rd almost reaching tip of 2nd segment of antennular peduncle; 4th reaching as far as 1st; 5th reaching from base to tip of dactyl of 3rd pereopod. A small blunt angle on ischium 1st pereopod. Merus of 5th pereopod ♂ with deep notch and blunt tubercle, slightly inclined upwards; a small ventral ischial keel.

Abdomen.—Dorsally carinated from anterior 4th somite, but in more pubescent specimens a narrow glabrous region on 2nd and 3rd somites. Telson fringed with numerous minute spines. Exopod ♂ uropod with an outer proximal depression.

Gastric mill (Fig. 18G).—Cardiac plate, with 26–32, usually 28 spinules. Zygocardiac ossicle with upper row of 7–8 short blunt spines, 1st 3 often flat-topped tubercles, and lower row of 10–12 longer spines, 1st 2 blunter than remainder; 2 small spines on edge of cardiac plate. Prepyloric ossicle with rounded median tubercle and 5–7 blunt lateral tubercles, followed by 2–3 minute spines.

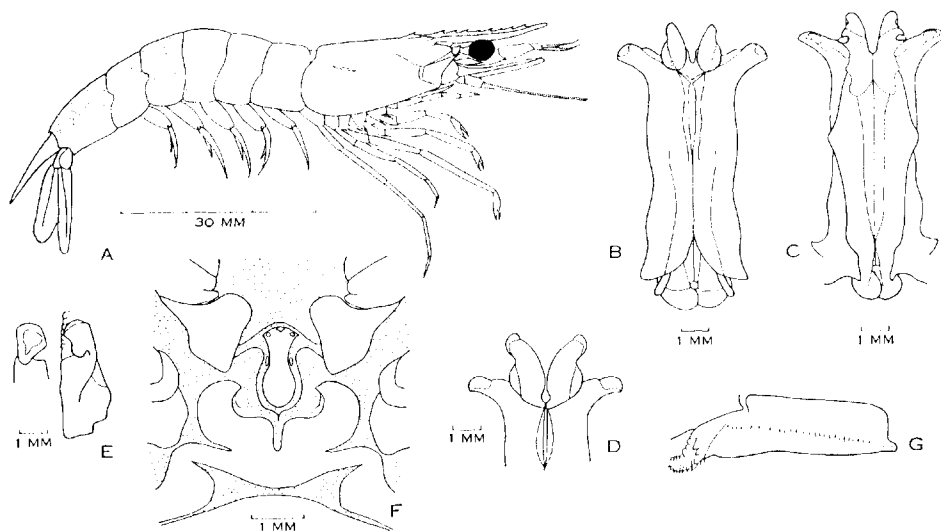


Fig. 18. *Metapenaeus macleayi* (Haswell). A, 92 mm σ ; B, ventral surface of petasma, 104 mm σ ; C, dorsal surface of same; D, distal ventral surface of petasma, 80 mm σ from Swan River; E, appendix masculina and end view of distal piece; F, thelycum, 92 mm σ ; G, cardiac plate and zygocardiac ossicle.

Petasma (Fig. 18B–D).—Reaching lower $\frac{1}{2}$ – $\frac{1}{3}$ basis of 3rd pereopod. Disto-median projections spout-like and tapering $\frac{1}{4}$ – $\frac{1}{5}$ total length petasma, inner edges convex and diverging, posteroventral edge with hemispherical minutely pitted projection, anterodorsal edge with an inwardly projecting convolution apparently dividing lateral aperture: position and extent of convolution varying, influencing extent to which anterodorsal edge projects beyond posteroventral edge. Distolateral projections spout-like with spatulate tips, distance between tips $\frac{1}{2}$ length petasma.

Appendix masculina (Fig. 18E).—Distal piece subspherical, almost equal length basal piece, and with posterior pear-shaped depression.

Thelycum (Fig. 18F).—Anterior plate with 5 tubercles, 2 anterolateral and conical on either side of an anteromedian triangular tubercle, and 2 blunt lateral tubercles which lie on either side of an elongate flask-shaped sulcus with “neck” anterior to “bulb”. Seminal receptacle slightly concave laterally, otherwise flat with median fissure, width slightly more than twice length. Lateral part hooked, tip of hook facing inwards. Coxa of 5th leg with small tuft of setae; coxa of 4th leg and hooks of seminal receptacle with dense tufts of setae overlying anterior plate.

Colour in life.—Body irregularly pubescent, the extent and number of these areas varying with age and locality: semitransparent, speckled with dark brown; tips of uropods, pleopods, and antennal scales green.

Distribution

Ranging from Port Hacking, N.S.W., northwards to Swan River, W.A., Djangkar (Java), Lombok, Bay of Bima, Saleyer anchorage (de Man 1911). Found principally in estuaries and very shallow coastal waters, commercially important in Australia. Spawning takes place in coastal lakes or coastal waters of about 3-5 fm (Morris and Bennett 1952; Dall, unpublished data).

Discussion

Metapenaeus mastersii has previously been confused with *M. monoceros*, although Whitelegge (1890) regarded it as being "probably an undescribed species", but made no mention of Haswell's material. Schmitt (1926) included both Haswell's cotype and McCulloch's Cooktown "*Penaeus mastersii*" with the *Endeavour* "*Penaeopsis monoceros*", and subsequently the estuarine *M. mastersii* was regarded as the deeper-water *M. monoceros*. Burkenroad in Morris and Bennett (1952) was the first to identify *M. mastersii* as a different species. The rostrum and postrostral carina of the cotype figured by Schmitt (1926) could be that of *M. monoceros* but the thelycum is like that of *M. mastersii*. At the time of writing (Dec. 1954) Haswell's cotype could not be located in the Macleay Museum, but was examined by Dr. A. A. Racek about 18 months previously, who states (personal communication) that the specimen was a dried one and immature, but that he did not think it was *M. monoceros*. McCulloch's specimens were identified from Haswell's cotypes and the Australian Museum contains other specimens of *M. mastersii* identified in the same way. While it is quite possible that McCulloch erred in his identification, it seems likely that Haswell's "*Penaeus mastersii*" is the estuarine *Metapenaeus* sp. (Unfortunately Haswell does not state method or depth of collection.) Rather than create a new name for this species, it is preferable to retain Haswell's name, unless well-preserved type material can be located in the Macleay Museum.

The present species is very closely akin to *M. burkenroadi* Kubo. The petasmas of the Western Australian specimens are similar to that figured by de Man (1911, Plate VI, Fig. 15*a, b*), and de Man's "*Penaeopsis affinis*" is undoubtedly *M. mastersii*.

The following are the differences between *M. mastersii* (eastern Australia) and *M. burkenroadi* (part latter after Kubo 1949, 1954):

Feature	<i>M. mastersii</i>	<i>M. burkenroadi</i>
Rostrum ♂	Shorter than antennular peduncle	Longer than antennular peduncle
Abdominal carina on 4th somite	Beginning from anterior	Beginning from middle
Cardiac plate	26-32 spinules	32-35 spinules
Zygocardiac ossicle	7-8/10-12 teeth	10-14 teeth
Median projections of petasma	Retort-shaped, tapering to a more or less blunt point	As wide apically as at base

Feature	<i>M. mastersii</i>	<i>M. burkenroadi</i>
Posterior thelycum	Lateral edges rounded	Lateral edges almost rectangular

Subspecies of M. mastersii.—There are a number of small but constant differences between specimens from Western Australia (Peel Inlet to Exmouth Gulf) and those from Queensland:

Queensland Specimens	Western Australian Specimens
Posterior $\frac{1}{2}$ of postrostral carina a narrow strip almost to margin of carapace	Carina becoming a wide glabrous strip towards its posterior end
Apical portions of distomedian projections of petasma small (Fig. 18B)	Apical portions of distolateral projections of petasma large (Fig. 18D)
Anterolateral tubercles of anterior plate of thelycum not much more prominent than the anteromedian tubercle	Anterolateral tubercles of anterior plate of thelycum much more prominent than the barely perceptible anteromedian tubercle
Average length at sexual maturity, ♂ 75 mm, ♀ 95 mm	♂ 65 mm, ♀ 78 mm (Peel Inlet specimens)

This raises the question whether these are valid subspecies. *M. mastersii* appears to become less common in northern Queensland, and there may be a break in its distribution somewhere in northern Australia. The petasma at least appears constant from Indonesia to Perth. Lack of material from northern Australia makes it impossible to decide whether there is a gradual transition here from one set of characters to the other. It may be that this species, being largely estuarine, tends to produce localized races to a greater extent than those spawning in deeper waters, where planktonic larvae would be distributed more widely. The Western Australian specimens are in some respects intermediate between the eastern Australian *M. mastersii* and *M. burkenroadi* Kubo, and future work may show that the 2 species should be united.

METAPENAEUS EBORACENSIS, sp. nov.

Fig. 19A-G

Material.—QUEENSLAND: Mouth Norman River, Gulf of Carpentaria, 1-2 fm, mud, Aug. 1953, coll. T. C. Marshall; holotype ♂, 64 mm, carapace 13.5 mm; allotype ♀, 90 mm, carapace 20.5 mm; paratypes 3 ♂, 45, 46, 48 mm, 5 ♀, 45, 50, 86, 89, 98 mm; Townsville, 20 fm, coll. R. K. Bryson, Aug. 1953, 3 ♂, 52, 62, 62 mm, ♀, 67 mm; Townsville, main beach, 25.vii.1945, 2 ♀, Aust. Mus. regd. No. P11662 (101 mm), P11663 (81 mm); Cairns, mud flats, Aust. Mus. regd. No. P4293, ♀, 43 mm.

Diagnosis

Body with pubescent patches small and widely separated. Rostrum with 6-7 teeth + epigastric, sigmoidal, the distal $\frac{1}{3}$ naked. Adrostral sulcus ending below epigastric tooth. Branchiocardiac carina present reaching $\frac{1}{2}$ carapace. Cardiac plate with 19-20 spinules. Petasma with simple flap-like median projections, appendix masculina with square depression on ventral surface of distal piece. Thelycum with small leaf-shaped anterior plate, posterior plate convex except for median cleft.

Description

Rostrum.—Teeth 6-7 + epigastric; sigmoidal, proximal $\frac{2}{3}$ free portion armed and curving downwards, distal $\frac{1}{3}$ naked and curving upwards; reaching to or slightly exceeding tip of antennular peduncle. Adrostral carina ending between 1st and 2nd teeth, sulcus shallow, feebly defined, and ending below epigastric. Postrostral carina broad and low, posterior $\frac{1}{3}$ indistinct, ending in a glabrous expansion $\frac{1}{10}$ length carapace from its posterior edge. Epigastric and 2nd tooth on carapace, former at $\frac{1}{3}$ carapace.

Carapace.—Gastrofrontal sulcus present, very wide and shallow, bounded posteriorly by postocular sulcus, which lies at angle of 40° to rostrum. Orbito-antennal sulcus shallow and ending in front of hepatic spine. Antennal carina ending $\frac{1}{3}$ distance between antennal and hepatic spine. Cervical sulcus straight, ending at not quite $\frac{1}{2}$ carapace. Hepatic sulcus descending vertically then curving towards pterygostomial angle. Branchiocardiac sulcus present, the anterior end at posterior $\frac{1}{3}$ carapace; carina becoming indistinct at $\frac{1}{2}$ carapace.

Antennules.—Flagella subequal and almost equal to length of peduncle in ♂, equal and $\frac{1}{3}$ - $\frac{1}{2}$ length of peduncle in ♀. Prosartema reaching most distal point of junction of ophthalmopod peduncle with cornea. Stylocerite not reaching $\frac{1}{2}$ basal segment.

Antennae.—Flagellum twice length body. Spine of scaphocerite reaching as far as tip of antennular peduncle, exceeded by tip lamellar portion; scaphocerite thrice as long as broad.

Mandible.—Distal segment of palp reaching tip of basicerite, twice as long as wide and twice length basal segment. Incisor process with shallow notch, molar process with smooth raised ventral and anterior edges.

Maxillule.—Basal segment of palp with long spine with base at $\frac{3}{4}$ segment, its tip reaching as far as segment; a row of about 10 long spines on distal $\frac{1}{2}$ posterior face towards the outer edge. Distal segment $\frac{1}{3}$ length basal segment.

Thoracic appendages.—Dactyl of 3rd maxilliped $\frac{3}{4}$ propodus and reaching $\frac{1}{2}$ carapocerite. First pereopod reaching from tip of basicerite to base of carapocerite; 2nd not quite reaching tip of carapocerite; 3rd reaching from $\frac{1}{2}$ to tip of 2nd antennular segment; 4th barely exceeding tip of basicerite; 5th slender and reaching to or almost to tip of antennular peduncle. Ischium of 1st pereopod angled but not spinous. Fifth pereopod ♂ with a very shallow depression and feeble tubercle.

Abdomen.—Dorsally carinated from the anterior of 4th somite. Telson with single row of minute spinules on either side.

Gastric mill (Fig. 19F, G).—Cardiac plate with 19–20 spinules. Zygocardiac ossicle with upper row of 9–10 tubercles, 1st 2 wide and blunt, and lower row of 8–9 tubercles of which 1st 2 are larger, blunter, and separated from the remainder, which are larger than corresponding tubercles in upper row. Prepyloric ossicle with median rounded tubercle projecting beyond the 9–11 lateral tubercles. Urocardiac ossicle broadly subpentagonal; cardiac ossicle heart-shaped; pterocardiac ossicles together making an angle of about 120° to urocardiac.

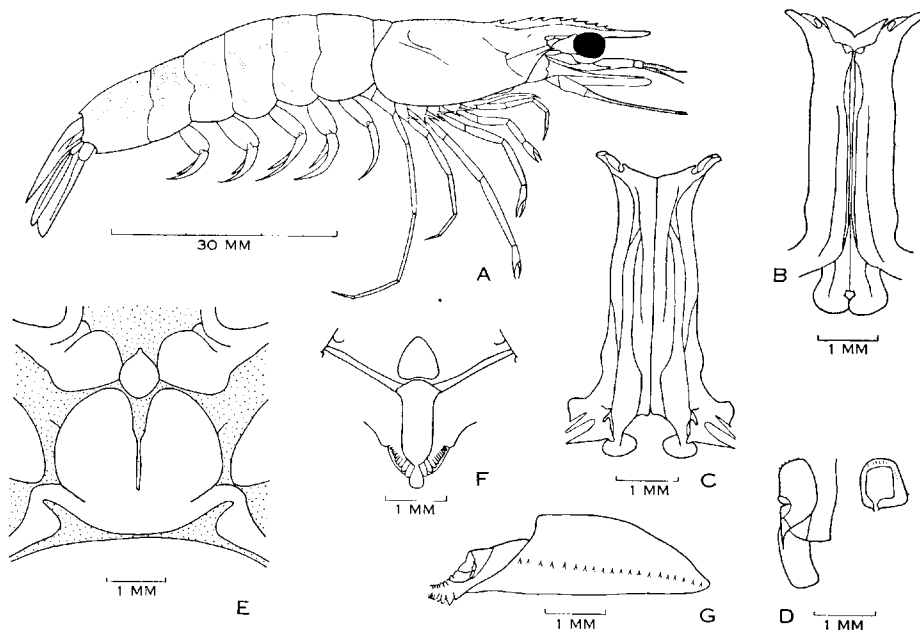


Fig. 19.—*Metapenaeus eboracensis*, sp. nov. *A*, allotype; *B*, ventral surface of petasma of holotype; *C*, dorsal surface of petasma; *D*, appendix masculina and end view of distal piece; *E*, thelycum of allotype; *F*, cardiac, urocardiac, pterocardiac, and prepyloric ossicles; *G*, cardiac plate and zygocardiac ossicle.

Petasma (Fig. 19B, C).—Median projections flaps closing distal opening of petasma. Distolateral projections slender, attaining $\frac{1}{2}$ coxae of 3rd pereopods, distance between tips equal $\frac{1}{3}$ total length petasma.

Appendix masculina (Fig. 19D).—Distal piece with ovoid dorsal surface; ventral surface with large, more or less square depression of which proximal side runs into a narrow channel; a few small apical setae.

Thelycum (Fig. 19E).—Anterior plate small, flat, leaf-shaped, as long as wide, bounded, and level with coxal projections from 4th pereopods. Posterior plates oval and level with anterior plate; with deep median cleft with rounded edges, otherwise convex. Length posterior plate thrice that of anterior plate. In allotype posterior plate is fused almost completely with sternal plate of 5th pereopods, but in 81- and 101-mm ♀♀ from Townsville, sternal plate is separated partially from posterior plate by narrow sulcus, latter plate then being completely divided by median cleft and about twice as wide as long.

Colour in life.—Semitransparent, speckled with brown, tips of uropods green. Body with relatively few pubescent patches.

Distribution

So far known only from the vicinity of Cape York, Qld. (hence the specific name), viz. Norman River (Gulf of Carpentaria), Townsville, Cairns.

Discussion

M. eboracensis is similar to *M. dobsoni* (Miers), the petasmas being alike. The thelyca are also similar but as figured by Alcock (1906), the anterior plate of *M. dobsoni* is larger and rounded anteriorly. Further, ♂ *M. eboracensis* has a simple spine on 3rd pereopod and a feeble meral tubercle on 5th, whereas *M. dobsoni* has a much enlarged barbed basal spine on 3rd pereopod and 2 tubercles on merus of 5th.

METAPENAEUS MACLEAYI (Haswell)

School Prawn, eastern Australia

Fig. 20A–F

Penacus macleayi Haswell, 1879, p. 40; 1882, p. 210.

Penaeopsis macleayi Schmitt, 1926, pp. 333–8.

Metapeneus macleayi Alcock, 1906, p. 17.

Metapenaeus macleayi Racek, 1955, pp. 228–9.

Penaeus haswelli Phillipps, 1925, p. 3.

Material.—QUEENSLAND: Off Point Lookout, Stradbroke I., 39 specimens, 96–162 mm. NEW SOUTH WALES: Lake Illawarra, 1953, 5 ♀, 118–134 mm. Material has also been examined from Eden Harbour, N.S.W., to Mary River, Qld., and from Australian Museum collection.

Description

Rostrum.—5 6 teeth + epigastric; epigastric absent in large ♂♂, its position indicated by a shallow depression, but present in many immature ♂♂. Tip of rostrum often damaged or malformed but when intact reaching $\frac{1}{2}$ 3rd segment of antennular peduncle in ♂, and as far as tip or exceeding it in ♀. Rostrum sigmoidal, almost $\frac{1}{2}$ free portion naked and usually strongly upcurved. Adrostral carina almost reaching 1st rostral tooth, sulcus shallow, not well defined, reaching beyond epigastric to $\frac{1}{3}$ carapace. Postrostral carina broad and ending at $\frac{2}{3}$ carapace.

Carapace.—Postocular sulcus at angle of 35° to rostrum. Orbito-antennal sulcus wide and deep and meeting hepatic below hepatic spine. Hepatic sulcus descending almost vertically with slight posterior curve for $\frac{2}{3}$ length then turning sharply forward towards pterygostomial angle, lower part but slightly curved; a small isolated horizontal posterior hepatic sulcus $\frac{1}{10}$ length carapace, its anterior end behind hepatic spine. Cervical sulcus deep, slightly curved, and reaching 0.45 length carapace. Branchiocardiac sulcus wide, feeble, $\frac{1}{4}$ length carapace, anterior end at $\frac{1}{3}$ carapace; branchiocardiac carina barely defined below sulcus.

Antennules.—Flagella equal, slightly longer than $\frac{1}{2}$ peduncle in ♂, slightly less than $\frac{1}{2}$ in ♀. Prosartema reaching as far as tip, stylocerite attaining $\frac{1}{2}$ 1st segment.

Thoracic appendages.—Third maxilliped reaching or slightly exceeding tip, 1st pereopod reaching base of carapocerite; 2nd pereopod exceeding carapocerite by $\frac{1}{2}$ dactyl; 3rd reaching as far as tip of 2nd segment of antennular peduncle; 4th reaching from base to tip of carapocerite; 5th reaching from base to tip of 2nd segment of antennular peduncle. Ischium of 5th pereopod in ♂ with keel almost as long as segment, merus with deep notch, followed by a bulbous tubercle slightly reflected outwards.

Abdomen.—Dorsal carina commencing middle 4th somite. Telson with 4 large lateral spines becoming progressively larger towards tip, base of last pair level with end of median sulcus.

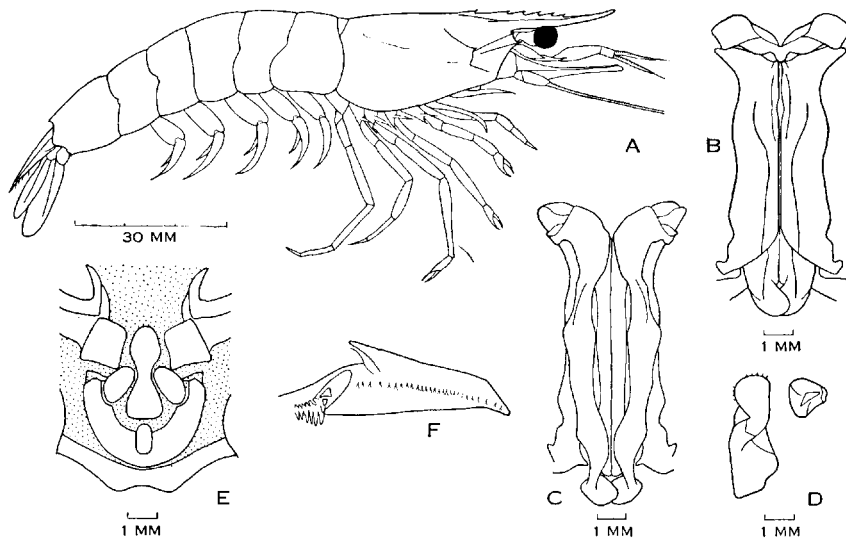


Fig. 20.—*Metapenaeus nucleayi* (Haswell). *A*, 129 mm ♀; *B*, ventral surface of petasma, 112 mm ♂; *C*, dorsal surface of petasma; *D*, appendix masculina and end view of distal piece; *E*, thelycum, 132 mm ♀; *F*, cardiac plate and zygocardiac ossicle.

Gastric mill (Fig. 20*F*).—Cardiac plate with 19–28 spinules. Zygocardiac ossicle with upper row of 5–7 short tubercles and lower row of 2 conical tubercles separated from remaining 6–8 long tubercles. Prepyloric ossicle with 7–10 lateral teeth, most lateral 2–4 minute and spinous.

Petasma (Fig. 20*B, C*).—Reaching from base to $\frac{1}{2}$ basis of 3rd pereopods. Mediodistal lobes an inverted cup shape, closing very wide openings of distolateral projections, from which they are separated by shallow indentations in edges of distal openings of petasma. Mediodistal projections extending laterally to exceed distolateral projections, distance between lateral extremities of latter $\frac{1}{2}$ total length petasma.

Appendix masculina (Fig. 20*D*).—Distal piece with rounded apex bearing a number of minute setae, and about equal to length basal piece. Ventral depression an elongate triangular shape.

Thelycum (Fig. 20E).—Anterior plate spatulate, the wide part lying anteriorly, concave, and above level of expansions of coxae of 4th pereopods which bound the narrower part. Coxal expansions produced into a ventral keel. Posterior plates with rounded median process not projecting beyond rest of plate; anterolaterally enclosing 2 prominent ovoid tubercles projecting below level of flat ventral surface of posterior plate. Posterior plate twice as wide as long. Transverse sternite of 5th pereopods with 2 tufts of long setae.

Appearance in life.—A small pubescent patch at top of cervical sulcus, another 2, very small, anterior to this, and a narrow strip of pubescence above the orbito-antennal sulcus, and on either side of the postrostral carina. Body otherwise glabrous. Body translucent, with olive-green chromatophores; tips of uropods blue. *Estuarine juveniles* (Brisbane River).—Translucent with brown chromatophores, other colours absent.

Distribution

Ranging from Eden Harbour, N.S.W., to Mary River, Qld. One of the common commercial prawns of New South Wales, but not very common in Queensland. Juveniles appear in the Brisbane River in January–March.

Discussion

Burkenroad (1934a) states that the description of *M. demani* Roux “seems very like” *M. macleayi*, the former not possessing large spines on telson. However, rostrum, thelycum, and petasma of the 2 species are distinctive, and there is little possibility of confusion. The only other well-established *Metapenaeus* spp. which are mainly glabrous are *M. brevicornis* (Milne Edwards) and *M. spinulatus* Kubo, but these closely related species have distinctive rostra, more or less straight with high blades, and simple hepatic sulci, only the lower portion being present. Thus *M. macleayi* seems to be a quite isolated species both morphologically and geographically.

Genus ATYOPENAEUS (Alcock) (emend.)

Atyopeneus Alcock, 1905, p. 524; 1906, p. 45.

Atyopenueus de Man, 1911, p. 83. Kubo, 1949, p. 365.

Rostrum dorsally toothed only. Pterygostomial angle blunt; orbito-antennal sulcus and antennal carina absent; no longitudinal sutures on carapace. Antennular flagella longer than carapace; no spine on distoventral border of 1st segment of peduncle. Maxillary palp with 2 segments. Exopods on all pereopods; propodus and dactyl of 5th very long and slender. Ischial spines on 1st and 2nd pereopods, basal spines on 2nd and 3rd. Petasma tubular, lateral lobes forming distolateral openings and with posterior projections. Thelycum with simple open seminal receptacle, anterior plate elongate, posterior plates bar-like. Pleurobranchiae on 2nd–6th thoracic somites; a rudimentary dendroid arthrobranch on 1st thoracic somite; 2nd–6th each with 2 and 7th with a posterior arthrobranch, anterior arthrobranch of this somite represented only by a bar; mastigobranchiae on 1st, 2nd, 4th–6th thoracic somites.

De Man (1911) does not mention presence of a rudimentary arthrobranch on 1st thoracic somite, but Kubo (1949) notes it as being very small in *A. compressipes*

(Henderson). It is also difficult to distinguish in *A. formosus* and it is probable that de Man overlooked it.

The genus comprises 3 species, viz. *A. compressipes* (type species), *A. dearmatus* de Man, and *A. formosus*, sp. nov. *Penaeus stenodactylus* Stimpson possibly belongs to this genus.

KEY TO THE SPECIES OF ATYOPENAEUS

1. Rostrum long, reaching tip of antennular peduncle; petasma with ovoid distolateral projections; thelycum with lanciform anterior plate *A. formosus*, sp. nov.
Rostrum short, not exceeding 1st segment of antennular peduncle; petasma with more or less acute distolateral projections; thelycum with tongue-like anterior plate 2
- 2(1). Hepatic spine absent; petasma constricted distally, distolateral projections directed laterally; anterior plate of thelycum pointed anteriorly *A. dearmatus* de Man
Hepatic spine present; petasma not constricted distally, distolateral projections directed anteriorly; anterior plate of thelycum rounded anteriorly ... *A. compressipes* (Henderson)

ATYOPENAEUS FORMOSUS, sp. nov.

Fig. 21A-H

Material.—QUEENSLAND: Moreton Bay, off Sandgate, 2-3 fm, sandy mud, 28.xii.1951: holotype ♂, 59 mm, carapace 13 mm; allotype ♀, 80 mm, carapace 20 mm; paratypes, ♂, 56 mm, 6 ♀, 63, 66, 68, 70, 71, 72 mm. Off Cape Moreton, 15.ix.1951, 2 ♂, 27, 55 mm, 3 ♀, 44, 66, 72 mm. 3 miles E. of Redcliffe, Moreton Bay, sandy mud, 3-5 fm, 20.ii.1952, 9 ♀, 66-91 mm; July 1953, 5 ♀, 74-83 mm. Mouth Norman R., Gulf of Carpentaria, 1-2 fm, mud, coll. T. C. Marshall, Aug. 1953, 3 ♀, 51-58 mm.

Diagnosis

Rostrum long, reaching to or beyond tip of antennular peduncle; adrostral and postrostral carinae indistinct. Postorbital sulcus deep, cervical sulcus feeble, short, hepatic sulcus absent. Fourth and 5th abdominal somites with large postero-dorsal spines. Petasma short, wide, with a pair of rounded distolateral projections. Thelycum with lanciform anterior plate, and parallel bar-like posterior plates.

Description

Rostrum.—Teeth 5-8, usually 6, + epigastric. Rostrum long, slender, and upcurved, slightly exceeding tip of antennular peduncle; excepting epigastric, teeth uniformly spaced along its length. A distinct adrostral carina not present, instead a blunt barely defined ridge ending at about 2nd tooth; sulcus absent. Postrostral carina indistinct and not reaching more than $\frac{1}{2}$ carapace, usually less.

Carapace.—Postocular sulcus very deep, indenting base of rostrum, below 2nd rostral tooth, and running at angle of 45° to rostrum; sigmoidal when viewed laterally; a small blunt orbital spine. Antennal and hepatic spines conical; cervical sulcus ill defined, often less than $\frac{1}{10}$ length carapace, its upper limit at 0.35-0.4 length carapace. A wide shallow indentation only in front of and below hepatic spine; no sulcus. Sometimes very feeble indications of a branchiocardiac sulcus.

Eye.—Peduncle slender, cornea (measured anteroposteriorly) about $\frac{1}{2}$ length carapace.

Antennules.—Flagella equal, about twice length antennular peduncle and $1\frac{1}{2}$ length carapace in ♂, nearly twice length antennular peduncle and $1\frac{1}{5}$ length carapace in ♀. Prosartema reaching tip of junction of optic peduncle with cornea. Stylocerite slender, diverging from and projecting above, tip attaining $\frac{2}{3}$ basal segment. Second segment cylindrical, equal length of 1st; 3rd segment $\frac{1}{3}$ length 2nd, often inclined upwards at right angles to it.

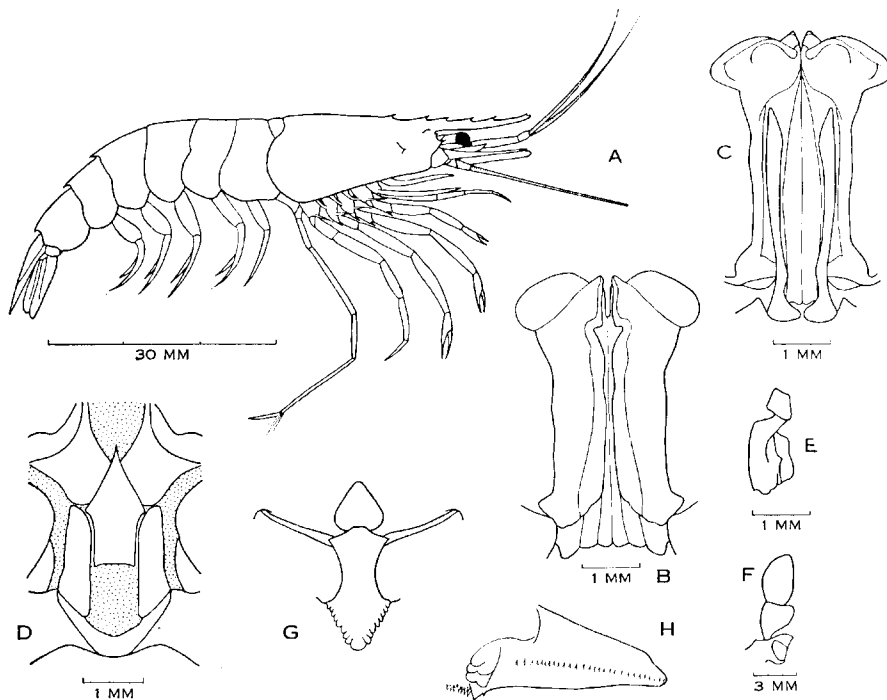


Fig. 21.—*Atyopenacus formosus*, sp. nov. A, allotype; B, ventral surface of petasma of holotype; C, dorsal surface of petasma; D, thelycum of allotype; E, appendix masculina; F, mandible and palp of allotype; G, cardiac, urocardiac, pterocardiac, and prepyloric ossicles of allotype; H, cardiac plate and zygocardiac ossicle of allotype.

Antennae.—Length carapocerite $2\frac{1}{2}$ times width, reaching as far as stylocerite. Length scaphocerite 4 times width, reaching $\frac{1}{2}$ 3rd segment of antennular peduncle.

Mandible (Fig. 21F).—Palp reaching tip of basicerite, outer edge of distal segment convex, $1\frac{1}{2}$ times length rounded basal segment. Cutting edge of incisor process straight except for a small tooth at anterior extremity; molar process flat except for a low posterior rim rising sharply medially with appearance of a low tubercle.

Maxillule.—Basal segment of palp with angular setose projection on inner basal $\frac{1}{3}$; a large spine on inner edge with base at $\frac{2}{3}$ segment, followed by a smaller spine; posterodistal surface towards outer edge with a spine, with smaller spine on either side. Distal segment narrow, $\frac{1}{4}$ length basal segment.

Thoracic appendages.—Third maxillipeds reaching $\frac{1}{2}$ 2nd segment of antennular peduncle; 1st pereopod exceeding carpocerite by dactyl; 2nd and 3rd reaching about $\frac{1}{2}$ 2nd segment of antennular peduncle, 4th slightly exceeding its base; 5th reaching as far as or slightly exceeding tip of antennular peduncle. Excepting 5th legs, thoracic appendages with long setae, particularly on ventral edges of 2nd–4th pereopods. Fifth pereopods very slender, particularly propodus and carpus, with small tuft of apical setae on propodus.

Abdomen.—Fourth to 6th abdominal somites with high carina, ending on each somite in an acute spine, that of 6th smaller than the others. Abdomen often characteristically flexed between 3rd and 4th somites. Telson unarmed, median sulcus very feeble, only a short proximal depression indicating its position. Telson almost 0.6 length carapace and slightly exceeding uropods. Pleopods long and slender, total length of the 2nd $\frac{4}{5}$ length carapace. Sixth abdominal somite rounded postero-inferiorly, with a very small blunt spine.

Gastric mill (Fig. 21G, H).—Cardiac plate with 24–30 spinules. Zygocardiac ossicle with 4 large tubercles (2nd and 3rd double) running across cardiac plate, followed at right angles by irregular row of about 20 tubercles which get progressively smaller. Cardiac ossicle cordiform; urocardiac with rounded apex, distolateral sides slightly concave and forming an obtuse angle; pterocardiac ossicles simple, bar-shaped, and making an obtuse angle with urocardiac. Prepyloric with a large median tooth and 7–8 lateral teeth.

Petasma (Fig. 21B, C).—Reaching $\frac{1}{2}$ bases of 4th pereopods with prominent ovoid distolateral projections overlying 2 posterodistal plates, together closing distolateral openings of petasma; 2 blunt distomedial projections. Distance between lateral extremities of distolateral projections $\frac{2}{3}$ total length petasma. Median lobes with posterior, blunt incurved projections.

Appendix masculina (Fig. 21E).—Distal piece irregularly cuboid and $\frac{1}{3}$ length basal piece.

Thelycum (Fig. 21D).—Anterior plate lanciform with oval median depression and spinous apex, coxal projections from 4th pereopods lying above it; posterior end rectangular, bearing a number of small setae. Two posterior plates a rounded bar shape, enclosing rectangular part of anterior plate; posteriorly these bars meet a pair of V-shaped processes from posterior sternal plate, making a pentagonal seminal receptacle. Coxae of 4th and 5th pereopods each with tuft of setae.

Appearance in life.—Body and appendages uniformly a striking reddish-pink. Surface of abdomen and carapace minutely and irregularly sculptured.

Distribution

So far known only from the type locality and Norman River, Gulf of Carpentaria. During 1951–1953 it was fairly common in Moreton Bay in catches of *Penaeus plebejus* and *Metapenaeus mastersii*. *Atyopenaeus compressipes* (Henderson) is also common but not abundant in southern Japan, though formerly considered rare (Kubo 1949).

Discussion

Rostrum, thelycum, and petasma of *A. formosus*, in addition to a number of minor features, set this species apart from the remaining members of the genus. All prawns of the genus are small (*A. formosus* apparently being the largest, the females showing gravid ovaries at 60–70 mm), and so far none have been found in the very abundant quantities characteristic of many other Penaeinae.

Genus TRACHYPENAEUS (Alcock) (emend.)

Trachypeneus Alcock, 1901, p. 15; 1906, p. 43. Burkenroad, 1934b, pp. 94–6.

Trachypenaeus de Man, 1911, pp. 87–8. Kubo, 1949, pp. 391–2.

Rostrum toothed dorsally only. Carapace with longitudinal sutures which may be very short and barely perceptible; transverse sutures indistinct or absent. Cervical, orbito-antennal, and hepatic sulci often ill defined or absent. Pterygostomial angle sharp or blunt, never spinous. Abdomen usually with pronounced dorsal carination posterior to 3rd somite. Telson with movable lateral spines. First antennular segment without a spine on ventral distomedian border. Antennular flagella much shorter than carapace. Maxillary palp unsegmented. Petaloid exopods on all pereopods, 1st and 2nd pereopods with basal spines. Median lobes of petasma thickened, apices slightly recurved ventrally; lateral lobes bearing large distolateral projections, wide and wing-like extending laterally, or more slender and directed forward. Distal piece of appendix masculina angular, with few to many small distal setae. Thelycum with a broad, thickened anterior plate, often with posterior median pocket-like seminal receptacle as wide as anterior plate. Zygocardiac ossicle with 3 large principal teeth and double row of smaller teeth which get progressively smaller. Pleurobranchiae on 3rd–6th thoracic somites, a rudimentary arthrobranch on 1st, anterior and posterior arthrobranchiae on 2nd–6th, and posterior arthrobranch only on 7th thoracic somites; mastigobranchiae on 1st, 2nd, 6th somites, sometimes also on 4th and 5th. Carapace densely pubescent.

Type species *T. anchoralis* (Bate).

The posterior arthrobranch on 7th thoracic somite is displaced forward in *T. fulvus* and sometimes is actually partially fused at the side with epimeral plate, although actual attachment is on arthroidal membrane, making the arthrobranch deceptively like a pleurobranch in appearance. In *T. curvirostris* (Stimpson) the arthrobranch is also displaced forward, but not quite as much as in *T. fulvus*. This displacement forward may be a feature common to Indo-Pacific *Trachypenaeus* spp.

The small number of closely similar species within the genus makes the division into 2 subgenera (Burkenroad 1934b) unnecessary, especially as the subgenera are established largely on the presence or absence of mastigobranchiae on the 1st and 2nd pereopods.

With the exception of *T. pescadorensis*, of which ♂ is unknown, species of this genus are well established. *T. pescadorensis* and *T. granulosus* both have a pair of shallow pockets on either side of the backward projections of the anterior plates of their thelyca, and the petasma of *T. granulosus* has forwardly directed distolateral projections. It is likely that ♂ *T. pescadorensis* will have a petasma similar to that of *T. granulosus*.

KEY TO THE SPECIES OF TRACHYPENAEUS

1. Epipods (mastigobranchiae) on 1st and 2nd pereopods2
Epipods absent from 1st and 2nd pereopods; (limited to Indo-Pacific)6
- 2(1). Ischium 1st leg with a small spine; no spine on basis 3rd maxilliped; carapace with longitudinal suture not reaching beyond hepatic spine3
Ischium of 1st leg unarmed; a spine on basis of 3rd maxilliped; carapace with longitudinal suture extending beyond the hepatic spine4
- 3(2). Rostrum not extending beyond the eye; telson with 4 pairs of lateral spines (limited to Pacific America)*T. brevisuturæ* Burkenroad
Rostrum exceeding the eye; telson with 3 or 4 pairs of lateral spines (species limited to Indo-Pacific)*T. curvirostris* (Stimpson)
- 4(2). Telson unarmed (limited to Pacific America)*T. byrdi* Burkenroad
Telson armed (limited to Atlantic and Pacific America)5
- 5(4). Exopod of 5th pereopod not reaching distal end of basis; telson tapering to point with slight indications of proximal shoulders; colour orange and red*T. similis* (Smith)
Exopod of 5th pereopod reaching to or beyond distal end of basis; telson with prominent subapical shoulders; colour lavender and chocolate*T. constrictus* (Stimpson)
- 6(1). Anterior plate of thelycum with a prominent longitudinal ridge (male unknown)
.....*T. pescadorensis* Schmitt
Anterior plate of thelycum flat or concave (not including posterior extensions)7
- 7(6). Distolateral projections of petasma directed forwards8
Distolateral projections of petasma directed laterally*T. fulvus*, sp. nov.
- 8(7). Distolateral projections of petasma with spatulate tips, reaching coxae of 3rd pereopods, posterior plate of thelycum U-shaped, enclosing an open ovoid depression
.....*T. anchoralis* (Bate)
Distolateral projections of petasma with sharp tips reaching coxae of 4th pereopods; anterior plate of thelycum with posterior tongue-like extension fused with posterior plate*T. granulosus* (Haswell)

TRACHYPENAEUS CURVIROSTRIS (Stimpson)

Fig. 22A-F

Penaeus curvirostris Stimpson, 1860, p. 44. Kishinouye, 1900, p. 23.

Penaeus granulosus Miers, 1884, p. 295.

Parapenaeus curvirostris Rathbun, 1902, p. 38.

Trachypeneus asper Alcock, 1905, p. 531; 1906, p. 43.

Trachypeneus curvirostris Alcock, 1905, p. 523. Schmitt, 1926, pp. 353-8. Racek, 1955, pp. 235-6.

Trachypenaeus curvirostris Kubo, 1949, pp. 393-5.

Material.—QUEENSLAND: Off Point Lookout, 20-30 fm, 4 ♂, 41-72 mm, 6 ♀, 52-87 mm.

Description

Rostrum.—6-9 teeth + epigastric, usually 6-7; reaching tip of 2nd segment of antennular peduncle, strongly upcurved in ♀, sometimes almost straight in ♂, varying in either case with degree of maturity. Adrostral carina faint, reaching to or just beyond 1st tooth; postrostral carina reaching to middle of carapace. Epigastric at $\frac{1}{3}$ - $\frac{1}{4}$ length carapace.

Carapace.—Longitudinal suture sometimes barely distinguishable, usually $\frac{1}{5}$ - $\frac{1}{4}$ length carapace. Transverse suture extremely faint and irregular. Antennal carina extending half way between antennal and hepatic spines. Hepatic sulcus present,

the spine below or slightly in advance of epigastric. Supra-orbital spine present, pterygostomial angle sharp.

Antennules.—Flagella equal in length, 0.85 length peduncle in mature ♀, 1.1 length peduncle in ♂. Distolateral spine of 1st segment diverging from longitudinal axis and pointing slightly upwards. Prosartema reaching almost as far as eye, stylocerite reaching to $\frac{2}{3}$ basal segment.

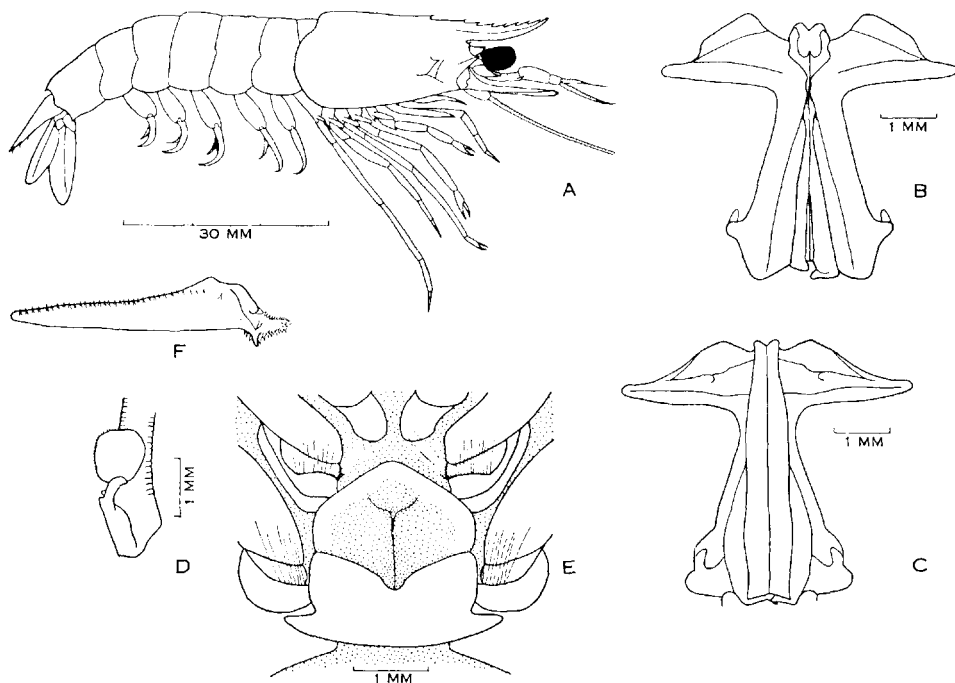


Fig. 22.—*Trachypenaeus curvirostris* (Stimpson). *A*, 84 mm ♀; *B*, ventral surface of petasma, 60 mm ♂; *C*, dorsal surface of petasma; *D*, appendix masculina; *E*, thelycum, 51 mm ♀; *F*, cardiac plate and zygocardiac ossicle.

Antennae.—Scale reaching as far as or slightly exceeding tip of antennular peduncle.

Thoracic appendages.—Endopod of 3rd maxilliped exceeding tip of basal segment of antennular peduncle by $\frac{1}{2}$ dactyl. First pereopod reaching to or slightly exceeding base of carpocerite, 2nd exceeding it by dactyl; 3rd reaching to or almost to tip of antennular peduncle; 4th reaching as far as stylocerite; 5th reaching from base to tip of 2nd segment of antennular peduncle. Epipodites on 1st 3 pereopods, a small ischial spine on 1st.

Abdomen.—A small median dorsal tubercle on 2nd, dorsal carina proper beginning at anterior $\frac{1}{3}$ – $\frac{1}{4}$ of 4th somite. Telson with 3 pairs of easily discernible spines, the subapical but slightly larger than remaining 2 pairs, and borne on very slight projections.

Gastric mill (Fig. 22*F*).—Cardiac plate with 29–35 spinules; zygocardiac ossicle, 3 principal + 2 longitudinal rows each of 8–12 smaller teeth; prepyloric with 10–12 rounded lateral teeth.

Petasma (Fig. 22*B, C*).—Width lateral projections 1.0–1.1 times length petasma. Anterior projections from median plates overhanging apical opening by $\frac{3}{4}$ its diameter.

Appendix masculina (Fig. 22*D*).—Distal piece globular, as wide as long, $\frac{1}{2}$ length basal piece, inner and distal edges fringed with minute setae.

Thelycum (Fig. 22*E*).—Anterior plate with bluntly pointed anterior margin and with median shallow groove which widens out in anterior $\frac{1}{2}$ to form concave depression. Anterior edges of seminal receptacle meeting at obtuse angle with median notch, giving anterior plate a rhombic outline. Spermatophore mass hard and very firmly cemented in receptacle. Coxae of 4th legs with plate-like projection densely fringed with setae, and tuft of setae on coxae of 5th legs. Sternal plate of 5th pereopods tomentose.

Colour.—Body pink to reddish brown, pereopods whitish.

Distribution

Off Point Lookout, and off Fraser I., Qld. Japan, Hakodate to Kagoshima and Nagasaki, to depth of 150 m, and Inland Sea; Formosa; Indonesia; Halmaheira Sea; off Selawatti I., south of Timor, Molo Strait, 18–141 fm; Australia, Port Darwin, Thursday I. (Schmitt 1926). Generally found in deeper waters (20–30 fm) than *T. fulvus*, which is common in waters of 2–3 fm.

Discussion

T. curvirostris may readily be distinguished from *T. fulvus* by the following features:

Feature	<i>T. curvirostris</i>	<i>T. fulvus</i>
Epipodites 1st and 2nd pereopods	Present	Absent
Hepatic sulcus	Present	Absent
Fifth pereopod	Not extending beyond 2nd segment of antennular peduncle	Reaching at least to tip of peduncle
Cardiac plate	29–35 spinules	22–28 spinules
Zygocardiac ossicle	2 rows 8–12 small teeth	1 row 7–11, 1 row 15–30 teeth
Thelycum	Anterior plate rhombic; 4th pereopod with coxal plate	Anterior plate semicircular; no coxal plate on 4th pereopod
Telson	3 pairs distinct spines, subapical pair not on prominent shoulders	A pair of large subapical spines on prominent shoulders, and 2 pairs of minute spines

The petasma has no marked distinguishing features from that of *T. fulvus*, but the incurved posterior projections of median lobes are much shorter and blunter than those of *T. fulvus*.

Kubo (1949) has shown that the rostrum varies greatly with age, and to a lesser extent with sex, being straighter in smaller specimens and males, and becoming more strongly upcurved in females. Thus degree of curvature of the rostrum is a poor specific feature. The above specimens are at variance with those described by Kubo (1949) in the following features:

Feature	Present Description	Kubo (1949)
Length antennular flagella	♂ 1.1, ♀ 0.85 length peduncle	♂ 0.6–0.7, ♀ 0.45–0.6 length peduncle
Prepyloric ossicle	10–12 lateral teeth	About 23 teeth, 10 of which are minute

Schmitt (1926) observes that length of antennular flagella varies greatly, and lack of minute teeth of prepyloric ossicles does not warrant a separation from *T. curvirostris*. A further difference between the present specimens and those of de Man (1911) and Schmitt (1926), is that there are but 3 pairs of spines on the telsons, whereas both authors refer to 4 pairs. Nor is there any trace of a pit for a minute tooth between subapical and next pair of distinct spines as noted by Schmitt. It seems reasonable to assume that there is specific variation in this respect.

TRACHYPENAEUS FULVUS, sp. nov.

Fig. 23A–G

Material.—QUEENSLAND: Townsville, Aug. 1953: holotype ♂, 51 mm; allotype ♀, 64 mm; paratypes, 3 ♂, 47, 49, 49 mm, ♀, 64 mm. Moreton Bay, 28.xii.1951, paratypes, 4 ♂, 49–55 mm, 12 ♀, 46–103 mm. Moreton Bay, 17.viii.1951, 2 ♂, 51, 63 mm, 4 ♀, 32–55 mm. Brisbane R., Hamilton, 14.i.1954, 24 postlarvac, 10–25 mm. Norman R., Gulf of Carpentaria, Aug. 1953, 2 ♀, 62, 68 mm. WESTERN AUSTRALIA: Hampton Harbour, 5.ix.1952, 3 ♂, 47–60 mm. Numerous specimens from Exmouth Gulf.

Diagnosis

Rostrum more or less straight, usually with 7–8 teeth + epigastric. Third and 5th pereopods reaching to or beyond tip of antennular peduncle. Telson with 2 subapical and 4 minute lateral spines. Anterior plate of thelycum semicircular, sternal plate of 5th pereopods glabrous, no setae on coxae of 4th pereopods.

Description

Rostrum.—Teeth 6–9 + epigastric (usually about equal numbers with 7 or with 8 teeth + epigastric). Rostrum reaching to or almost to tip of 2nd segment of antennular peduncle, dorsal surface usually straight, ventral surface convex, giving tip a slightly upcurved appearance. Adrostral carina reaching 1st tooth, post-rostral carina reaching posterior border of carapace. Epigastric at $\frac{1}{4}$ length carapace.

Carapace.—Sulci and carinae feeble; longitudinal suture sometimes indistinct, $\frac{1}{5}$ – $\frac{1}{7}$ length carapace; a small transverse suture present. Antennal carina reaching $\frac{1}{2}$ distance between antennal and hepatic spines. Cervical sulcus not defined, sometimes a faint indication thereof at hepatic spine, latter usually conical and slightly in advance of epigastric. Supra-orbital spine present, pterygostomial angle blunt.

Antennules.—Flagella equal in length, equal to length peduncle. Distolateral spine of basal segment diverging at an angle from longitudinal but in plane of horizontal axis. Prosartema barely exceeding tip of junction of peduncle of eye with cornea. Stylocerite $\frac{1}{2}$ basal segment.

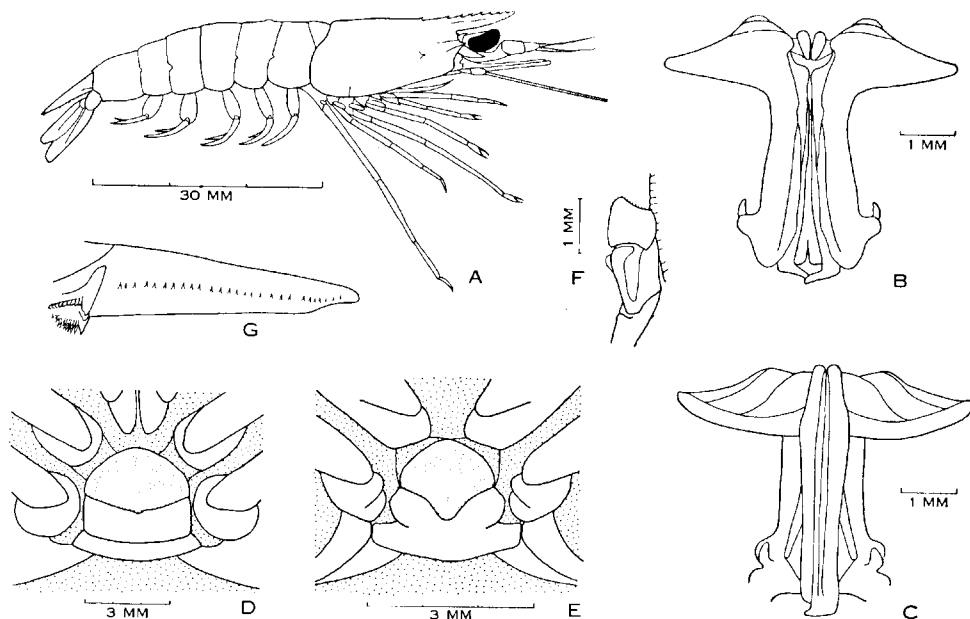


Fig. 23.—*Trachypenaeus fulvus*, sp. nov. A, 64 mm allotype, Townsville; B, ventral surface of petasma, 52 mm holotype; C, dorsal surface of petasma; D, thelycum, 86 mm ♀, Moreton Bay; E, 52 mm ♀, Moreton Bay; F, appendix masculina; G, cardiac plate and zygocardiac ossicle.

Antennae.—Scale extending beyond tip of antennular peduncle.

Mandibular palp.—Distal segment reaching tip basicerite length twice its greatest width.

Thoracic appendages.—Endopod of 3rd maxilliped reaching to or slightly beyond tip of basal segment of antennular peduncle; 1st pereopod reaching tip of or slightly exceeding carpopocerite; 2nd from base to tip of 2nd segment of antennular peduncle, 3rd from tip of peduncle to exceeding it by chela; 4th exceeding carpopocerite by dactyl; 5th reaching to or beyond antennular peduncle, but usually reaching to base of dactyl of 3rd. An epipod on 3rd pereopod only. A small ischial spine on 1st pereopod.

Abdomen.—An elongate median dorsal tubercle on 2nd, dorsal carina proper beginning at anterior $\frac{1}{3}$ of 4th somite. Telson with a pair of large subapical spines

arising from marked projections, with 2 pairs of minute lateral spines; occasionally with some of these spines missing. Length of telson thrice width at base.

Gastric mill (Fig. 23G).—Cardiac plate with 22–28 spinules, usually 26–28, zygo-cardiac ossicle 3 principal teeth + an upper single row of 7–11 teeth and a lower double row of 15–30 teeth. Urocardiac ossicle trapezoidal, prepyloric with concave sides bearing 11–15 rounded teeth.

Petasma (Fig. 23B, C).—Width lateral projections 1.1–1.2 times length petasma. Median plates with anterior projections overhanging the opening by $\frac{3}{4}$ its diameter.

Appendix masculina (Fig. 23F).—Distal piece hemicylindrical, width equal to length, inner edge slightly longer than outer, distal edge slightly concave and fringed with a few small setae. Anterior piece $\frac{3}{4}$ length basal piece.

Thelycum (Fig. 23D, E).—Anterior plate with semicircular front edge. Anterior edge of seminal receptacle deeply notched in small unimpregnated females, notch tending to be much reduced or obliterated in impregnated females, the anterior edge becoming shallowly concave. Sternal plate of 5th pereopods smooth.

Colour in life.—Body densely pubescent, varying from mid to light yellowish brown; pleopods usually light-brown, pereopods darker, eyes with a distinct green iridescence.

Distribution

Moreton Bay to Norman River, Gulf of Carpentaria; north-western Australia. Sometimes quite common, approaching commercial abundance in Moreton Bay, in catches of *Penaeus plebejus* and *Metapenaeus mastersii*.

Discussion

Although Schmitt (1926) gives reasons for regarding *T. asper* Alcock, 1906, as a synonym of *T. curvirostris*, Kubo (1949) regards a Japanese species as *T. asper*. There seems little doubt that *T. asper* as described by Alcock was *T. curvirostris*, a further point in support of this being that the colour of *T. asper* and *T. curvirostris* is the same. This raises the point whether the specimens described by Kubo are *T. fulvus* or another new species. The following are the principal differences between *T. fulvus* and "*T. asper*":

Feature	<i>T. fulvus</i>	" <i>T. asper</i> " (Kubo's description)
First pereopod	Barely exceeding carpopacrite	Reaching tip of basal segment of antennular peduncle
Second pereopod	Not exceeding 2nd segment of antennular peduncle	Reaching tip of peduncle
Third pereopod	Not exceeding tip of antennular peduncle by more than chela	Exceeding tip of peduncle by part of carpus

Feature	<i>T. fulvus</i>	" <i>T. asper</i> " (Kubo's description)
Fourth pereopod	Exceeding carapocrite by dactyl	Reaching tip of 2nd segment of antennular peduncle
Fifth pereopod	Rarely exceeding antennular peduncle by more than dactyl	Exceeding peduncle by $\frac{1}{2}$ propodus
Telson	3 pairs lateral spinules, 2 of which are minute	2 pairs of lateral spinules
Cardiac plate	22-28 spinules	35-39 spinules

Although lengths of pereopods are variable within *T. fulvus* the range for Australian specimens does not cover lengths given by Kubo (1949) for "*T. asper*". Thelycum, petasma, and appendix masculina appear to be indistinguishable and may be evidence for regarding Kubo's "*T. asper*" as *T. fulvus*. Nevertheless, until specimens intermediate with regard to the above features are found, it seems best to regard Kubo's specimens as doubtful.

TRACHYPENAEUS ANCHORALIS (Bate)

Fig. 24A-G

Penaeus anchoralis Bate, 1888, p. 258, pl. XXXV, fig. 1 (female only).

Trachypeneus anchoralis Schmitt, 1926, pp. 348-51. Racek, 1955, pp. 236-7.

Material.—WESTERN AUSTRALIA: Exmouth Gulf, 24.ix.1954, coll. K. Godfrey, 2 ♂, 53 mm, 36 ♀, 55-77 mm. QUEENSLAND: Bowen (Aust. Mus. regd. No. P3528), ♂, 47 mm.

Description

Rostrum.—Teeth 8-9 + epigastric; reaching tip of 2nd segment of antennular peduncle, slightly upcurved in ♂, strongly upcurved in ♀. Epigastric at $\frac{1}{4}$ carapace. Adrostral carina reaching just behind 1st rostral tooth. Postrostral carina well defined, reaching posterior border of carapace.

Carapace.—Transverse sutures absent, longitudinal sutures barely perceptible, and $\frac{1}{3}$ length carapace. Antennal carina extending to $\frac{1}{3}$ distance between antennal and hepatic spines. Supra-orbital spine and shallow postocular sulcus present. Cervical sulcus shallow, reaching $\frac{1}{2}$ carapace, length $\frac{1}{4}$ carapace. Hepatic sulcus wide and deep immediately below and posterior to hepatic spine, becoming narrow and shallow in front of spine, ending in wide depression immediately behind sharp pterygostomial angle. Antennal carina reaching $\frac{1}{2}$ distance between antennal and hepatic spines. Sulci partly obscured by dense pubescence.

Antennules.—Flagella equal in length, 0.9-1.0 peduncle in ♂, and 0.8 length peduncle in ♀. Distolateral spine on basal joint diverging laterally from longitudinal

axis of peduncle. Prosartema reaching as far as tip of eye. Stylocerite reaching $\frac{1}{2}$ basal segment.

Antennae.—Scaphocerite reaching as far as tip of antennular peduncle.

Thoracic appendages.—Third maxillipeds reaching as far as basal segment of antennular peduncle, dactyl slender and propodus with longitudinal row of spinules on distomedian edge; 1st pereopod reaching $\frac{1}{2}$ carpoperite, 2nd exceeding it by dactyl; 3rd reaching tip of antennular peduncle; 4th reaching as far as or slightly exceeding tip of carpoperite; 5th slender, reaching base of dactyl of 3rd pereopod. Ischial spine on 1st pereopod. A lamellar mastigobranch on 3rd pereopod only.

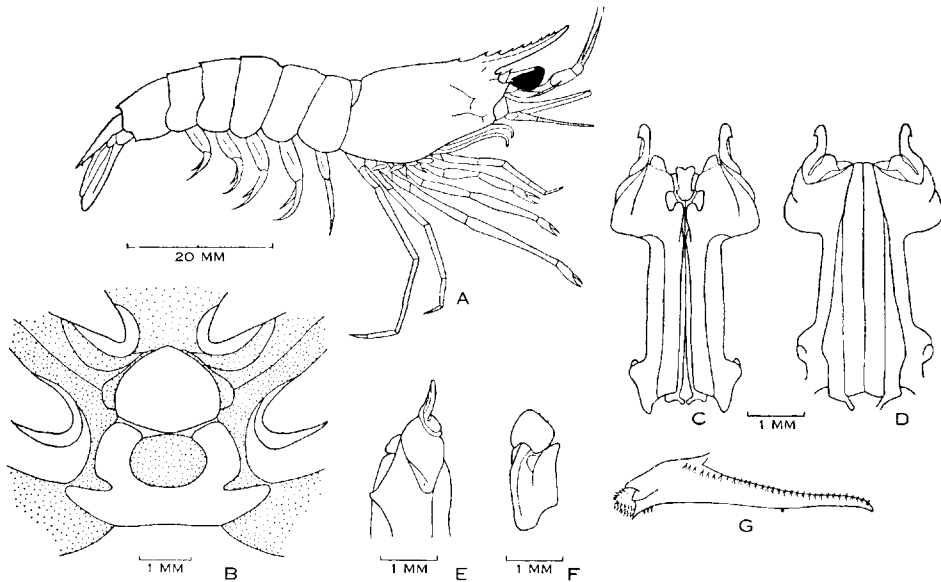


Fig. 24.—*Trachypenaeus anchoralis* (Bate). *A*, 74 mm ♀, Exmouth Gulf; *B*, telson, 74 mm ♀; *C*, ventral surface of petasma, 53 mm ♂; *D*, dorsal surface of petasma, 53 mm ♂; *E*, lateral aspect of distal half of petasma; *F*, appendix masculina, 53 mm ♂; *G*, cardiac plate and zygocardiac ossicle, 74 mm ?.

Abdomen.—Second somite with elongate dorsal tubercle, 3rd with the posterior $\frac{2}{3}$ dorsally carinated, 4th–6th strongly carinated. Telson with 3 pairs of lateral spines, subapical small and borne on small shoulders, the remaining 2 minute and barely perceptible.

Gastric mill (Fig. 24*G*).—Cardiac plate with 26–32 spinules. Zygocardiac ossicle principal teeth + an upper row of 8–10 of which the 1st 2 are blunt, and lower double row of 12–16 teeth meeting upper row; 3–4 small teeth on lower edge of cardiac plate; prepyloric with 12–15 lateral teeth.

Petasma (Fig. 24*C–E*).—Distolateral projections of lateral lobes twisted anteriorly, the extremities more or less parallel, spatulate with a distolateral recurved spinous projection, and reaching coxae of 3rd pereopods.

Appendix masculina (Fig. 24F).—Distal piece bluntly conical, apex inclined medially, with a few minute distolateral spinules; length equal to width and 0.6 length basal piece.

Thelycum (Fig. 24B).—Anterior plate slightly concave, closely bounded on its anterolateral edges by coxae of 4th pereopods. Seminal receptacle a simple, completely open, suboval depression; bounded posteriorly by transverse sternal plate of 5th pereopods, laterally by flat curved forward extensions of sternal plate, and anteriorly by edge of anterior plate. Spermatophore closely and firmly cemented in seminal receptacle.

Discussion

Superficially this species resembles *T. curvirostris*, but apart from the distinctive petasma and thelycum, does not possess mastigobranchiae on 1st and 2nd pereopods.

TRACHYPENAEUS GRANULOSUS (Haswell)

Fig. 25A–F

Penaeus granulatus Haswell, 1879, p. 41; 1882, p. 202 (♀ only).

Trachypeneus granulatus Schmitt, 1926, pp. 351–3.

Trachypenaeus salaco de Man, 1907, p. 135; 1911, pp. 90–2.

Material (part examined by Schmitt (1926)).—QUEENSLAND: Bowen (Aust. Mus. regd. Nos. E3116, P3527, E6727, P3529), 4 ♀, 80–84 mm; Darnley I., Torres Strait (Macleay Mus. coll.), ♀, 80 mm (possibly holotype but not marked), 3 ♀, 45–72 mm; Albany Passage, Cape York, coll. M. Ward, ♂, 43 mm.

Description

Rostrum.—Teeth 8–9 + epigastric; reaching to or almost to tip of 2nd segment of antennular peduncle, dorsal surface straight or slightly upcurved at tip, ventral surface convex, accentuating upcurved appearance of tip of rostrum. Adrostral carina reaching 1st tooth, postrostral carina distinct, reaching posterior border of carapace. Epigastric at $\frac{1}{4}$ length carapace.

Carapace.—Longitudinal and transverse sutures distinct, former very short, $\frac{1}{5}$ length carapace. Antennal carina reaching $\frac{1}{3}$ distance between antennal and hepatic spines. Cervical and hepatic sulci sometimes obscured by dense pubescence, removal revealing short distinct cervical sulcus reaching $\frac{1}{2}$ carapace and hepatic sulcus, beginning behind hepatic spine, descending to deep depression below it; sometimes continuing distinctly almost to pterygostomial angle. Hepatic spine slightly in advance of epigastric. Supra-orbital spine small; pterygostomial angle quadrangular.

Antennules.—Flagella equal to length peduncle. Distolateral spine of 1st segment diverging from longitudinal, but in plane of horizontal axis. Prosartema reaching almost as far as tip of eye. Stylocerite reaching $\frac{1}{2}$ – $\frac{2}{3}$ length basal segment.

Antennae.—Scaphocerite reaching as far as tip of antennular peduncle.

Thoracic appendages.—Third maxilliped variable in length, reaching from $\frac{1}{2}$ 2nd to tip of 3rd segment of antennular peduncle; 1st pereopod reaching tip of or exceeding carapocerite by dactyl; 2nd reaching from $\frac{1}{2}$ to tip of 2nd segment of antennular peduncle; 3rd exceeding the peduncle by at least chela; 4th exceeding

carpocerite by dactyl; 5th exceeding antennular peduncle by $\frac{1}{3}$ propodus. An epipodite on 3rd pereopod only. A small ischial spine on 1st pereopod.

Abdomen.—An elongate median dorsal tubercle at anterior $\frac{1}{3}$ of 2nd somite, dorsal carina proper beginning anterior $\frac{1}{3}$ of 4th somite. Telson with pair of large subapical spines arising from appreciable projections, with 2 pairs minute lateral spines. Pleuron 1st somite with small ventral notch.

Gastric mill (Fig. 25*F*).—Cardiac plate with 31–35 spinules. Zygocardiac ossicle with principal + an upper row of up to 12 teeth and lower row ending in cluster of minute teeth; several small spines on lower edge of cardiac plate; prepyloric with concave sides each with 12–15 teeth.

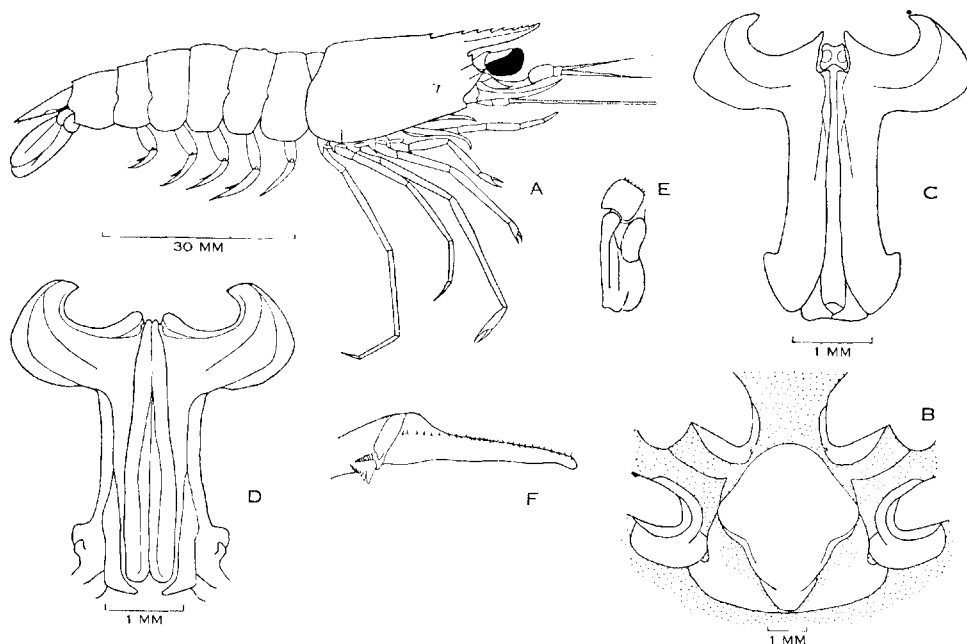


Fig. 25.—*Trachypenaeus granulosus* (Haswell). *A*, 84 mm ♀; *B*, thelycum of same; *C*, ventral surface of petasma, 43 mm ♂; *D*, dorsal surface of petasma; *E*, appendix masculina; *F*, cardiac plate and zygocardiac ossicle.

Petasma (Fig. 25*C, D*).—Reaching bases of 3rd pereopods, greatest width across distolateral projections almost equal to length petasma. Distolateral projections broad, tips curving forward in a broad sweep and ending in inwardly directed mucronate tips; anterior edges reflected dorsally and forming blunt median projections. Median lobes ending in projections completely closing distal opening of petasma.

Appendix masculina (Fig. 25*E*).—Distal piece subrectangular in outline and with a distal fringe of minute setae, and $\frac{1}{2}$ length proximal piece.

Thelycum (Fig. 25*B*).—Anterior plate rounded, the anterolateral margins very slightly concave. Ventral surface of plate concave, with posterior rounded convex projection fused with posterior plate, and extending to posterior margin of latter. Posterior plate excavate on either side of median convexity, the depressions

extending as shallow pockets under indented posterolateral margin of anterior plate. Coxae of 4th pereopods each with small tuft of inwardly directed setae. Anterior and posterior plate of thelycum covered with minute scattered tubercles.

Distribution

7 and 12 miles NNE. Bowen (Schmitt 1926); Darnley I., Torres Strait (type locality (Haswell 1879)); Albany Passage, Cape York; Lohio Bay, Buton Strait, Kei Is. (de Man 1911). This species must at present be considered rare.

Discussion

Apart from secondary sexual characters this species has few features enabling it to be readily distinguished from *T. fulvus*, carapace and rostrum in particular being almost identical. Apart from the distinctive secondary sexual characters the following are the principal distinguishing features:

Feature	<i>T. granulosus</i>	<i>T. fulvus</i>
Pterygostomial angle	Quadrangular	Not angular
Antennal scale	Reaching tip of antennular peduncle	Exceeding antennular peduncle
Fourth pereopod	Exceeding carpocerite by dactyl	Exceeding basicerite by dactyl
Cardiac plate	28-35 spinules	22-28 spinules

Both de Man (1911) and Schmitt (1926) raise the possibility of *T. salaco* de Man being synonymous with *T. granulosus*. The 43 mm male agrees in all external features with the females of *T. granulosus*, and the correspondence of armature of the respective gastric mills removes all doubt of the identity of *T. salaco*. The petasma of the male is undoubtedly the same as that figured by de Man for the latter species.

Genus PARAPENAEOPSIS (Alcock) (emend.)

Parapeneopsis Alcock, 1901, p. 14; 1906, pp. 34-5.

Parapeneopsis de Man, 1911, pp. 92-3. Burkenroad, 1934a, pp. 58-9. Kubo, 1949, pp. 368-70. Barnard, 1950, p. 604.

Rostrum dorsally toothed only. Carapace with longitudinal sutures not reaching as far as median posterior border of carapace and with transverse sutures at base of 3rd or 4th pereopods. Cervical and orbito-antennal sulci rather feeble; hepatic sulcus present, usually well developed anteriorly. Antennal and hepatic carinae often present. Pterygostomial angle without a spine. Telson armed with small spinules or unarmed. First segment of antennular peduncle without a spine on ventral distomedian border. Maxillary palp usually with 2 segments, sometimes unsegmented. Exopods on all pereopods. Petasma tubular, median lobes with simple apices or produced into laterally directed processes; lateral lobes with short

simple spout-like or long, more or less complex distolateral projections, and with proximolateral projections which may be very large. Appendix masculina with 2 or 3 segments, the proximal large in relation to distal segments. Thelycum with a broad, usually concave anterior plate, the posterior plate usually slightly broader than the anterior. Zygocardiac ossicle consisting of 3 large teeth and 2 irregular rows of much smaller teeth. Pleurobranchiae on 3rd-6th thoracic somites; a rudimentary arthrobranch on 1st, anterior and posterior arthrobranchiae on 2nd-6th, and posterior arthrobranch on 7th thoracic somites; mastigobranchiae on 1st, 2nd, sometimes on 4th and 5th thoracic somites. Carapace often minutely pitted.

Type species *P. stylifera* (Milne Edwards).

The genus comprises 14 species, of which *P. atlantica* Balss is found in the Atlantic.

The gender of *Parapenaeopsis* according to the rules of grammar is feminine, but as most authors have treated it as masculine gender, and as there is a possibility of the gender being decided by the International Commission of Zoological Nomenclature (Dr. L. B. Holthuis, personal communication), the gender of specific names has been left unaltered.

KEY TO THE INDO-PACIFIC SPECIES OF PARAPENAEOPSIS

1. Mastigobranchiae on 1st and 2nd pereopods2
Mastigobranchiae absent on 1st and 2nd pereopods10
- 2(1). First pereopods with basal spines3
First pereopods without basal spines9
- 3(2). Second pereopods with basal spines4
Second pereopods without basal spines*P. uncta* (Alcock)
- 4(3). Telson with pair of fixed subapical spines; at least distal $\frac{1}{2}$ free portion of rostrum unarmed*P. stylifera* (Milne Edwards)
Telson without fixed subapical spines, with or without lateral movable spines; $\frac{1}{3}$ or less free portion of rostrum unarmed5
- 5(4). Petasma with pair of long slender caliper-like distolateral projections directed forwards; thelycum with median tuft of long setae behind posterior edge of last thoracic sternite6
Petasma with a pair of distolateral projections directed laterally or distolaterally, usually short and spout-like7
- 6(5). Third pereopods ♀ with basal spine; cardiac plate with 56-59 spinules
.....*P. maxillipedo* (Alcock)
Third pereopods ♀ without basal spine; cardiac plate with 42-49 spinules
.....*P. cornutus* (Kishinouye)
- 7(5). Postrostral carina reaching almost to posterior border of carapace; petasma with pair of short spout-like distolateral projections, and pair of cap-like distal projections8
Postrostral carina reaching $\frac{3}{4}$ carapace; petasma with pair of distolateral projections directed laterally, cap-like distal projections absent*P. nana* (Alcock)
- 8(7). Antennular flagella 0.5-0.6 length of carapace; thelycum with median tuft of setae on posterior plate*P. sculptilis* (Heller)
Antennular flagella 0.7 length carapace or longer; thelycum without a median tuft of setae on posterior plate*P. hardwickii* (Miers)
- 9(2). Epigastric tooth present (species restricted to Pacific America)*P. balli* Burkenroad
Epigastric tooth absent (species found other than in Pacific America)
.....*P. gracillima* Nobili
- 10(1). Epigastric tooth present11
Epigastric tooth absent12

- 11(10). Rostrum exceeding tip of antennular peduncle; longitudinal suture extending to about 0.9 length carapace from anterior edge *P. hungerfordi* (Alcock)
 Rostrum short, reaching tip of 1st segment of antennular peduncle; longitudinal suture reaching as far as hepatic spine *P. venusta* de Man
- 12(10). Anterior plate of thelycum with V-shaped posterior edge, and 2 accessory ridges on anterior edge of posterior plate; rostrum with proximal $\frac{1}{3}$ rising from carapace, remainder more or less horizontal *P. tenellus* (Bate)
 Anterior plate of thelycum with a more or less straight transverse posterior edge, no accessory ridges on anterior edge of posterior plate; rostrum inclined upwards at an angle to carapace for whole of its length *P. acclivirostris* (Alcock)

PARAPENAEOPSIS CORNUTUS (Kishinouye)

Fig. 26A-F

Penaeus cornutus Kishinouye, 1900, p. 23, pl. 7, fig. 9.

Penaeus sp. Osada, Tanizaki, and Nakazawa, 1931, pp. 6-7.

Parapenaeopsis cornuta de Man, 1911, p. 93.

Parapenaeopsis cornutus Maki and Tsuchiya, 1923, pp. 43-4. Kubo, 1949, pp. 374-8.

Material.—QUEENSLAND: Townsville, 20 fm, Aug. 1953, ♂, 73 mm, 3 ♀, 67, 81, 82 mm; Townsville, main beach, 25.viii.1945 (Aust. Mus. regd. No. P11659), ♀, 82 mm.

Description

Rostrum.—Teeth 6-7 + epigastric; sigmoidal, distal $\frac{1}{3}$ unarmed, strongly upcurved and reaching to 3rd segment of antennular peduncle. Adrostral carina ending half way between 1st and 2nd rostral teeth, sulcus shallow. Postrostral carina widening and becoming indistinct posteriorly, ending $\frac{1}{10}$ length carapace from posterior edge; with a small, very feeble sulcus at $\frac{1}{2}$ its length, sulcus $\frac{1}{10}$ length carapace. Epigastric and 1st tooth on carapace, former at $\frac{1}{4}$ carapace.

Carapace.—Orbital spine and postocular sulcus present, latter shallow and at angle 45° to rostrum. Longitudinal suture sometimes indistinct posteriorly, but usually reaching $\frac{1}{2}$ carapace. Cervical sulcus sometimes very indistinct, and meeting longitudinal suture. Antennal carina ending below hepatic spine. Posterior hepatic sulcus and carina of equal length, sinuous and running from behind hepatic spine towards pterygostomial angle, sulcus then turning sharply and continuing towards antennal spine, making a V-shape. A shallow branchiocardiac sulcus $\frac{1}{4}$ length carapace, its anterior end $\frac{2}{3}$ length carapace from orbital spine.

Antennules.—Flagella equal in length, the outer thicker, 0.7 length carapace and $\frac{1}{2}$ length peduncle in ♂, 0.6 length carapace and $\frac{2}{5}$ length peduncle in ♀. Prosartema reaching $\frac{3}{4}$ longitudinal diameter of cornea; stylocerite reaching $\frac{1}{2}$ basal segment peduncle.

Thoracic appendages.—Third maxilliped reaching almost to or to tip of basal segment of antennular peduncle; 1st pereopod reaching pterygostomial angle; 2nd reaching $\frac{1}{2}$ carpocerite; 3rd reaching as far as eye; 4th reaching base of, 5th reaching as far as or slightly exceeding tip of carpocerite. First and 2nd pereopods with mastigobranchiae and basal spines, 3rd pereopods with slightly smaller pair of basal spines in ♂ only.

Abdomen.—Dorsally carinated from anterior 4th somite, carina incised posteriorly on 4th and 5th somites. Sixth somite with 2 pairs faint lateral cicatrices and small horizontal suture at lower $\frac{1}{4}$ posterior edge. Telson unarmed.

Gastric mill (Fig. 26F).—Cardiac plate with 32–36 spinules. Zygocardiac ossicle principal teeth + upper row of 5 teeth leading to cluster of about 20 teeth; prepyloric acute with 12–14 teeth on either side.

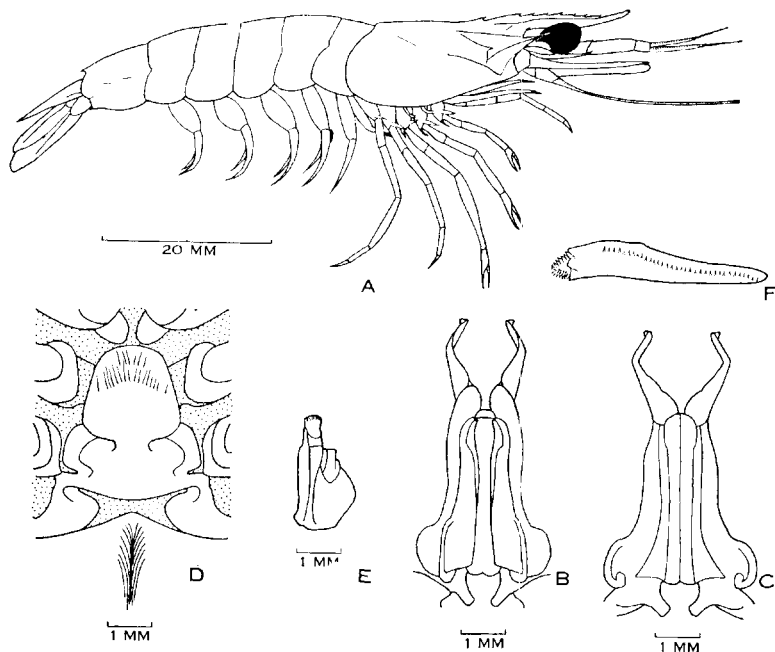


Fig. 26.—*Parapenaeopsis cornutus* (Kishinouye). A, 73 mm ♂; B, ventral surface of petasma, 73 mm ♂; C, dorsal surface of petasma; D, thelycum, 81 mm ♀; E, appendix masculina; F, cardiac plate and zygocardiac ossicle.

Petasma (Fig. 26B, C).—With a pair of long slender distal projections which diverge and ascend slightly for the proximal $\frac{2}{3}$, distal $\frac{1}{3}$ curving inwards fairly sharply; reaching coxae of 3rd pereopods and enclosing sharp triangular setose projection on sternal plate of 4th pereopods. Lateral lobes with a pair of posterior incurving projections, and a pair of large flattened proximolateral projections. Openings of vasa deferentia on either side of a channel leading to triangular sternal plate.

Appendix masculina (Fig. 26E).—Appendix masculina 3-segmented. Distal piece with rounded, minutely tuberculate anterodistal rim leading posteriorly to sharp angle. Basal piece thrice length distal piece and penultimate piece together. Endopod of 2nd plopod shortened, resembling a long boot distally.

Thelycum (Fig. 26D).—Anterior plate as wide as long, concave, and with a number of setae across ventral face; with posterior extension fused with posterior plate, on either side of which are a pair of depressions; with prominent median tuft of setae behind the posterior plate.

Colour in life.—Body faintly pinkish with transverse blue bands; uropods proximally red, distally greenish blue; antennal flagella reddish and crossed by broad yellow bands (Kubo 1949).

Distribution

Townsville, Qld.; Ariake-wan, Japan; Java; Takao and Tainan, Formosa (Kubo 1949).

Discussion

This species is apparently an uncommon one. It closely resembles *P. maxillipedo* Alcock, especially thelycum and petasma, but may be distinguished by the following features:

Feature	<i>P. cornutus</i>	<i>P. maxillipedo</i> (Kubo 1949)
Postrostral carina	Straight, not reaching posterior carapace	Convex, reaching posterior carapace
Rostral teeth	6–7 + epigastric	8–10 + epigastric
Basial spine of 3rd pereopods ♀	Absent	Present
Cardiac plate	32–36 spinules (41–46 (Kubo 1949))	56–59 spinules

The above description differs from that of Kubo (1949) in the following details:

Feature	Present Description	Kubo (1949)
Transverse groove at $\frac{3}{10}$ carapace in ♂	Absent	Present
Branchiocardiac sulcus	Present in both sexes	Present only in ♂
Prosartema	Reaching $\frac{3}{4}$ eye	Reaching as far as eye
Cardiac plate	32–36 spinules	41–46 spinules
Zygocardiac ossicle	5 teeth on upper row	3 teeth on upper row

As the agreement is otherwise good, the creation of a new species is not justified, especially as differences of the gastric mill armature are the only important ones.

PARAPENAEOPSIS SCULPTILIS (Heller)

Fig. 27A–G

Penaeus sculptilis Heller, 1862, p. 528; 1865, p. 122, pl. XI, fig. 1.

Parapenaeopsis sculptilis Kubo, 1949, pp. 389-91.

Parapenaeopsis sculptilis var. *cultrirostris* Alcock, 1906, p. 39.

Parapenaeopsis cultrirostris Kubo, 1949, pp. 378-80.

Material.—QUEENSLAND: Keppel Bay, July 1953, 4 ♂, 91-97 mm, 4 ♀, 106-130 mm; Norman River, Gulf of Carpentaria, Aug. 1953, 3 ♂, 53-75 mm, 6 ♀, 59-111 mm.

Description

Rostrum.—Teeth, 6-8, usually 6 + epigastric, latter always feeble, often represented by a barely perceptible depression in ♂ (cf. *Metapenaeus macleayi*). Apparently sexually dimorphic in ♂♂ 70 mm and above, unarmed portion absent,

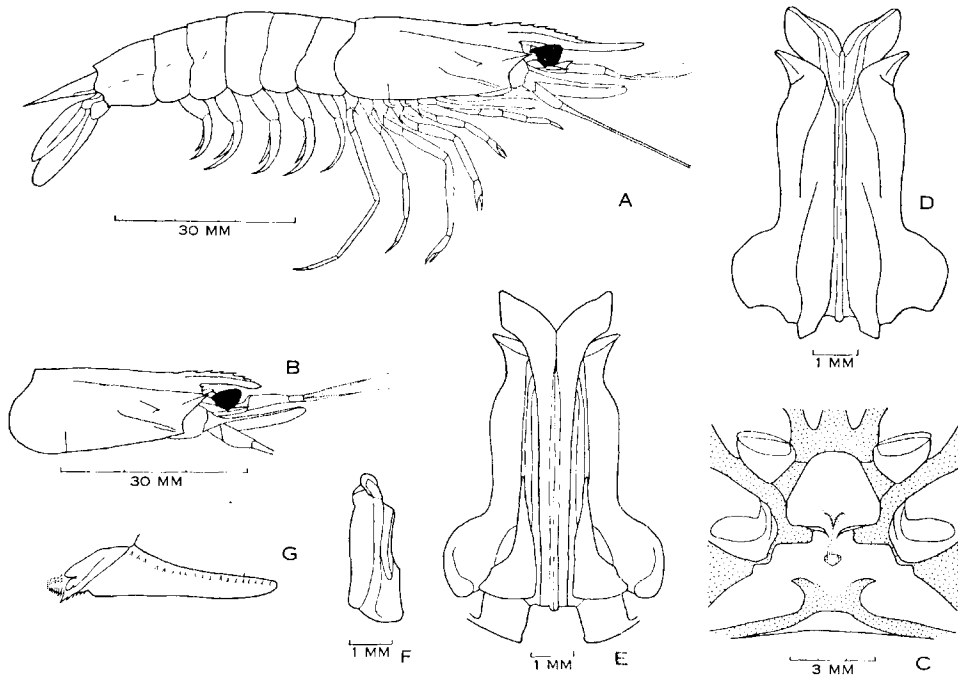


Fig. 27. *Parapenaeopsis sculptilis* (Heller). *A*, 116 mm ♀; *B*, cephalothorax, 100 mm ♂; *C*, thelycum, 128 mm ♀; *D*, ventral surface of petasma, 97 mm ♂; *E*, dorsal surface of petasma; *F*, appendix masculina; *G*, cardiac plate and zygocardiac ossicle.

rostrum curving downwards, reaching to 2nd segment of antennular peduncle; in ♀ rostrum is long, strongly sigmoidal, unarmed distal $\frac{1}{2}$ strongly upcurved and reaching beyond tip antennular peduncle. (In 53-mm ♂ rostrum is of latter shape.) Epigastric tooth at $\frac{1}{3}$ carapace, 1st tooth at or slightly behind anterior margin of carapace. Postrostral carina low, of uniform height, ending $\frac{1}{10}$ length carapace from posterior end; feebly sulcate, sometimes merely flat-topped, throughout its length and narrowing slightly about the middle. Adrostral carina ending mid way between 1st and 2nd teeth.

Carapace.—Orbital angle small. Longitudinal suture reaching $\frac{3}{4}$ length carapace from postorbital margin, and reaching level of transverse suture. Orbito-antennal

sulcus absent. Antennal spine large, the carina reaching $\frac{1}{2}$ distance between spine and hepatic spine. Cervical sulcus straight, feeble, wide, its upper end indistinct. Hepatic sulcus pronounced, $\frac{1}{3}$ – $\frac{1}{2}$ length carapace, inclined downwards at angle of 15° to horizontal, sinuous, posterior end indistinct and curving upwards, ending at $\frac{1}{2}$ carapace at level of hepatic spine; hepatic carina distinct only for lower $\frac{1}{2}$ sulcus, starting below hepatic spine and running towards sharp pterygostomial angle. Feeble indications of a branchiocardiac sulcus usually present.

Antennules.—Flagella subequal, 0.85 length peduncle, and 0.6 length carapace in ♂, and $\frac{3}{4}$ length peduncle and $\frac{1}{2}$ length carapace in ♀. Prosartema reaching tip of junction of peduncle of eye with cornea, stylocerite attaining $\frac{1}{2}$ basal segment.

Thoracic appendages.—Third maxilliped reaching from $\frac{3}{4}$ to slightly exceeding carpoperite; 1st pereopod reaching from pterygostomial angle, to base of carpoperite; 2nd reaching from base to $\frac{1}{2}$ carpoperite; 3rd reaching from tip to exceeding carpoperite by dactyl; 4th reaching base of, 5th reaching tip of carpoperite. Mastigobranchiae on 1st and 2nd pereopods, ischial spines absent.

Abdomen.—Dorsally carinated from middle 4th somite, carinae of 4th and 5th ending in angular, sometimes very minutely spinous projections, that of 6th ending in large spine. The 3rd and anterior 4th somites with feeble dorsal sulcus or flat-topped strip indicating its position, often present on 1st and 2nd somites also. Fourth somite with 1, 5th with 1, 6th with 3 pairs of faint lateral cicatrices. Telson unarmed.

Gastric mill (Fig. 27G).—Cardiac plate with 17–21 spinules. Zygocardiac ossicle 3 principal + upper row of 7–8 smaller and lower cluster of about 25 teeth; 5 teeth on edge of cardiac plate; prepyloric with 9–12 lateral teeth.

Petasma (Fig. 27D, E).—Reaching basis of 4th pereopods, with pair apical spout-like projections directed anterolaterally and opening ventrally, distance between their apices almost equal that of distolateral projections, which is $\frac{2}{3}$ total length petasma. Petasma constricted at 0.7 its length; a pair of very large prominent lateral proximal projections, slightly curved dorsally, ending posteriorly in knob-like processes.

Appendix masculina (Fig. 27F).—Distal piece with expanded, flattened distolateral region inclined at 45° to longitudinal axis and $\frac{1}{3}$ length basal piece.

Thelycum (Fig. 27C).—Anterior plate slightly concave, length 0.7–0.8 width; with 2 low tubercles on posterior edge separated by shallow median depression and articulating with corresponding pair of tubercles on rectangular posterior sternal plate, latter with tubercle bearing tuft of setae.

Colour (*freshly preserved*).—Four wide whitish transverse bands, evenly spaced along carapace and abdomen, edged with narrow pink bands, region between white and pink bands light to dark brown; appendages pink to red.

Distribution

Keppel Bay to Gulf of Carpentaria, Qld.; Indonesia, Singapore, Hong Kong, Gulf of Martaban, Bombay (Kubo 1949). Abundance in commercial quantities has been reported for Keppel Bay.

Discussion

Burkenroad (1934b) does not regard the shorter rostrum of ♂ as being even a variant of normal form, but "an adult instar ultimately attained by all males". While ♀♀ often seem to have damaged rostra, this apparently being a feature of slender, long rostra generally, none examined were as short as those of ♂♂, which seem to have been derived by the unarmed portion being broken off close to the last tooth. Tips of all ♂ rostra were variable and appeared slightly malformed. Alcock (1906) states that the unarmed portion is often lost, and presumably had examined intact adult ♂♂. It may be that ♂, just before reaching adult instar, is for some reason more likely to suffer rostral damage, possibly because ♂ rostrum is less robust than that of ♀.

Kubo (1949) elevates *P. sculptilis* var. *cultrirostris* to *P. cultrirostris* but it is significant that Kubo did not examine any ♂ *P. sculptilis* nor any ♀ *P. cultrirostris*. The description of the latter agrees well with that of ♂♂ described above. Position of epigastric tooth, sulcation of postrostral carina and 1st and 2nd abdominal somites, appear to be variable and therefore not valid for creating a distinct species.

PARAPENAEOPSIS VENUSTA de Man

Fig. 28

Parapenaeopsis venusta de Man, 1907, p. 134; 1911, pp. 93-5, pl. IX, fig. 30.

Material.—QUEENSLAND: Albany Passage, Cape York, Sept. 1928, coll. M. Ward, ♀, 45 mm.

Description

Rostrum.—Teeth 7 + epigastric. Rostrum slightly exceeding 1st antennular segment, distal $\frac{1}{3}$ free portion curving slightly ventrad, extreme tip upturned. Adrostral carina ending just behind 1st tooth; postrostral carina ending at $\frac{1}{2}$ carapace. Epigastric 0.36 length carapace, 1st tooth on carapace. Greatest depth of rostrum just in front of 2nd tooth.

Carapace.—Postocular sulcus present. Orbital angle not spinous. Longitudinal suture ending just behind level of hepatic spine, transverse suture at tip of coxae of 3rd pereopods. Upper edge of antennal spine forming a right angle with border of carapace; carina not extending behind edge of carapace. Hepatic spine slender; cervical sulcus $\frac{1}{2}$ length carapace, slightly inclined upwards. Hepatic sulcus extending horizontally for $\frac{1}{2}$ length behind hepatic spine, its anterior $\frac{1}{2}$ inclined downwards towards pterygostomial angle. Hepatic carina along anterior $\frac{1}{2}$ sulcus, anterior edge with row of spinous setae. Pterygostomial angle sharp.

Antennules.—Flagella subequal and 0.8 length peduncle and $\frac{1}{2}$ length carapace. Stylocerite $\frac{1}{3}$ length 1st segment; prosartema reaching as far as tip of junction of peduncle of eye with cornea.

Thoracic appendages.—Third maxillipeds much stouter than pereopods and reaching $\frac{1}{2}$ 2nd segment of antennular peduncle; 1st pereopod reaching base of, 2nd reaching tip of carpocerite. 3rd exceeding it by dactyl; 4th reaching $\frac{1}{2}$ and 5th exceeding carpocerite by dactyl. No ischial spines and mastigobranchiae on pereopods.

Abdomen.—Fifth and 6th somites dorsally carinated. Telson with 4 small lateral movable spines, most distal largest. Distal and penultimate spines close together, distance separating them less than $\frac{1}{2}$ that separating remaining 2.

Thelycum (Fig. 28).—Anterior plate mucronate, $\frac{2}{3}$ as long as wide, not including posterior extension. Posterior $\frac{1}{2}$ concave, concavity extending along a posterior extension, which lies in a rectangular incision of posterior plate. Distolateral extensions of posterior plate flat, enclosing posterior $\frac{1}{3}$ anterior plate; a transverse depression occupying middle region of posterior plate.

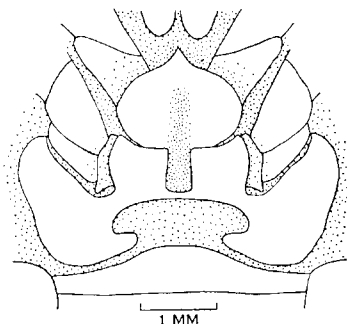


Fig. 28.—*Parapenaeopsis venusta* de Man. Thelycum, 45 mm ♀.

Distribution

So far known only from the type locality (13 m, east coast of Aru Is.) and from Albany Passage.

Discussion

The present specimen agrees in most respects with de Man's (1911) description, except that the anterior plate of thelycum is wider than that shown in de Man's figure.

The integument of the Albany Passage specimen is very soft and damaged, making it unsuitable for figuring. However, absence of mastigobranchiae on 1st and 2nd pereopods, presence of an epigastric tooth, short rostrum and longitudinal suture, enables *P. venusta* to be readily separated from other species of the genus. ♂ is still unknown.

PARAPENAEOPSIS TENELLUS (Bate)

Fig. 29A–G

Penaeus tenellus Bate, 1888, pp. 270–1. Kishinouye, 1900, p. 22.

Penaeus curcifer Ortman, 1890, p. 451.

Penaeus (*Parapenaeopsis*) *tenellus* de Man, 1907, pp. 435–6, 454.

Parapenaeopsis tenella de Man, 1911, pp. 9, 92.

Parapenaeopsis tenellus Kubo, 1949, pp. 371–4.

Material.—QUEENSLAND: Townsville, 20 fm, Aug. 1953, ♀, 44 mm; mouth Norman R., Gulf of Carpentaria, Aug. 1953, 2 ♂, 32 mm, 2 ♀, 36, 37 mm.

Description

Rostrum.—Teeth 6–8, epigastric absent; reaching almost to tip of 2nd segment of antennular peduncle, proximal $\frac{1}{3}$ rising from carapace, remainder more or less horizontal, tip with slight upward curve. Adrostral carina ending at $\frac{1}{4}$ carapace, postrostral carina broad, indistinct posteriorly, ending at $\frac{1}{2}$ carapace; 1st tooth at edge of carapace.

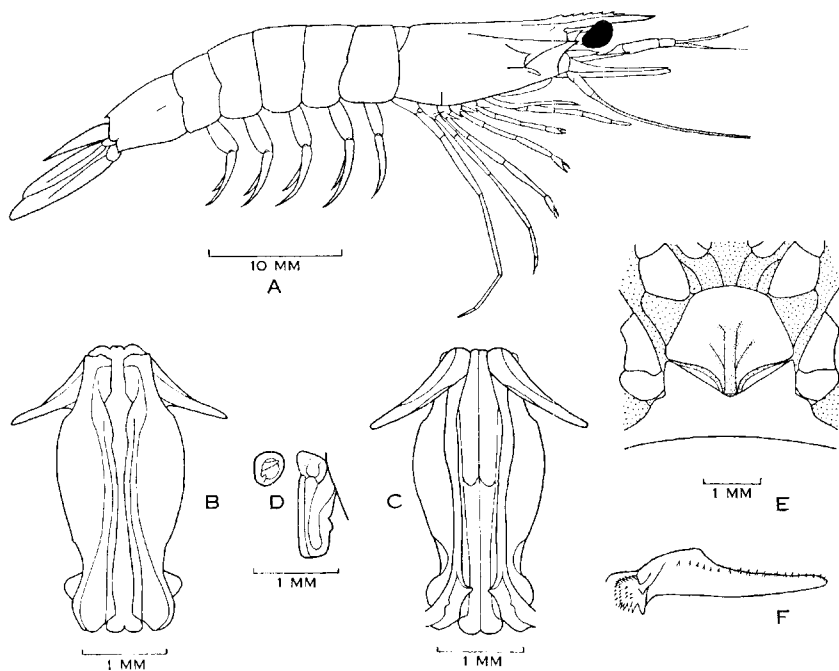


Fig. 29.—*Parapenacopsis tenellus* (Bate). *A*, 44 mm ♀; *B*, ventral surface of petasma, 32 mm ♂; *C*, dorsal surface of petasma; *D*, appendix masculina and end view of distal piece; *E*, thelycum, 44 mm ♀; *F*, cardiac plate and zygocardiac ossicle.

Carapace.—Minutely punctate, with acute orbital angle and a postocular sulcus. Longitudinal suture reaching $\frac{2}{3}$ carapace from anterior edge. Antennal spine large, carina indistinct, occupying anterior $\frac{1}{4}$ distance between antennal and hepatic spines. Cervical sulcus feeble, wide, and reaching almost to longitudinal suture. Hepatic sulcus almost horizontal posteriorly, anterior $\frac{1}{2}$ inclined downwards towards acute pterygostomial angle; hepatic carina along anterior $\frac{1}{2}$ sulcus only.

Antennules.—Flagella subequal, equal to length peduncle and 0.8 carapace in ♂, 0.7–0.8 peduncle and 0.5 carapace in ♀. Prosartema reaching tip of junction of optic peduncle with cornea; stylocerite reaching $\frac{1}{2}$ basal segment.

Thoracic appendages.—Third maxillipeds reaching as far as or slightly exceeding basal segment of antennular peduncle; 1st pereiopod exceeding pterygostomial angle by dactyl; 2nd reaching $\frac{1}{2}$ carapocerite; 3rd reaching base of dactyl of 3rd maxillipeds; 4th reaching as far as tip of 1st, 5th reaching as far as tip of 2nd segment of antennular peduncle. No mastigobranchiae on 1st and 2nd pereiopods.

Abdomen.—Dorsally carinated from 4th somite. Exopods uropods $1\frac{1}{2}$ times length unarmed telson. Sixth somite with horizontal anterior lateral cicatrice, and horizontal suture on lower $\frac{1}{4}$ posterior edge.

Gastric mill (Fig. 29F).—Cardiac plate with 16–21 teeth. Zygo-cardiac ossicle 3 principal + upper row of about 6, and lower row of 3–4 teeth, and total of 15–20 in 4 vertical rows between ends of these rows. Prepyloric acute with 8–10 lateral teeth, most median 3–5 large and prominent.

Petasma (Fig. 29B, C).—Reaching basis of 3rd pereopods, distolateral projections of lateral lobes slender, tapering, and reflected posterolaterally, making angle of 60° with longitudinal axis of petasma; distance between tips of projections $\frac{1}{3}$ total length petasma. Lateral lobes expanded laterally into elongate keeled projections, their length, and also distance across their most lateral extremities, $\frac{1}{2}$ length petasma. Peduncle of pleopod with mediolateral process, consisting of proximal sharp tubercle and distal larger, blunter tubercle.

Appendix masculina (Fig. 29D).—Distal piece broad, minutely setose, $\frac{1}{3}$ length basal piece, with posterodistal excavation with tongue-like process, and with tubercle on anterior rim of excavation.

Thelycum (Fig. 29E).—Anterior plate $1\frac{1}{2}$ times as wide as long, with median groove occupying posterior $\frac{2}{3}$; with a posterior tongue-like projection enclosed by large flat anterior processes of posterior plate, and with an accessory ridge on each side of front of posterior plate.

Distribution

Townsville and Norman River, Gulf of Carpentaria, Qld. Southern half of Japan (Kubo 1949).

Discussion

The above description is in close agreement with that of Kubo (1949) except that Kubo states that a postocular sulcus is absent. All specimens examined had a distinct, though shallow, postocular sulcus, and it is possible this was overlooked by Kubo, whose description was mainly based on 1 female.

P. tenellus is one of the 4 *Parapenaeopsis* spp. which lack mastigobranchiae on 1st and 2nd pereopods, the others being *P. hungerfordi* Alcock, *P. venusta* de Man, and *P. acclivirostris* Alcock. Of these only the last lacks an epigastric tooth and is closely similar to *P. tenellus*. However, in *P. acclivirostris* the antennular flagella are $\frac{1}{2}$ length peduncle, and anterior plate of thelycum wants a posterior tongue-like extension, according to Alcock (1906). Both species are very small penaeids (σ *P. tenellus* mature at 30 mm, ϕ 40 mm), and this may account for their apparent rarity and discontinuous distribution.

IV. ZOOGEOGRAPHICAL DISTRIBUTION

The majority of Penaeinae are restricted to tropical and warm-temperate shallow seas, being most abundant in the former. Little collecting has been done in northern Australia and adjacent areas. There are few records from New Guinea and from most of the Pacific islands. There are a number of records from northern Queensland

and north-western Australia, but except for a few specimens from Darwin the region between these areas has been almost entirely neglected. Nevertheless, in spite of these shortcomings it is possible to integrate the zoogeography of the Australian Penaeinae. Of 28 species described above, 17 are considered in this respect. Five new species, with *Funchalia villosa*, *Metapenaeopsis borradailei*, *M. durus*, *M. mogiensis*, *Trachypenaeus granulatus*, and *Parapenaeopsis venusta*, comprise the remainder and are omitted from subsequent discussion.

(a) *Australian Distribution (Table 1)*

A cool-temperate Australian penaeine fauna is virtually non-existent. Prawns are absent from the cold Maugean Province (as defined by Bennett and Pope (1953)), and *Penaeus latisulcatus* and *Metapenaeopsis novae-guineae* are rare in South Australia and confined to sheltered inlets (Hale 1927). Only *Penaeus plebejus* and *Metapenaeus macleayi* are not found in tropical waters and are confined to the region corresponding roughly to the Peronian Province (Bennett and Pope 1953). Decreasing temperature, in the vicinity of Twofold Bay (D. Rochford, personal communication), probably limits the southern distribution of these two species. On the other hand, *Penaeus plebejus* and *Metapenaeus macleayi* do not extend far into Queensland waters. This may be explained by regarding them as endemic Australian species. This is in accord with the general principle that species peculiar to Australia are found only in the colder southern regions (Bennett and Pope (1953), rocky shores; various authors quoted by them; Thomson (1947), chaetognaths; Thompson (1948), pelagic tunicates; Munro (1949), silver bream; Kott (1952), ascidians; Stephenson and McNeill (1955), stomatopods). As such species are lacking in the Penaeinae, it is likely that any endemic Australian species would be found in the adjacent warm-temperate Peronian Province. Stephenson and McNeill (1955) record one endemic species for this region. Thomson (1947) did not find any tropical species of chaetognath further south than 38° S. latitude (approximately Cape Howe) and Kott (1952) found the southern limit for tropical ascidians to be Sydney. It seems likely, therefore, that if endemic Australian species have evolved from typically tropical animal groups, they would be restricted to the Peronian Province.

Apart from *Penaeus plebejus* and *Metapenaeus macleayi*, only *M. endeavouri* and *Trachypenaeus anchoralis* are not also recorded outside Australian waters. It is likely that these species will be found in Indonesia, as *Penaeus esculentus*, while most common in Australian waters, has recently been recorded from Borneo (Kubo 1949). In addition to these four species, *P. latisulcatus*, *P. semisulcatus*, *P. merguensis*, *Metapenaeopsis novae-guineae*, and *Trachypenaeus fulvus* are found across northern Australia. It is probable that further collecting will show a similar distribution for the widely ranging *Penaeus monodon*, *Metapenaeus monoceros*, *Trachypenaeus curvirostris*, and *Parapenaeopsis sculptilis*. The two remaining *Parapenaeopsis* spp. are rare as yet and predictions concerning their distribution cannot be made.

Thus in the Penaeinae there is little to substantiate the division of tropical and subtropical Australia into a Banksian Province, extending inside the Great Barrier Reef from Cape York to approximately Wide Bay, and a Dampierian Province from Geraldton to Cape York (Bennett and Pope 1953). A similar situation has been

found for chaetognaths (Thomson 1947), ascidians (Kott 1952), stomatopods (Stephenson and McNeill 1955), portunid crabs (Stephenson, unpublished data), and the dominant littoral molluscs and barnacles (Endean, Kenny, and Stephenson 1956; Endean, Stephenson, and Kenny 1956). Clark (1946) found it convenient to erect a division of the echinoderm fauna at Cape York, but admits to the paucity of records west of the Cape. It is probable that the proximity of Cape York to New Guinea is responsible for the concept of some kind of geographical barrier in this region, whereas most faunal evidence to date is to the contrary.

TABLE I
DISTRIBUTION OF 17 PENAEIDAE WITHIN AUSTRALIA
? indicates probable occurrence

Species	N.S.W.	S. Qld.	N. Qld.	N.T.	W.A.	S.A.
<i>Penaeus plebejus</i>	+	+				
<i>P. latisulcatus</i>			+	+	+	+
<i>P. monodon</i>		+	+	?	+	
<i>P. esculentus</i>	+	+	+	+	+	
<i>P. semisulcatus</i>	+	+	+			
<i>P. merguensis</i>	+	+	+	+	+	
<i>Metapenaeopsis novae-guineae</i>	+	+	+	+	+	+
<i>Metapenaeus monoceros</i>	+	+	+	?	+	
<i>M. endeavouri</i>	+	+	+	+	+	
<i>M. mastersii</i>	+	+	+	+	+	
<i>M. macleayi</i>	+	+				
<i>Trachypenaeus curvirostris</i>	+	+	?	?		
<i>T. fulvus</i>	+	+	+	+	+	
<i>T. anchoralis</i>		+	+	+	+	
<i>Parapenaeopsis cornutus</i>			+			
<i>P. sculptilis</i>			+			
<i>P. tenellus</i>			+			

(b) Indo-West Pacific Distribution (Fig. 30)

The tropical and subtropical oceans inhabited by the Penaeinae can be subdivided into three regions:

- (i) The Atlantic and Mediterranean,
- (ii) Pacific America,
- (iii) Indo-West Pacific.

Each has a discrete fauna, none of the species in a given region so far being recorded from another, though the Suez and Panama Canals are possible avenues of migration from one region to another (Monod 1930). Most of the species of Penaeinae are found in the Indo-West Pacific.

The distribution and abundance of Penaeinae shown in Figure 30 indicates that Australian species of the subfamily are very largely a southern extension of the

Indonesian fauna. The two exceptions are *Penaeus plebejus* and *Metapenaeus macleayi* as noted above. Clark (1946) arrived at the same conclusion for echinoderms, and Stephenson and McNeill (1955) for stomatopods. This situation is to be expected in view of Australia's geographical position, with the continental shelf extending northwards into Indonesia.

SPECIES	AFRICA			INDIA		MALAYA		INDONESIA		AUSTRALIA			CHINA SEAS	
	SOUTH AFRICA	EAST AFRICA	RED SEA	ARABIAN SEA	BAY OF BENGAL	GULF OF MARTABAN	MALAY PENINSULA	SUMATRA TO WEST GUINEA	WESTERN AUSTRALIA	NORTHERN AUSTRALIA	EASTERN AUSTRALIA	PHILIPPINE ISLANDS AND SOUTH CHINA SEA	FORMOSA TO JAPAN	
PENAEUS PLEBEJUS														
P. LATISULCATUS														
P. MONODON														
P. ESCULENTUS														
P. SEMISULCATUS														
P. MERGUIENSIS														
METAPENAEOPSIS NOVAE-GUINEAE														
METAPENAEUS MONOCEROS														
M. ENDEAVOURI														
M. MASTERSII														
M. MACLEAYI														
TRACHYPENAEUS CURVIROSTRIS														
T. ANCHORALIS														
T. FULVUS														
PARAPENAEOPSIS CORNUTUS														
P. SCULPTILIS														
P. TENELLUS														

Fig. 30.—Indo-West Pacific distribution of 17 Australian Penaeinae. Heavy lines, commercial abundance; unbroken lines, recorded in the literature, but abundance not stated; broken lines, occurrence probable, but no actual record; dotted lines, present but rare.

In Figure 30 it can be seen that some species have very wide distribution while others are curiously restricted. *Penaeus latissulcatus* ranges from the Red Sea to Japan, and occurs in Western Australian waters in commercial quantities, but is rare on the east coast. The very closely related *P. plebejus*, on the other hand, is found only on the east coast where it is commercially abundant. Another example of one species breaking the distribution of another is shown by *P. esculentus* and *P. monodon*. The former occurs in commercial abundance across northern Australia, whereas the latter, which has an extremely wide distribution in large numbers, is not abundant on the east coast and probably will be found sparsely scattered on the north and west coasts of Australia. There is also the possibility of a similar relationship existing between the wide-ranging *Metapenaeus monoceros* and *Metapenaeus endeavouri*, though the abundance of the latter in northern Australia is unknown. In the Atlantic *Penaeus brasiliensis* Latreille is widely distributed but does not occur in the Gulf of Mexico, where the closely related *P. duorarum* Burkenroad and *P. aztecus*

Ives are found (Anderson and Lindner 1945). However, the two latter differ from *P. plebejus* in having a range similar to that of *P. brasiliensis*. The existence of some sort of mutual exclusion between certain penaeid species therefore seems possible. Summarizing the zoogeography of Australian Penaeinae, it is possible to state that:

(1) There are two endemic species, the southern limits of which are probably determined by hydrographical conditions, and the northern limits of which may be determined by either ecological or hydrographical factors, or a combination of both.

(2) The rest of the Australian species are a southern extension of the Indonesian fauna.

(3) Certain abundant species may interrupt the distribution of otherwise widely ranging closely related species elsewhere abundant.

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