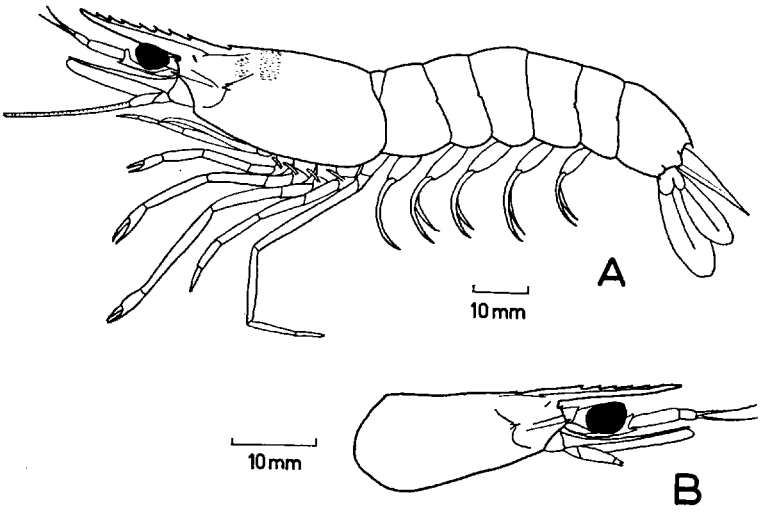

Fig. 11. *Metapenaeus suluensis*, sp. nov.
A, ♀, 120 mm, allotype; B, cephalothorax of ♂, 99 mm, holotype.

tooth, adrostral sulcus extending well behind epigastric tooth. Postrostral carina broad and low, posterior $^1/_4$ indistinct, ending $^1/_{10}$ length of carapace from its posterior margin. Epigastric and penultimate tooth on carapace, former at a little over $^1/_3$ carapace. Gastrofrontal sulcus indistinct and wide, postocular sulcus at an angle of about 40° to rostrum, and deep. Orbito-antennal sulcus wide but distinct, ending in front of hepatic spine. Antennal carina ending $^1/_5$ distance between antennal and hepatic spines. Cervical sulcus straight, ending at not quite $^1/_2$ carapace. Hepatic sulcus descending vertically in its posterior part, turning towards pterygostomial angle anteriorly. Branchiocardiac carina distinct, almost meeting posterior extension of hepatic spine, not quite extending to posterior margin of carapace; branchiocardiac sulcus wide and distinct, barely setose in ♀, fully glabrous in ♂.

Antennules with subequal flagella which are $^2/_3$ length of peduncle in ♂, $^1/_3$ length of peduncle in ♀. Prosartema almost reaching tip of basal segment, stylocerite attaining $^1/_2$ basal segment.

Third maxilliped and 1st pereopod reaching $^1/_2$ carpocerite; 2nd pereopod surpassing tip of 1st antennular segment by dactyl, 3rd attaining tip of antennular peduncle; 4th surpassing tip of carpocerite by dactyl; 5th slightly surpassing base of 2nd antennular segment. A sharp ischial spine on 1st pereopod, only slightly smaller than basial spine. Distoventral keel on ischium of ♂ 5th pereopod triangular, notch on merus proximally bounded by a triangular prominent spine pointing ventrally at angle 50° to axis of merus, and inward at angle 45°; further distally a ventral row of 8–9 conical tubercles which end in a small keel at distal $^1/_4$ merus.

Abdominal somites 1 to 3 without a dorsal carina; 4th with a carina in its posterior $^2/_3$, 5th and 6th strongly carinated, carina of 6th posteriorly

ending in a sharp tooth. Telson somewhat shorter than inner uropods, its lateral margins armed with a single row of minute spinules.

The petasma of the holotype is shown in Plate 5 figs. 6, 7. Distomedian projections $^1/_5$ total length of petasma, overlying distolateral projections, with openings facing dorsally; apices turned at about 30° towards the midline, semicircular, their anterior margins strongly crenulated. Distolateral projections similar to those of *M. ensis*, spout-like, with large distal openings.

The thelycum of the allotype is shown on Plate 10 fig. 8. Anterior plate spoon-like, with a deep median depression in its anterior $^1/_2$, bounded laterally and anteriorly by a high, parabolic ridge. Lateral plates with a crescent-shaped ventral ridge, ending anterolaterally and posteromedially in a large and blunt spinous process; the posterior of these processes very close together, slightly diverging, and pointing anterolaterally.

Distribution. As yet known only from the type locality.

Discussion. *Metapenaeus suluensis* is a close relative of *M. ensis* (de Haan) but may readily be distinguished from it by the following features:

Criterion	*M. suluensis*	*M. ensis*
Rostrum	6–7 teeth+epigastric; strongly sexually dimorphic.	8–10 teeth+epigastric; less sexually dimorphic.
Branchiocardiac sulcus	Distinct, barely setose in ♀ glabrous in ♂.	Indistinct, being strongly setose in both sexes.
Ischial spine 1st pereopod	Sharp and large.	Blunt and small.
Abdomen	Anterior 3 somites non-carinated; carina beginning on posterior $^2/_3$ of 4th.	Traces of carina beginning on 1st somite; 2nd to 6th with distinct carina.
Pubescence	Completely lacking in ♂; in ♀ restricted to dorsum of anterior $^1/_2$ carapace, and a lateral pair of setose patches on abdominal pleura 4 to 6.	Carapace strongly pubescent in both sexes even below branchiocardiac carina, large patches on all abdominal pleura.
Petasma	Distomedian projections pointing inward, moderately large.	Distomedian projections parallel, very large.
Thelycum	Anterior plate spoon-like; lateral plates with raised ventral ridges, each with an anterolateral and a posteromedian spinous process; thelycum posteriorly closed.	Anterior plate tongue-like; lateral plates with raised lateral ridges, each with a posterior inwardly-curved triangular plate; cup-like structure of thelycum posteriorly open.

The large and sharp ischial spine on the 1st pereopod is a feature which *M. suluensis* shares with HALL's (1962) "variety" *baramensis* of *M. ensis*. However, even though the male of *M. e. baramensis* has not as yet been found, the thelycum of HALL's "variety" is completely different from that of the species discussed here.

Metapenaeus conjunctus sp. nov.
(Figure 12; Plate 5 figs. 8, 9; Plate 11 fig. 1)

Material. NORTH BORNEO (Sabah): shallow brackish water at mouth of Tuaran R., coll. CHIN PHUI KONG, 18.XII.1959, 4–5 fm, holotype ♂, 88 mm, allotype ♀, 100 mm, paratypes ♂, 81 mm, ♀, 84 mm; Sandakan Fish Market, coll. CHIN PHUI KONG, 5.XI.1959, 2 ♂♂, 75, 77 mm, 4 ♀♀, 76–88 mm. MALAYA: Johore Bahru, coll. E. CHEAH, December 1961, numerous adolescent ♂♂ and ♀♀.

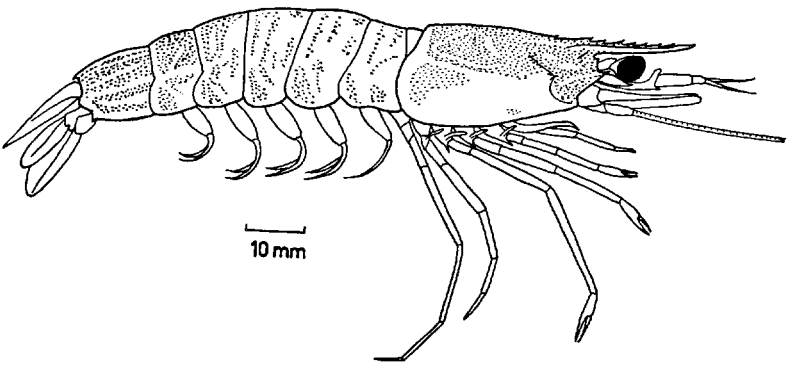

Fig. 12. *Metapenaeus conjunctus*, sp. nov. ♀, 100 mm, allotype.

Description. In both sexes body strongly pubescent in dorsal half of carapace; branchiostegites glabrous except for a small setose patch below the posterior boundary of branchiocardiac carina; abdomen with a number of moderately large setose patches on all somites. Rostrum distinctly ascending in mature ♀, only slightly lower in ♂, straight, reaching at least tip of basal antennular segment in ♂, but usually reaching mid point of 2nd segment in ♀; armed with 6–8 teeth + epigastric, the latter and the penultimate tooth on carapace. Adrostral carina ending between epigastric and penultimate tooth, adrostral sulcus well behind epigastric tooth. Postrostral carina well developed, distinct in its entire length, ending $^1/_{10}$ length of carapace from its posterior margin. Gastro-

frontal sulcus indistinct, postocular sulcus at an angle of about 40° to rostrum. Orbito-antennal sulcus deep and distinct, ending in front of hepatic spine. Antennal carina ending $^1/_3$ distance between antennal and hepatic spine. Cervical sulcus straight, ending at $^2/_5$ carapace. Hepatic sulcus descending at about 95° to longitudinal axis in its posterior part, turning towards pterygostomial angle anteriorly. Branchiocardiac carina distinct, meeting posterior extension of hepatic spine, almost extending to posterior margin of carapace; branchiocardiac sulcus wide but distinct, strongly setose in both sexes.

Antennules with subequal flagella which are $^8/_{10}$ of peduncle in ♂, $^1/_2$ to $^2/_3$ of peduncle in ♀. Prosartema exceeding eye, stylocerite attaining tip of basal segment.

Third maxilliped and 1st pereopod reaching $^1/_2$ carpocerite; 2nd pereopod surpassing tip of basal antennular segment by dactyl, 3rd surpassing tip of scaphocerite by dactyl, 4th reaching tip of carpocerite, 5th not quite reaching tip of 2nd antennular segment. A blunt and small ischial spine on 1st pereopod. Distoventral keel on ischium of ♂ 5th pereopod triangular, notch on merus bounded by a bluntly triangular spine pointing ventrally at angle 40° to axis of merus, and inward at angle of 45°; further distally a ventral row of 6–7 rounded tubercles terminate in a small keel at distal $^1/_2$ merus.

Traces of dorsal carina occasionally present on 1st and 2nd abdominal somite, carina on 3rd indistinct, becoming progressively more prominent from 4th to 6th, carina of 6th ending in a sharp tooth. Telson somewhat shorter than inner uropods, its lateral margins armed with a single row of minute spinules.

The petasma of the holotype is shown on Plate 5 figs. 8, 9. Distomedian projections directed anterolaterally, almost completely overlying distolateral projections, with openings facing anteriorly. Distolateral projections similar to those of *M. ensis*, spout-like, with large distal openings.

The thelycum of the allotype is shown on Plate 11 fig. 1. Anterior plate tongue-like, medially deeply grooved, about of the same width in its raised anterior $^2/_3$. Lateral plates basically very like those of *M. dalli* Racek, retort-shaped in ventral view, but with strongly raised ventrolateral ridges which are separated from each other posteriorly by a wide space.

Distribution. Apparently ranging, as an estuarine species, from Singapore to North Borneo.

Discussion. *Metapenaeus conjunctus* is closely related to both *M. burkenroadi* Kubo and *M. ensis* (de Haan), and its thelycum can be considered a link between these two species. In regard to its petasma, however, the species under discussion differs markedly from *M. ensis* and *M. burkenroadi*, and displays certain similarities to *M. affinis* (Milne Edwards). HALL (1956, fig. 11) depicted the distal part of a petasma which he then considered to belong to *M. monoceros*, and which is certainly

identical with that of *M. conjunctus*. In his latest publication, HALL (1962) correctly withdrew figure 11 from the synonyms of *M. ensis*, but did not explain the identity of the petasma depicted. From this fact, as well as from the material of adolescent specimens examined from the Singapore region, it can be assumed that *M. conjunctus* could be the estuarine species, referred to by HALL (1956, 1962) as the "glabrous condition" of *M. ensis*. Since this form from the Jurong prawn ponds has not been described in detail by HALL, this assumption will have to be clarified by future work. Should it be found correct, however, the writers cannot accept HALL's (1956, p. 78) remarks that there are no differences between the genitalia of the "glabrous condition" and those of the true *M. ensis*. As already demonstrated, the petasma of *M. conjunctus*, when fully developed, is strikingly different from that of *M. ensis*, and the mature thelycum is also easily separable in both species. It must be admitted, however, that the discrimination of juvenile specimens of both sexes is a difficult task in most *Metapenaeus* spp. with minute telsonic spinules. Had it not been possible to compare the adolescent specimens from Johore Bahru morphometrically with the adult specimens from North Borneo, the identification of the majority of the former would certainly have presented some difficulties.

Metapenaeus papuensis sp. nov.
(Plate 3 fig. 3; Plate 6 figs. 1, 2; Plate 11 fig. 2)

Material. NEW GUINEA: Mouth of Panaroa R., Gulf of Papua, coll. Dr. A. RAPSON, 5.IV.1955, holotype ♂, 78 mm, allotype ♀, 98 mm, paratypes 2 ♀♀, 65, 92 mm; Gulf of Papua, 8° 16′ S., 144° 12′ E., coll. Dr. A. RAPSON, 6.IV.1955, ♂, 70 mm, ♀, 86 mm; Hercules Bay, coll. L. W. FILEWOOD, 15.VI.1963, 3 ♀♀, 86, 95, 96 mm.

Description. Pubescence restricted in both sexes to dorsum of carapace and pleura of 6th abdominal somite; setae scattered and very short. Rostrum straight and horizontal in its proximal $^2/_3$, then distinctly uptilted in adult ♀, but less so in adult ♂; reaching to, or slightly surpassing, tip of antennular peduncle in ♀, only slightly shorter in ♂; armed with 9–10 teeth + epigastric, the latter and the penultimate tooth on carapace. Adrostral carina ending between epigastric and penultimate tooth, adrostral sulcus well behind epigastric tooth. Postrostral carina broad and low, but distinct in its whole length, ending $^1/_{10}$ length of carapace from its posterior margin. Gastrofrontal sulcus ill-defined, postocular sulcus at an angle of about 40° to rostrum. Orbito-antennal sulcus wide but distinct, ending in front of hepatic spine. Antennal carina ending $^1/_6$ distance between antennal and hepatic spine. Cervical sulcus straight, ending at $^2/_5$ carapace. Hepatic sulcus descending at about 95° to longitudinal axis in its posterior part, turning towards pterygostomial

angle anteriorly. Branchiocardiac carina distinct, meeting posterior extension of hepatic spine, almost reaching to posterior margin of carapace; branchiocardiac sulcus short and glabrous.

Antennules with subequal flagella; lower flagellum $^{8}/_{10}$ of peduncle in ♂, $^{2}/_{3}$ of peduncle in ♀. Prosartema exceeding eye, stylocerite attaining tip of basal segment.

Third maxilliped reaching $^{3}/_{4}$ carpocerite, 1st pereopod as far as carpocerite; 2nd pereopod surpassing tip of basal antennular segment by $^{1}/_{2}$ dactyl, 3rd surpassing antennular peduncle by $^{1}/_{2}$ dactyl; 4th reaching $^{3}/_{4}$ carpocerite, 5th reaching middle of 2nd antennular segment. A small and blunt ischial spine on 1st pereopod. Distoventral keel on ischium of ♂ 5th pereopod smoothly rounded, notch on merus bounded by a bluntly-triangular small spine pointing ventrally at angle of 45° to axis of merus, its tip only very slightly bent inward; further distally 2–4 inconspicuous tubercles.

Abdominal somites 1–3 without dorsal carina; carination beginning from posterior $^{2}/_{3}$ of 4th somite, becoming progressively sharper on 5th and 6th; carina of 6th ending in acute tooth. Telson shorter than inner uropods, its lateral margins armed with a single row of minute spinules.

The petasma of the holotype is shown on Plate 6 figs. 1, 2. Distomedian projections large, anteriorly bilobed, not overlying distolateral projections, pointing anteriorly, and with large openings facing anterodorsally. Longitudinal sulcus shallow, not dividing distomedian projection into two distinct lobes. Distolateral projections spout-like, with small distal openings.

The thelycum of the allotype is shown on Plate 11 fig. 2. Anterior plate tongue-like, with a slightly rounded anterior margin and smoothly rounded anterolateral corners, medially grooved; anteriorly widest, posteriorly tapering to a narrow plate which is bounded laterally by a pair of rounded bosses. Lateral plates posteriorly fused, their lateral margins strongly raised in form of a salient ridge, the posterior end of which is slightly turned outwards. The thelycal structure posteriorly open by a broad space between the hind ends of the salient ridges.

Distribution. To date known only from New Guinea waters.

Discussion. Although the thelycum of *M. papuensis* displays some affinities with that of *M. elegans* (de Man), as depicted by HALL (1962), the specimens at hand can be distinguished from DE MAN's species by the features on next page.

Even though the structural differences of the thelycum of both species listed below are small, and perhaps not decisive, *M. papuensis* has a markedly different petasma, and this alone would justify its separation from *M. elegans*. Whether the differences listed are to be considered of specific or merely subspecific importance, could be decided only after an examination of many more specimens of both forms.

Criterion	*M. papuensis*	*M. elegans*
Pubescence	Restricted to dorsum of carapace and pleura 6th abdominal somite.	Almost completely absent (DE MAN).
♀ Rostrum	Tip distinctly upcurved.	Tip indistinctly uptilted (HALL).
Postrostral carina	Distinct in whole length.	Indistinct in posterior part (DE MAN).
Spine on merus of ♂ 5th pereopod	Slightly bent inward.	Bent outward (DE MAN).
Distomedian projections of petasma	Hood-like, parallel, directed anteriorly; longitudinal sulcus indistinct and shallow.	Leaf-like, strongly diverging, directed anterolaterally; longitudinal sulcus distinct and deep.
Lateral thelycal plates	Posterior end of salient ridges curved outward.	Posterior end of salient ridges curved inward (HALL)

Metapenaeus affinis (H. Milne Edwards, 1837)
(Plate 5 fig. 10; Plate 11 fig. 3)

Penaeus affinis H. Milne Edwards, 1837, p. 416.
Metapeneus affinis Alcock, 1906, pp. 20–21 (part synonymy only).
Penaeopsis affinis Kemp, 1915, p. 321. De Man, 1924, pp. 4–5 (non 1911).
Metapenaeus affinis Burkenroad, 1934*b*, pp. 29–32. Kubo, 1954, pp. 82–92 (non 1949). Dall, 1957, p. 183 (key). Cheung, 1960, p. 66 (key).
Penaeus mutatus Lanchester, 1901, pp. 572–73.
Metapenaeus necopinans Hall, 1956, pp. 83–84.
Metapenaeus mutatus Hall, 1962, p. 25.

Material. Numerous specimens of both sexes, 59–136 mm; MALAYSIA: Penang, North Borneo; INDONESIA: Java, East Borneo.

Distribution. Indian Seas (most authors), through Malaysia and part of Indonesia to Hong Kong (Cheung).

Colour in life. Translucent green, uropods tipped with conspicuous green.

Discussion. *Metapenaeus affinis* has been adequately described, and the reader is referred particularly to the papers by ALCOCK (1906) and KUBO (1954) as well as to the descriptions and figures by HALL (1956, 1962) under the name of *M. necopinans* and *M. mutatus* respectively. The material examined has not offered any additional criteria for further discussion. However, the genitalia of *M. affinis* have been photographed so that they may be compared with those of a new species from India

which will be described in a forthcoming paper by Mr. M. J. GEORGE of the Central Marine Fisheries Research Station in Ernakulam, India (personal communication).

Since *M. affinis* is not present in the material collected east of the general line between Hong Kong in the north and the eastern tip of Java in the south, it can be assumed that the Makassar Strait and the western Sulu Sea represent some barrier to its eastern distribution.

Metapenaeus insolitus sp. nov.

(Figure 13 A–C; Plate 6 figs. 3, 4; Plate 11 fig. 4)

Material. NORTHERN TERRITORY: Chambers Bay, coll. V. WELLS ("Paxie"), 24.VI.1961, mud and coral, 17 fm, holotype ♀, 85 mm, allotype ♂, 67 mm; paratypes 2 ♂♂, 58, 61 mm, 7 ♀♀, 45–86 mm; 50 miles W.N.W.

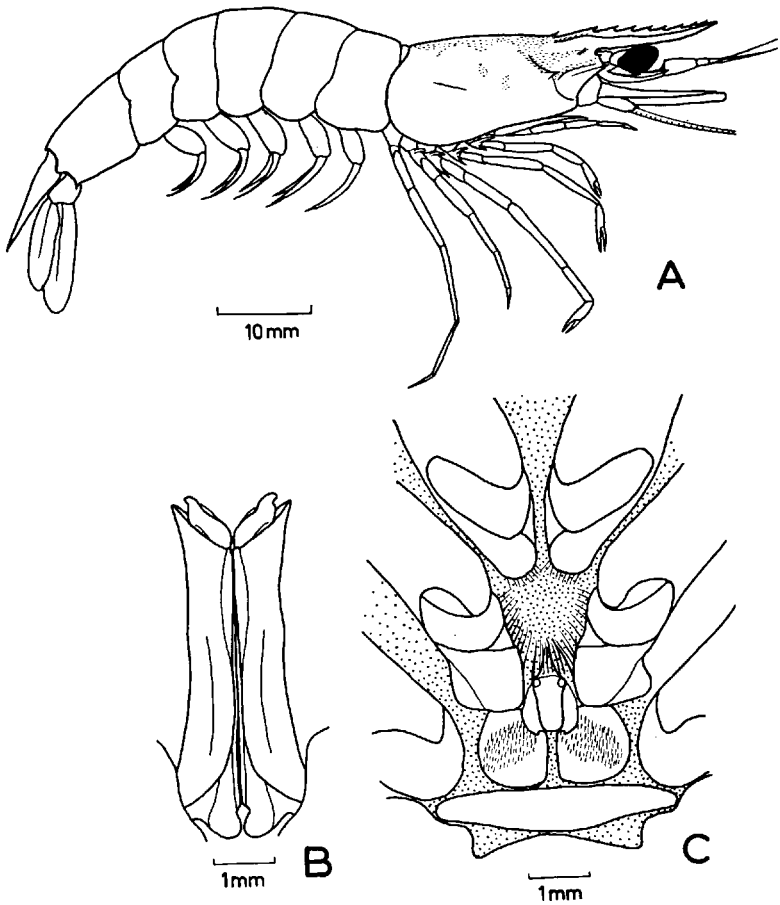

Fig. 13. *Metapenaeus insolitus*, sp. nov.
A, ♀, 85 mm, holotype; B, ventral view of petasma of allotype; C, thelycum of holotype.

of Darwin, coll. V. WELLS ("Paxie"), 5.X.1951, sand bottom, 18 fm, ♂ 56 mm; QUEENSLAND: Mouth of Norman R., Gulf of Carpentaria, coll. "Rama" Prawn Survey, October 1963, mud, 7 fm, 2 ♂♂, 67, 68 mm, 2 ♀♀, 96, 111 mm; off Karumba, Gulf of Carpentaria, coll. "Rama" Prawn Survey, November 1963, mud, 8 fm, 8 ♂♂, 50–71 mm, 15 ♀♀, 58–94 mm.

Description. Pubescence restricted in both sexes to larger part of dorsum on carapace down to branchiocardiac carina, with one to two larger setose patches on branchiostegites; terga and pleura of all pleonic somites with a number of setose areas; tomentum scarce and short, conspicuous only in dry specimens. Base of rostrum between epigastric and penultimate tooth distinctly ascending, rest of rostrum slightly uptilted but straight in ♂, rostral tip in ♀ inconspicuously upcurved; reaching to, or slightly surpassing tip of antennular peduncle in ♀, attaining posterior $^1/_3$ of 3rd antennular segment in ♂; armed with 8 teeth + epigastric in both sexes, epigastric and penultimate tooth on carapace. Epigastric tooth in ♂ often extremely small or rudimentary, its position marked by the anterior median sulcus. Adrostral carina ending between epigastric and penultimate tooth, adrostral sulcus fading away immediately behind epigastric tooth. Postrostral carina ill defined, broad and flat, and recognizable only as a glabrous strip, ending $^1/_{10}$ length of carapace from its posterior margin. Gastrofrontal sulcus wide and shallow, continuous posteriorly with comparatively long postocular sulcus which runs at angle of 45° to rostrum. Orbito-antennal sulcus narrow posteriorly and ending in level with posterior end of antennal carina which reaches to $^1/_5$ distance between antennal and hepatic spine. Cervical sulcus straight and ending at about $^2/_5$ carapace. Hepatic sulcus descending vertically for more than $^1/_3$ length, the rest inclined at an angle towards pterygostomial angle. Branchiocardiac carina flat but distinct, branchiocardiac sulcus shallow and tomentose, the anterior end of both only slightly exceeding the posterior $^1/_3$ carapace.

Antennular flagella $^7/_{10}$ of peduncle in ♂, slightly more than $^1/_2$ in ♀. Prosartema slightly overreaching eye, stylocerite attaining tip of basal segment.

Third maxilliped reaching tip of carpocerite, 1st pereopod only slightly shorter; 2nd pereopod reaching anterior margin of cornea, 3rd attaining $^3/_4$ of 2nd antennular segment; 4th almost reaching to tip of carpocerite, 5th reaching tip of scaphocerite. Distoventral keel on ischium of ♂ 5th pereopod smoothly rounded, notch on merus bounded by a blunt spinous process with a posterolateral suboval facet, the distolateral corner of which bears a rounded tubercle; a small ventral meral keel without tubercles.

Abdominal somites 1 to 3 without a dorsal carina, although a glabrous median strip on terga often present; dorsal carination beginning from posterior $^8/_{10}$ of 4th somite in ♂, from posterior $^2/_3$ of 4th somite in ♀,

becoming progressively sharper on 5th and 6th; carina on 6th ending in acute tooth. Telson shorter than inner uropods, its lateral margins armed with a single row of minute spinules.

The petasma of the immature allotype is shown in figure 13 B, that of a fully grown male is depicted on Plate 6 figs. 3, 4. Distomedian projections fully overlying distolateral projections, and strongly diverging; they are posteromedially simple, their anterolateral margins forming a broad outwardly curved tooth, their posterolateral margins ear-like and rounded; anterodorsal edge strongly crenulated and slightly convoluted. Distolateral projections with spatulate tips, similar to those of other species of the genus.

The thelycum of the holotype is shown in figure 13 C, that of a fully mature female is depicted on Plate 11 fig. 4. Anterior plate tongue-like with a broad longitudinal depression, its almost straight anterior margin with a lateral pair of conspicuous rounded tubercles, its lateral margins bounded by a pair of bulbous elongated plates. Lateral plates medially separated from each other by a narrow sulcus, broadly kidney-shaped; superficially divided by a curved sulcus into a crescent-shaped posterior, and an inwardly curved and pointed anterior part; this sulcus is present only in fully mature females and overgrown by a characteristic wide patch of strong and long setae; position of the yet invisible sulcus in less mature females already marked by this typical tomentum.

Colour in life. Translucent green with brownish chromatophores, antennal scale and tips of uropods vivid green.

Discussion. The interspecific relationship of *M. insolitus* is somewhat obscure. In regard to its thelycum, this species comes closest to the *M. burkenroadi* complex and the two anterolateral tubercles on the anterior thelycal plate are, to some extent, comparable with those in *M. dalli*. However, the strongly setose and curved dividing sulcus present on the lateral plates, shows some affinities to the thelycal structure of *M. affinis*. On the other hand, the petasma of *M. insolitus* displays characters not shared by the *M. burkenroadi* group, and can be considered intermediate between the *M. ensis* complex and *M. affinis*.

The species discussed was first discovered in the vicinity of Darwin, Northern Territory, but has since been found quite abundantly by the Joint Commonwealth-Queensland Prawn Survey in the Gulf of Carpentaria. It occupies the niche separating the western species *M. dalli* Racek, from its endemic eastern congener, formerly called *M. mastersii* by the present writers, in which an intermediate form between these two species was anticipated (DALL, 1957, p. 193). However, *M. insolitus* cannot possibly represent such a link since it does not possess transitional characters between *M. "mastersii"* (= *M. bennettae* sp. nov.) and *M. dalli*.

The original discovery of this new species in the Darwin area made the re-examination of characters displayed by *Penaeus mastersii* Haswell a necessity. In the course of detailed morphometric studies, a number of

the criteria of *M. insolitus* were found at pronounced variance with those of HASWELL's syntype from Darwin; these are as follows:

Criterion	*M. insolitus*	*P. mastersii*
Pubescence on carapace	Larger part of dorsum; branchiostegites with 1–2 setose patches.	Smaller part of dorsum; branchiostegites glabrous.
Pubescence on pleon	All terga and pleura with setose patches.	Setose patches only on 5th and 6th somites.
Rostrum	Base distinctly ascending; 8 teeth + epigastric.	Base slightly ascending; 9 teeth + epigastric.
Adrostral sulcus	Ending just behind epigastric tooth.	Extending well behind epigastric tooth.
Branchiocardiac carina	Anterior end slightly exceeding posterior $^1/_3$ carapace.	Anterior end almost reaching posterior extension of hepatic spine.
Petasma at body length 72 mm	Fully mature.	Petasmal halves simple and separate.
5th pereopod ♂ at body length 72 mm	Notch on merus deep, spinous process fully formed.	Notch on merus hardly perceptible, spinous process small tubercle.

Metapenaeus burkenroadi Kubo, 1954

Metapenaeus burkenroadi Kubo, 1954, pp. 92–93. Dall, 1957, p. 183 (key). Racek, 1957, pp. 6–7. Cheung, 1960, pp. 66, 68.
Penaeus affinis Kishinouye, 1900, pp. 16–18.
Penaeopsis affinis Balss, 1914, p. 7; 1924, p. 44 (non de Man, 1911).
Parapenaeus affinis Rathbun, 1902, p. 38.
Metapenaeus affinis Kubo, 1949, pp. 340–44 (part synonymy only).
Metapenaeus mastersii Hall, 1962, pp. 23–24 (non Racek, 1955, 1957, 1959; Dall, 1957, 1958).

Material. 38 specimens of both sexes, 42–97 mm; QUEENSLAND: S.E. off Thursday I., coll. V. WELLS ("Paxie"), December 1960, 25 fm, mud; NORTH BORNEO: shallow brackish water at mouth of Tuaran R., coll. CHIN PHUI KONG, December 1959; Tawau Fish Market, caught with tidal net "togoh", 3–5 fm, 18.XII.1959; Sandakan Fish Market, 27.II.1953; MALAYA: Johore Bahru, coll. E. CHEAH, December 1961; comparative specimens from Japanese waters donated by Dr. I. KUBO, May 1956.

Distribution. Chiefly restricted to waters north of the equator, ranging from Japan (KISHINOUYE, RATHBUN, KUBO) through Hong Kong Seas

(CHEUNG) and Malaysia (HALL) to southern India (GEORGE, unpublished data).

Discussion. *Metapenaeus burkenroadi* has been adequately described by KUBO (1954) and RACEK (1957), and the material examined during the present study has not offered any additional criteria for discussion. HALL (1962), although not having comparative material from Australia to examine, considered this species, together with *M. dalli* Racek, synonymous with the eastern Australian species formerly named *M. mastersii* by the present authors. The distinguishing criteria in mature specimens of these 3 species have already been demonstrated by RACEK (1957) to be constant features, although the differentiation of juveniles will remain a difficult task. The authors were able to examine a wide range of specimens from Johore Bahru, which are identical with those collected in North Borneo, both having the characteristic petasma and thelycum of a typical *M. burkenroadi*. There can be no doubt as to the true identity of the specimens examined by HALL, and that author's figures 92 *a–b*, perhaps with the exception of the anterior margin of the anterior thelycal plate, certainly refer to KUBO's species.

Even though the differences between the 3 species discussed by RACEK (1957) may yet be considered as of merely subspecific importance, as HALL claims, it is inevitable that these 3 clearly distinct forms should be taxonomically separated, a fact which is obscured by merging them under the one name. Moreover, since the name *M. mastersii* can no longer be applied to the endemic eastern Australian species formerly so called, *M. burkenroadi* now has priority for the specimens examined by HALL, regardless of whether the 2 Australian forms of this group are considered conspecific or not.

M. burkenroadi has now also been found near Thursday I., although its occurrence in tropical Australian waters is apparently rare. It has recently also been recorded from South India (Mr. M. J. GEORGE, personal communication) though specimens from that area have not yet been examined by the present authors. Its apparently wide distribution in waters north of the equator is in contrast to the more restricted occurrence of *M. dalli*, which ranges from Western Australia into Indonesia, and to that of *M. bennettae* sp. nov. (previously known as *M. mastersii*), which is restricted to the eastern coast of Australia.

Metapenaeus dalli Racek, 1957

Metapenaeus dalli Racek, 1957, pp. 4–5.
Penaeopsis affinis de Man, 1911, pp. 57–58.
Metapenaeus mastersii Racek, 1955, p. 233 (Western Australian distribution). Dall, 1956, pp. 13, 15; 1957, p. 193 (Western Australian specimens).

Material. Numerous specimens of both sexes, 45–81 mm; WESTERN

AUSTRALIA: Shark Bay, Exmouth Gulf, Mandurah, Gascoyne R.; NORTHERN TERRITORY: 50 miles W.N.W. off Darwin, 18 fm, sand; INDONESIA: Eastern Java, 5 fm, mud.

Distribution. Greatest abundance along the coast of Western Australia from about Mandurah to Broome, ranging north into southern Indonesian waters, and north-east towards Darwin.

Discussion. *Metapenaeus dalli* has been adequately described by RACEK (1957) and its structural differences from the eastern Australian endemic species were also discussed by DALL (1957). Its distribution has been further substantiated by the present studies as reaching Java and its adjacent waters though apparently it does not transgress the distributional path of *M. burkenroadi*, which latter species is not uncommon in northern parts of Borneo. *M. dalli*, although ranging east to about Darwin, is absent in material collected between Darwin and Cape York from where the morphologically different species *M. insolitus* sp. nov. has now been recorded.

Metapenaeus bennettae sp. nov.

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

Penaeopsis monoceros Schmitt, 1926, pp. 325–29 (♂ 74 mm of "Endeavour" material only, Reg. No. P4287).

'"Dana" *Metapenaeus* sp. n.' Morris and Bennett, 1952, pp. 164–82 (life history and larval development).

Metapenaeus mastersii Racek, 1955, pp. 232–35; 1957, pp. 5–6; 1959, pp. 10, 12. Dall, 1957, pp. 190–93; 1958, pp. 111–32 (ecology and behaviour) (non Hall, 1962, pp. 23–24).

Material. NEW SOUTH WALES: Lake Budgewoi, Tuggerah Lakes, coll. I. BENNETT, 1945–1947, holotype ♂, 70 mm, allotype ♀, 79 mm, paratypes 23 ♂♂, 76 ♀♀, 26–95 mm, Aust. Mus. Reg. No. P 12525; additional paratypes numerous specimens of both sexes from Port Jackson (Sydney Harbour), collected and identified by HASWELL and WHITELEGGE, Aust. Mus. Reg. Nos. P 440–444; extremely numerous specimens of both sexes, larval stages to 109 mm; NEW SOUTH WALES: Coila L., Conjola L., St. George's Basin, Sussex Inlet, Greenwell Pt., Illawarra L., Sydney Harbour, Hawkesbury R., Tuggerah Lakes, L. Macquarie, Hunter R., Wallis L., L. Innes, Cathie Cr., Clarence R., Richmond R., Tweed R.; QUEENSLAND: Moreton Bay, Brisbane R., Noosa L., Mary R., Pioneer R., Cooktown (Reg. No. P 4287 – part, male 74 mm, "Endeavour" material).

Diagnosis. Rostrum slender, with slight upward curve, reaching tip of 2nd antennular segment in ♂, usually at least attaining tip of antennular peduncle in ♀, armed with 7–8 teeth + epigastric. Postrostral carina low, but distinctly visible as glabrous strip extending to about posterior $^1/_{10}$ of carapace. Adrostral sulcus ending immediately behind

epigastric tooth, which latter is situated at 1/4 carapace. Branchiocardiac carina low and short, branchiocardiac sulcus feeble, anterior end of both not exceeding posterior 1/3 carapace. Mature petasma with more or less parallel distomedian projections which are distally twisted dorso-ventrally. Mature thelycum with flask-shaped anterior plate which has a bluntly triangular anterior margin bearing a larger median conical tubercle, and a pair of less prominent anterolateral rounded tubercles; lateral plates kidney-shaped, their posterolateral margins slightly raised.

Distribution. Restricted to the greater part of the warm temperate and tropical coasts of eastern Australia, ranging from southern New South Wales to at least Bowen, Queensland, occasionally occurring further north to Cooktown.

Discussion. The reasons for the erection of this new species have already been given in the discussion of *M. ensis* (de Haan). Since *M. bennettae* has never before been described under a valid name, and its type specimens have not been designated, its separation from other species of this group by using a *nomen novum* would have been taxonomically impossible. However, a renewed detailed description of this new species is unnecessary since it has been adequately described and figured by RACEK (1955, 1957) and DALL (1957) as *M. mastersii* (Haswell). It has been named after Miss ISOBEL BENNETT, School of Biological Sciences, University of Sydney, in recognition of her extensive studies of the life history of this species.

Metapenaeus demani (Roux, 1922)

(Plate 6 fig. 5; Plate 11 fig. 5)

Penaeopsis demani Roux, 1922, pp. 599–601.

Metapenaeus demani Burkenroad, 1934*b*, p. 30. Rapson, 1955, p. 15. Dall, 1957, p. 183 (key).

Material. NEW GUINEA: Gulf of Papua, off Purari R., coll. C.S.I.R.O., 4.IV.1955, 2 ♂♂, 75, 79 mm; 8° 16′ S., 144° 12′ E., coll. Dr. A. RAPSON, 6.IV.1955, ♀, 87 mm; off Fly R. mouth, coll. Dr. A. RAPSON, 7.IV.1955, impregnated ♀, 84 mm; 8° 32′ S., 143° 55′ E., near entrance to Fly R., coll. C.S.I.R.O., 7.IV.1955, 2 ♀♀, 90, 91 mm; Orangerie Bay, Papua, coll. Dr. A. RAPSON, 14.II.1961, 17 fm, 11 ♀♀, 79–121 mm, 4 ♂♂, 73–79 mm; Orangerie Bay, Papua, coll. L. W. FILEWOOD, July 1963, 2 ♂♂, 89, 96 mm, ♀, 118 mm; QUEENSLAND: Near Cairns, coll. F. BARDSLEY, date unknown, 3 ♀♀, 78–81 mm.

Description. Body almost completely glabrous, sulci on carapace and abdomen occasionally with scarce and short tomentum. Base of rostrum abruptly ascending towards 2nd posterior rostral tooth, rostrum becoming anteriorly rather horizontal, its styliform tip somewhat upcurved; reaching tip of antennular peduncle in ♂, slightly surpassing it in ♀. Rostral

teeth 7–8+epigastric; posterior 5–6 rostral teeth placed equidistantly, the anterior 2 separated from each other by a wider space which is equal the distance between foremost tooth and rostral apex. Adrostral carina ending between penultimate tooth and epigastric, adrostral sulcus indistinct and ending just below epigastric tooth. Postrostral carina broad and low, becoming posteriorly indistinct, ending $^1/_{10}$ length of carapace from its posterior margin. Epigastric and penultimate tooth on carapace, former at $^1/_4$ carapace. Gastrofrontal sulcus barely perceptible, postocular sulcus at angle of 45° to rostrum and deep. Orbito-antennal sulcus wide but distinct, ending in front of hepatic spine. Antennal carina ending $^1/_5$ distance between antennal and hepatic spines. Cervical sulcus straight, tomentose, ending at $^1/_2$ carapace. Hepatic sulcus descending vertically in its posterior part, turning towards pterygostomial angle anteriorly. Branchiocardiac carina indistinct in its anterior part, reaching to posterior extension of hepatic spine; branchiocardiac sulcus ill-defined, glabrous and short, ending at posterior $^1/_3$ of carapace.

Antennular flagella $^9/_{10}$ length of peduncle in ♂, $^3/_5$ length of peduncle in ♀. Prosartema reaching as far as eye, stylocerite attaining tip of basal antennular segment.

Third maxilliped surpassing tip of carpocerite by dactyl; 1st pereopod attaining $^1/_2$ carpocerite, 2nd surpassing tip of carpocerite by $^1/_2$ dactyl, 3rd reaching to tip of 2nd antennular segment; 4th attaining middle of cornea, 5th exceeding scaphocerite by distal $^1/_8$ of propodus and dactylus. Distoventral keel on ischium of ♂ 5th pereopod a rounded lobe, the deep notch on merus proximally bounded by a wide and long lanceolate spinous process, which reaches distal margin of ischium and is bent outward at about 25°; meral keel without tubercles. A small but distinct ischial spine on 1st pereopod.

Abdominal somites 1 to 3 without a dorsal carina; 4th with a carina in its posterior $^7/_8$, carination becoming progressively more acute towards 6th somite, the latter with a median tooth. Telson only slightly shorter than inner uropods, its lateral margins with a single row of minute spinules.

The mature petasma is shown on Plate 6 fig. 5. Distomedian projections low, wrapping around anterior margin of distolateral projections, with a 2-lobed ventral, and an elongated dorso-lateral convolution. Distolateral projections with slightly inward curved apices.

The mature thelycum is shown on Plate 11 fig. 5. Anterior plate in its distal $^1/_2$ very broad, smoothly rounded and slightly concave, proximally very narrow, stem-like; this latter part laterally bounded by a pair of large semicircular bosses, and posteriorly by a setose triangular anterior projection of the fully fused lateral plates; lateral plates of rounded W-shape defining, together with the semicircular bosses, a bowl-like depression.

Discussion. The specimens examined agree in most details with the description by ROUX (1922) but differ from it in the following:

Criterion	Present specimens	Roux' description
Rostrum	Distinctly ascending at base; slightly surpassing antennular peduncle in ♀.	Horizontal at base; surpassing antennular peduncle by as much as 1/4 of rostrum in ♀.
Thoracic pubescence	Almost completely absent, restricted to some sulci.	Anterior part of carapace finely pubescent.
Ischial spine 1st pereopod	Small but distinct.	Not mentioned.
Thelycum	Lateral plates fused, with a median triangular anterior projection.	Lateral plates separated medially, anteriomedian projection indistinct.
Petasma	Distance between disto-lateral projections only slightly greater than width of petasma.	Distance between disto-lateral projections much greater than median width of petasma.

The differences listed, however, are of no great importance; some of them, particularly those relating to the shape of the outer genitalia, are certainly the result of incorrect drawings in Roux' paper, and the greater length of the rostra in the type material must be considered of doubtful significance. The opinion of Burkenroad (1934*b*, p. 30) that *M. demani* "seems very like" *M. macleayi* from eastern Australia, has already been contradicted by Dall (1957).

The badly preserved specimens from the Cairns area represent the first record of this species from outside New Guinea. It is therefore possible that *M. demani*, which has been considered a morphologically and geographically isolated species, may yet be found in other areas of northern Australia.

Metapenaeus endeavouri (Schmitt, 1926)

Penaeopsis endeavouri Schmitt, 1926, pp. 329–33.

Metapenaeus endeavouri Kubo, 1949, pp. 339–40. Racek, 1955, pp. 229–30; 1959, pp. 10, 12, 13. Dall, 1957, pp. 187–89.

Material. Numerous specimens of both sexes, 53–156 mm; Western Australia: Shark Bay, Exmouth Gulf; Northern Territory: Off Darwin, Joseph Bonaparte Gulf; Queensland: Gulf of Carpentaria, Mackay, Keppel Bay, Moreton Bay; New South Wales: Lennox Head, Ballina.

Distribution. Apparently endemic to Australia, ranging from Shark Bay in the west through northern coastal waters to southern Queensland, occasionally penetrating into northern New South Wales.

Discussion. This species has been adequately described and illustrated, and the specimens examined during the present study do not offer any additional criteria for discussion.

Metapenaeus intermedius (Kishinouye, 1900)
(Plate 6 fig. 7; Plate 11 fig. 6)

Penaeus intermedius Kishinouye, 1900, pp. 21–22.
Metapeneus ensis Alcock, 1906, pp. 24–25.
Penaeopsis ensis Balss, 1914, p. 8. Yokoya, 1933, p. 9.
Penaeopsis intermedia var. *anchista* de Man, 1922, pp. 5–8.
Metapenaeus intermedius Burkenroad, 1934*b*, pp. 36–40. Kubo, 1949, pp. 333–40. Hall, 1956, pp. 78–79; 1962, p. 23. Dall, 1957, pp. 183 (key), 189. Cheung, 1960, p. 66.

Material. NORTH BORNEO: Off Sandakan, trawled by CHIN PHUI KONG, 5.XI.1959, 7 fm, mud, ♂ 79 mm; JAPAN: ♀, 142 mm, donated by Dr. I. KUBO and used by him for his (1949) figure 122.

Distribution. Japan, Hong Kong, Malaysia.

Discussion. The single male from North Borneo agrees in all details with the description of a male from the Kei Is. by DE MAN (1922), who demonstrated the presence of a number of criteria which are at variance with the description of *M. intermedius* by KISHINOUYE (1900). The male at hand also possesses all the criteria tabulated by KUBO (1949, pp. 338–39) for the differentiation of DE MAN's "variety" *anchista* from Japanese specimens of *M. intermedius*: the setose patch below the glabrous branchiocardiac strip is absent; the transverse setose groove on the 1st pleonic tergum is simple; the cervical sulcus is unusually long and extends to the vicinity of the adrostral sulcus; the distomedian projections of the petasma are much shorter than the distolateral projections, which latter are directed almost completely anteriorly.

BURKENROAD (1934*b*) discussed certain discrepancies between the descriptions of *M. intermedius* by KISHINOUYE (1900) and SCHMITT (1926), and indicated the identity of BALSS' (1914) specimens with DE MAN's variety *anchista*. KUBO (1949) has since extensively redescribed KISHINOUYE's species from Japan so that it is readily distinguishable from the now equally well-known *M. endeavouri* (Schmitt) from northern Australia.

The examination of the single male specimen at hand does not allow the authors to revise the status of DE MAN's *P. intermedia anchista*, and females of this "variety" from the Indonesian–Malaysian region were not available for direct comparison. However, should the thelycal structures of specimens from that region be found as distinct from *M. intermedius* as DE MAN's (1922) and HALL's (1962) figures seem to indicate, *P. intermedia anchista* will have to be raised to specific rank since it would then differ from KISHINOUYE's species by criteria similar in number and importance to those separating *M. endeavouri* (Schmitt) from *M. intermedius* (Kishinouye).

The typical thelycum of *M. intermedius* from Japanese waters is shown on Plate 11 fig. 6 in order to facilitate its future comparison with that structure in DE MAN's "variety".

Metapenaeus lysianassa (de Man, 1888)
(Plate 6 fig. 10; Plate 11 fig. 7)

Penaeus lysianassa de Man, 1888, pp. 290–95.
Metapeneus lysianassa Alcock, 1906, pp. 23–24.
Metapenaeus lysianassa Burkenroad, 1934*b*, p. 36. Kubo, 1949, pp. 359–361; Hall, 1956, pp. 82–83; 1962, p. 24. Dall, 1957, p. 183 (key).

Material. North Borneo: Sandakan Fish Market, coll. Chin Phui Kong, 27.II.1953, ♂ 55 mm, 2 ♀♀, 62, 67 mm; off Tawau, coll. Chin Phui Kong, 18.XII.1959, tidal net "togoh", 3–5 fm, 5 ♀♀, 64–88 mm.

Distribution. Eastern Indian waters to North Borneo.

Discussion. Hall (1962) drew attention to consistent differences in petasmal structures between specimens of this species from the general region between India and Malacca, and those collected between Penang and Sumatra, and suggested the erection of a "variety" *M. lysianassa malaccaensis* for the latter group. Although the females of Hall's material, as well as those examined by the present authors, do not show any appreciable differences from those depicted by de Man (1888) and Alcock (1906), the petasma of the male from North Borneo is distinctly at variance with the figures of both these authors, but fully comparable with Hall's (1962) figure 93*e* referring to his *M. lysianassa malaccaensis*. The distolateral projections of the petasma examined lack the deep cleft present in the petasma of the "western" form, and the lateral spine on these projections is extremely small. The identity of the male at hand with the "variety" of Hall is thus established beyond doubt, and the range of this aberrant form can now be extended to North Borneo. Future research may justify the necessity of splitting *M. lysianassa* into two subspecies, i.e. *M. lysianassa lysianassa* and *M. lysianassa malaccensis*, as already suggested by Hall.

The conjoined white pads attached to the thelycum of 4 females from Tawau are of the same shape as those depicted by Kubo (1949, p. 355). However, these pads are fixed at an angle to the longitudinal axis of the thelycum, and one is inserted at full 90°. This unusual position in impregnated females of this species was first recorded by Burkenroad (1934*b*, p. 36).

As already pointed out by Burkenroad (1934*b*), *M. lysianassa* belongs to a group of *Metapenaeus* spp. which are clearly separable from other species of this genus by a number of morphological features as well as by the presence, in fertilized females, of the conjoined pads already mentioned. In this group the distomedian projection of the petasma usually produces a readily visible free filament or auxiliary lobe, a paired petasmal structure which is very conspicuous in 3 species, i.e. *M. joyneri* (Miers), *M. brevicornis* (Milne Edwards), and *M. tenuipes* Kubo. The presence of petasmal filaments in *M. dobsoni* (Miers) has since been demonstrated by Burkenroad (personal communication), and these structures will be mentioned in the discussion of *M. dobsoni* below.

M. lysianassa was hitherto considered to lack distomedian petasmal filaments, although it shares all other distinguishing criteria with the remainder of the group. Even though complete petasmal filaments could not be found in the male from North Borneo, a close examination of its petasma revealed a stumpy prominence on each ventral posteromedian corner of the distomedian projections which most probably represents the rudiment of such an apical outgrowth (Plate 6 fig. 10). The authors were unable to examine the petasma of the "western" form, as figured by DE MAN and ALCOCK, but the presence of a similar distoventral pair of petasmal prominences in the "true" *M. lysianassa* is most likely.

Metapenaeus dobsoni (Miers, 1878)
(Plate 6 figs. 6, 8, 9; Plate 11 fig. 8)

Penaeus dobsoni Miers, 1878, p. 302.
Metapenaeus dobsoni Nobili, 1903, p. 3. Menon, 1952, pp. 80–93. Dall 1957, p. 183 (key). Hall, 1962, p. 25.
Metapeneus dobsoni Alcock, 1906, pp. 21–22.
Penaeopsis sp. de Man, 1911, pp. 60–61.
Penaeopsis dobsoni Kemp, 1915, p. 322.

Material. 36 ♀♀, 13 ♂♂, 56–104 mm; INDONESIA: Djangkaran, Djokjakarta, Tjilatjap; PHILIPPINES: Manila Bay; CEYLON: Balapitiya Lagoon; INDIA: Narakkal.

Distribution. Indian waters (most authors) through Malaysia (HALL) and Indonesia (DE MAN) to Philippine Is.

Discussion. The specimens examined agree well with the previous descriptions of *M. dobsoni*. BURKENROAD (personal communication) has drawn attention to the fact that the free filament of the distomedian projection of the petasma, which is readily visible in other related species of this genus, is also present in this species. It follows the anterior curvature of the distomedian projection and is thus hidden in dorsal view. The position of the pair of filaments can be seen in the photograph on Plate 6 fig. 8, as well as in figure 98*a* of HALL's (1962) paper. The thelycum, which is shown on Plate 11 fig. 8, is obscured in impregnated females by a pair of white conjoined pads; these have a broadly triangular outline, tapering from a broad posterior base to a bluntly rounded anterior tip, and can thus be readily distinguished from those of other species.

The strong basial spine on the ♂ 3rd pereopod is shown on Plate 6 fig. 6. In 2 immature males from Indonesia this spine is short and lacks the terminal hook-like tooth, but its base is considerably wider than that of the basial spines on the 1st 2 chelipeds. This feature enables a ready distinction of juvenile males of *M. dobsoni* from those of other species, perhaps with the exception of *M. joyneri* where a similar basial spine can be found on the ♂ 3rd pereopod.

Unlike *M. lysianassa*, which often possesses a small but perceptible spine on the ischium of the 1st pereopod, *M. dobsoni* seems to lack this structure completely.

Metapenaeus brevicornis (H. Milne Edwards, 1837)
(Plate 6 fig. 11; Plate 12 fig. 1)

Penaeus brevicornis H. Milne Edwards, 1837, p. 417. Bate, 1881, p. 180. Lanchester, 1901, p. 571.
Metapeneus brevicornis Alcock, 1906, pp. 22–23.
Penaeopsis brevicornis Kemp, 1918, pp. 294–95.
Metapenaeus brevicornis Burkenroad, 1934*b*, pp. 33–36. Kubo, 1949, pp. 351–55. Hall, 1956, p. 81; 1962, pp. 24–25. Dall, 1957, p. 184 (key).
? *Penaeus avirostris* Dana, 1852, p. 603.
Penaeopsis avirostris Balss, 1914, p. 10.
Penaeus sp. Lanchester, 1901, pp. 571–72.

Material. 29 ♂♂, 41 ♀♀, 53–129 mm; MALAYA: Fishmarket Penang; NORTH BORNEO: Sandakan Harbour, Labuan, Sandakan Fishmarket; INDONESIA: Tjilatjap (Java). Depth of occurrence 2–23 fm.

Distribution. West Pakistan through Indian, Malaysian, Thai, and Indonesian waters to about East Borneo.

Discussion. *M. brevicornis* has been adequately described, and a detailed account of the various criteria found in the specimens examined is therefore not necessary. KUBO (1949) described the telson of this species as "devoid of lateral spines", a condition which is present in only 5 adult specimens of our material. All other adult specimens examined possess a pair of clearly perceptible distal spines, and in addition a series of minute spinules extending proximad to about $^2/_3$ of the length of the telson. In this regard our specimens are fully comparable with those described by DE MAN (1924*b*) and BURKENROAD (1934*b*).

The typical petasma (Plate 6 fig. 11) and thelycum (Plate 12 fig. 1) of this species will always readily separate adult specimens of *M. brevicornis* from those of the closely related *M. lysianassa* and *M. tenuipes*. The different outline of the white conjoined pads on the thelycum of impregnated females of these three species are, as already shown by KUBO (1949), a useful additional distinguishing criterion. The distinction of juveniles of *M. brevicornis* from those of *M. lysianassa* has already been discussed by BURKENROAD (1934*b*); however, the distinction of juveniles of the former from those of *M. tenuipes* Kubo will remain a difficult task, particularly when examining males with separate petasmal halves.

The ischial spine of the 1st percopod of *M. brevicornis* is well developed in both sexes, and only slightly smaller than the basial spine. This feature is already clearly perceptible in the smallest specimen examined (53 mm) and is therefore useful in the separation of juveniles of this species from those of *M. tenuipes*.

The identity of *Penaeus avirostris* Dana, 1852, has still to be resolved. HALL (1962) drew attention to the fact that the specimens in the British Museum, attributed to DANA's species, were so named by BURKENROAD in 1939, although they are typical representatives of *M. brevicornis*. HALL concluded from this that *P. avirostris* should therefore be relegated to a synonym of MILNE EDWARDS' *P. brevicornis*, since this specific name takes priority. However, DANA's (1852) description could equally apply to the species at present known as *M. tenuipes* Kubo (=*M. spinulatus* Kubo), a view which is now held by BURKENROAD (personal communication.) The present authors were unable to examine and compare the type specimens involved, and are therefore not in a position to clarify the status of *P. avirostris*.

Metapenaeus tenuipes Kubo, 1949
(Plate 7 fig. 1; Plate 12 fig. 2)

Metapenaeus tenuipes Kubo, 1949, pp. 348–51. Dall, 1957, p. 184 (key).
Metapenaeus spinulatus Kubo, 1949, pp. 355–59. Hall, 1956, pp. 81–82; 1962, p. 25. Dall, 1957, p. 184 (key).
? *Penaeus avirostris* Dana, 1852, p. 603.

Material. 9 ♂♂, 36 ♀♀, 53–97 mm; INDONESIA: Kuala Sungsang (Sumatra); NORTH BORNEO: Brunei Bay, brackish water; Labuan, 2–15 fm.

Distribution. Thailand to Java.

Discussion. *M. tenuipes* has been adequately described by KUBO (1949) under this specific name (males), as well as under the name of *M. spinulatus* (females), and its detailed redescription is therefore unnecessary. The erection of the separate species *M. spinulatus* by KUBO was obviously aided by the fact that *M. tenuipes* displays a number of morphological features which are sexually dimorphic to a greater degree than in other related species of this group. KUBO's failure in recognizing that *M. tenuipes* and *M. spinulatus* belong to the same species, can furthermore be explained by his lack of females of the former, and males of the latter species. The material examined during the present study revealed clearly that KUBO's 2 species represent the males and females of one species, and should therefore be united. Since *M. tenuipes* has page priority in KUBO's (1949) paper, *M. spinulatus* must be relegated to a synonym.

Features of sexual dimorphism in this species are the pubescence on carapace and abdomen, the shape and dentition of rostrum, the length of pereopods, the length of the ischial spine on 1st pereopod, and the armature of the telson. The tomentose areas on carapace and pleon of males examined during the present study are not as large or numerous as those shown by KUBO; nor is the body of females devoid of similar patches justifying KUBO's description "shell glabrous". However, in most

of our males the pubescence appears slightly more pronounced than in the females examined. The rostrum in males lacks the posterior triangular crest present in females, and the dentition in males is 5–6 + epigastric, while in the females of our series there are 6–7 teeth + epigastric. The pereopods are all longer in females than in males. The ischial spine on the 1st pereopod is small in both sexes, but in males it is obscured by long tomentum and can be easily overlooked. The telsonic spinules in males progressively increase in size towards the apex of the telson, and the distal pair of "spines" are therefore less distinct than in females, in which there is an abrupt increase in the length of these spinules in the posterior $^1/_3$ of the telson.

The petasma, which is shown on Plate 7 fig. 1, is similar to that of *M. joyneri*. The thelycum (Plate 12 fig. 2) is readily distinguishable from that of other species, although it shows close affinities to *M. brevicornis*.

As already mentioned in the discussion of the foregoing species, BURKENROAD (personal communication) considers both *M. tenuipes* and *M. spinulatus* synonymous with DANA's (1852) *P. avirostris*. The relative paucity of specimens of *M. tenuipes* available, and the somewhat obscure description of DANA's species, make it impossible for the present writers to attempt such a revision, and it is thought advisable to retain KUBO's specific name until additional information is available.

Metapenaeus eboracensis Dall, 1957
(Plate 7 fig. 2; Plate 12 fig. 3)

Metapenaeus eboracensis Dall, 1957, pp. 193–96. Racek, 1959, p. 10.

Material. 13 ♂♂, 29 ♀♀, 61–111 mm; NORTHERN TERRITORY: Van Diemen's Gulf, Chambers Bay; QUEENSLAND: S.E. off Thursday I., Gulf of Carpentaria, Princess Charlotte Bay, Townsville; NEW GUINEA: Daru, Orangerie Bay, Kinikini Bay. Depth of occurrence 2–15 fm.

Distribution. Northern Territory to Gulf of Carpentaria, through Torres Strait north to Papua, south to about Townsville, Queensland.

Discussion. *M. eboracensis* has been adequately described by DALL (1957) and the examination of the present specimens has not offered any criteria for further discussion. However, the petasma and the thelycum of mature specimens have been photographed in order to augment the drawings accompanying DALL's original description.

This species is probably also closely related to *M. dobsoni* and its allies, although it is distinct from that group in the complete absence of petasmal filaments or their rudiments, and conjoined white pads on the thelycum of impregnated females have not yet been observed.

The range of this species, originally thought to represent an Australian endemic form, can now be extended to New Guinea in the north and to the Darwin area in the west.

Genus **Atypopenaeus** Alcock

Atypopeneus Alcock, 1905, p. 524; 1906, p. 45.
Atypopenaeus de Man, 1911, p. 83. Kubo, 1949, p. 365.
Atyopenaeus Dall, 1957, pp. 198–99.

Type-species by original designation: *Penaeus compressipes* Henderson, 1893.

Prior to the revision of DALL (1957), who amended the generic definition of ALCOCK (1905, 1906), this genus comprised only two determinable species, i.e. *A. compressipes* (Henderson), the type species, and *A. dearmatus* de Man. DALL (1957) described an additional species, *A. formosus*, from north-eastern Australia, and the present investigations revealed the presence of still another species, *A. bicornis* sp. nov., in waters of New Guinea. HALL (1962) has relegated *A. compressipes* to a synonym of *A. stenodactylus* (Stimpson), an approach which as yet cannot be followed by the present authors, since in their material *A. compressipes* is represented by only a solitary female from New Guinea. *A. dearmatus* is not present in the collections for the present study.

Atypopenaeus compressipes (Henderson, 1893)
(Plate 12 fig. 4)

Penaeus compressipes Henderson, 1893, pp. 450–51.
Atypopeneus compressipes Alcock, 1906, pp. 45–46.
Atypopenaeus compressipes de Man, 1911, pp. 83–84. Kubo, 1949, pp. 366–68.
Atyopenaeus compressipes Dall, 1957, p. 199 (key).
Parapenaeopsis brevirostris Kubo, 1936, pp. 55–58.
? *Penaeus stenodactylus* Stimpson, 1860, p. 431.
? *Atypopenaeus stenodactylus* Hall, 1962, pp. 25–26.

Material. NEW GUINEA: Yule I., Papua, mud, coll. L. W. FILEWOOD, October 1962, ♀, 46 mm.

Distribution. Indian seas through Malaysian and Hong Kong waters to Japan.

Discussion. The single female examined, which represents the first record of this species from New Guinea, agrees in all major details with the previous descriptions of *A. compressipes*, except in some minor points as discussed by KUBO (1949). It is possible that distant populations will be found to show certain speciation trends, and detailed studies of this species and its allies appear desirable. The status of *P. stenodactylus* Stimpson from Hong Kong has still to be resolved. HALL (1962) relegated the readily determinable *A. compressipes* to a synonym of STIMPSON's (1860) species without giving any reasons for his decision, other than a reference to an apparently still unpublished manuscript. Even though *P. stenodactylus* certainly must be considered congeneric, its identity with *A. compressipes* has yet to be demonstrated. *P. stenodactylus*, judging from STIMPSON's description, still differs from *A. compressipes* by

the shorter postrostral carina, the finely granulated dorsum of the carapace, and the greater length of the outer maxillipeds, which extend beyond the antennal scales (fide DE MAN, 1911). In these details, the female from New Guinea is distinctly different from STIMPSON's description of *P. stenodactylus*, while it is readily comparable with all previous descriptions of *A. compressipes*.

Atypopenaeus formosus Dall, 1957
(Plate 7 figs. 3, 4; Plate 12 fig. 5)

Atyopenaeus formosus Dall, 1957, pp. 199–202.
Atypopenaeus formosus Racek, 1959, pp. 10, 12.

Material. 7 ♂♂, 15 ♀♀, 43–81 mm; NORTHERN TERRITORY: Joseph Bonaparte Gulf, coll. V. WELLS ("Paxie"), 5.X.1961, 17 fm, coral and polyzoa; Chambers Bay, coll. V. WELLS ("Paxie"), 7.XI. 1959; QUEENSLAND: Keppel Bay, coll. "Challenge", July 1957; NEW GUINEA: 8 miles E. off Parama I., in the Fly R. mouth, coll. L. W. FILEWOOD, July 1963.

Distribution. Moreton Bay (type locality) to Gulf of Carpentaria, Queensland, ranging west to the Darwin area, Northern Territory, and north into Papua, New Guinea.

Discussion. *A. formosus* has been adequately described by DALL (1957), and the present material has not offered any additional criteria for discussion. However, the petasma and thelycum of this species have been photographed in order to augment DALL's original illustrations. The range of this species can now be extended west to the vicinity of Darwin, Northern Territory, and north to Papua, New Guinea.

Atypopenaeus bicornis sp. nov.
(Figure 14; Plate 7 figs. 5, 6; Plate 12 fig. 6)

Material. NEW GUINEA: Off Fly R. mouth, coll. Dr. A. M. RAPSON, 6.IV.1955, holotype ♂, 61 mm, allotype ♀, 76 mm, paratypes 2 ♀♀, 65, 73 mm; paratypes: off South Fly R., 7.IV.1955, ♀, 74 mm; Yule I., Papua, coll. L. W. FILEWOOD, October 1962, ♂, 58 mm; 8 miles E. off Parama I., in the Fly R. mouth, coll. L. W. FILEWOOD, July 1963, ♀, 70 mm.

Description. Rostrum strongly sexually dimorphic; in ♂ distinctly sigmoid, its anterior $^1/_2$ edentate and styliform, reaching to middle of 2nd antennular segment, dorsally armed with 2 wide-set teeth + epigastric; in ♀ long, slender, and upcurved, teeth uniformly spaced along its entire length, exceeding tip of antennular peduncle, dorsally armed with 5–6 wide-set teeth + epigastric; in both sexes epigastric and penultimate tooth on carapace. Adrostral carina and sulcus absent. Postrostral carina distinct but flat, ending at $^1/_5$ length of carapace from its posterior margin. Postocular sulcus very deep, indenting base of rostrum, running at an angle of 40° to rostrum, sigmoidal in lateral view. Orbital spine completely

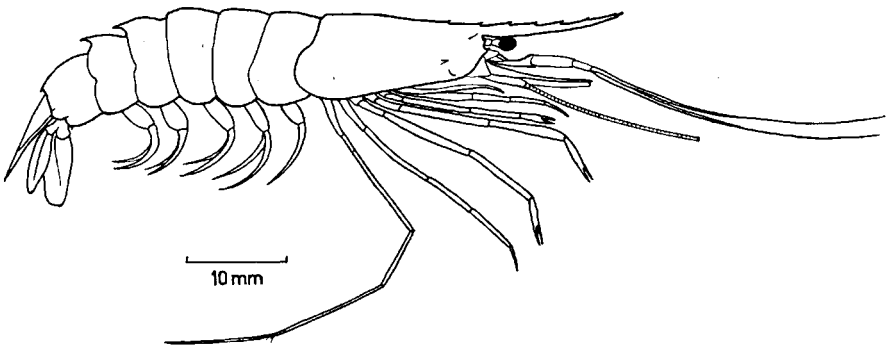

Fig. 14. *Atypopenaeus bicornis*, sp. nov., ♀, 65 mm, paratype, Fly R. mouth.

absent in ♂, in ♀ represented by a blunt tubercle. Antennal and hepatic spines small and conical; cervical sulcus extremely short and barely perceptible. A wide shallow indentation only in front of and below hepatic spine, sulcus absent. Branchiocardiac sulcus feebly indicated.

Eyes with slender peduncle, cornea (measured anteroposteriorly) from $^1/_{10}$ to $^1/_{12}$ length carapace.

Antennules with equal flagella, which are $2^1/_2$ length of antennular peduncle and $1^3/_4$ length carapace in ♂, slightly more than twice length antennular peduncle and about $1^1/_2$ length carapace in ♀. Prosartema reaching tip of junction of optic peduncle with cornea; stylocerite attaining $^2/_3$ basal segment. Second segment cylindrical, equal length of 1st; 3rd segment somewhat less than $^1/_3$ length 2nd, often inclined at blunt angles to it.

Third maxilliped reaching to tip of 2nd antennular segment; 1st pereopod exceeding carpocerite by entire chela; 2nd and 3rd surpassing tip of scaphocerite by $^1/_4$ carpus and entire chela, 4th by $^1/_4$ dactylus; 5th almost attaining tip of antennular flagella. Excepting 5th legs, thoracic appendages with long and dense setae, particularly on ventral edges of 2nd to 4th pereopods. Fifth pereopods very slender, particularly the distal 3 joints; dactylus usually long and filiform, a small tuft of apical setae on propodus. Telson without lateral spines or spinules.

A broad and low dorsal carina on 1st and 2nd abdominal somites, as well as in anterior $^1/_2$ of 3rd, a sharp carina beginning in posterior $^1/_2$ of 3rd pleonic tergum and extending to posterior margin of 6th; a conspicuous spine, arising from a flat and wide base, on posterior end of carina on 4th and 5th somite; small spine on tergum of 6th, often broken off, resulting in a bluntly or sharply rounded shape of the posteromedian angle.

The petasma is shown on Plate 7 figs. 5, 6. The prominent distolateral projections have the shape of curved incisor teeth, projecting forwards and bent inwards; their apices are bluntly serrated; 2 small and ovoid distomedian projections at the base of the "incisors".

The thelycum is shown on Plate 12 fig. 6. Anterior plate lanciform with oval median depression and spinous apex, coxal projections from 4th pereopod lying above it; posterior margin slightly convex. Lateral plates parallel to each other, flattish and leaf-shaped, enclosing posterior part of anterior plate; posteriorly the lateral plates meet a U-shaped extension of the posterior sternal plate, making an almost circular seminal receptacle.

Colour in life. Given by our collectors as a bright pink.

Distribution. So far known only from the type locality.

Discussion. *A. bicornis* shows close affinities to *A. compressipes* in regard to its petasma, but differs from the latter species, as well as from *A. dearmatus* in a great number of characters. It is very closely related to *A. formosus*, sharing with it the peculiar and long rostrum, the prominent abdominal median spines, and a similar arrangement of the thelycal structures. However, it differs from *A. formosus* in the features on next page.

All the specimens of *A. bicornis* examined were found to emit a strong and unpleasant odour, even though they were kept in alcohol for a relatively long time. The writers are as yet unable to ascertain whether this apparently characteristic odour is perceptible in live or freshly dead specimens, and field observations are desirable.

Genus **Trachypenaeus** Alcock

Trachypeneus Alcock, 1901, p. 15; 1906, p. 43. Burkenroad, 1934*a*, pp. 94–96.
Trachypenaeus de Man, 1911, pp. 87–88. Balss, 1914, p. 11. Kubo, 1949, pp. 391–92. Liu, 1955, p. 14. Dall, 1957, p. 202.

Type-species by original designation: *Penaeus anchoralis* Bate, 1881.

BURKENROAD (1934*a*), in his desire to demonstrate specified taxonomic characters within the genus *Trachypenaeus*, established two subgenera, *Trachypenaeus* and *Trachysalambria*, largely on the presence or absence of mastigobranchiae on the 1st and 2nd pereopods. However, since prior to 1962 only one species of the subgenus *Trachysalambria*, i.e. *T. curvirostris*, was known from the Indo-West Pacific, most of the workers on material from that region considered a subdivision of *Trachypenaeus* (Alcock) unnecessary. The description of an additional species, *T. sedili*, by HALL (1962), and the discovery of the similarly aberrant *T. gonospinifer* sp. nov. by the present writers, made it clear that these 2 species do not readily fit into any of BURKENROAD's subgeneric divisions. Both have mastigobranchiae on their 1st and 2nd pereopods, and would thus fall into BURKENROAD's subgenus *Trachysalambria*. However, their thelycum is quite an unusual structure, and cannot be interpreted as consisting of "a pair of invaginated sperm sacs, whose apertures are continuous medially with the opening of an unpaired pocket into which sperm-free male secretion is received" (BURKENROAD, 1934*a*, p. 94).

Criterion	*A. bicornis*	*A. formosus*
Rostrum	Strongly sexually dimorphic.	Similar in both sexes.
Postrostral carina	Flat but distinct.	Indistinct to absent.
Orbital spine	Rounded tubercle in ♀, absent in ♂.	Small but distinct in both sexes.
Cornea	$^1/_{10}$–$^1/_{12}$ length carapace.	$^1/_7$ length carapace.
Antennular flagella	$2^1/_2$ length of peduncle in ♂; twice length of peduncle in ♀.	Length of peduncle in ♂; at least twice length of peduncle in ♀.
Third maxilliped	Reaching to tip of 2nd antennular segment.	Reaching $^1/_2$ 2nd antennular segment.
First pereopod	Exceeding carpocerite by chela.	Exceeding carpocerite by dactyl.
2nd and 3rd pereopods	Surpassing tip of scaphocerite by $^1/_4$ carpus and chela.	Reaching about $^1/_2$ 2nd antennular segment.
Fourth pereopod	Surpassing tip of scaphocerite by $^1/_4$ dactylus.	Slightly exceeding base of 2nd segment.
Fifth pereopod	Almost attaining tip of antennular flagella; dactylus as long as propodus.	Slightly exceeding tip of antennular peduncle; dactylus much shorter than propodus.
Pleonic carination	Begins on 1st somite; acute spines on terga of 4th–5th somites strongly raised.	Begins on 4th somite; acute spines on terga of 4th–5th somites moderately raised.
Distolateral petasmal projections	Incisor-like, curved.	Ovoid, smoothly rounded.
Thelycum	Lateral plates flattish leaf-like; anterior extension of posterior sternal plate U-shaped, receptacle nearly circular.	Lateral plates a rounded bar shape; anterior extension of posterior sternal plate V-shaped, receptacle pentagonal.

The present writers consider it therefore advisable to treat their material as belonging to the genus *Trachypenaeus* (Alcock), as amended by DALL (1957). At the present, no effort is made to accentuate the possible interspecific relationship of the Indo–West Pacific species of this genus studied.

For the differentiation of the hitherto-known species of *Trachypenaeus* the reader is referred to DALL's (1957, p. 203) key, as well as to the recent work of HALL (1962, pp. 180–81). In view of the pronounced speciation trends perceptible in the majority of species of this genus, a revised key cannot as yet be contemplated and additional observations are desirable.

Trachypenaeus curvirostris (Stimpson, 1860)

Penaeus curvirostris Stimpson, 1860, p. 44. Kishinouye, 1900, p. 23.
Penaeus granulosus Miers, 1884, p. 295 (non Haswell, 1879, 1882).
Parapenaeus curvirostris Rathbun, 1902, p. 38.
Trachypeneus asper Alcock, 1905, p. 531; 1906, p. 43.
Trachypeneus curvirostris Alcock, 1905, p. 523. Schmitt, 1926, pp. 353–58. Hall, 1962, p. 29.
Trachypeneus (*Trachysalambria*) *curvirostris* Racek, 1955, pp. 235–56 (except fig. 4, Plate 7); 1959, p. 10.
Trachypenaeus curvirostris Balss, 1914, p. 11; 1924, p. 44. Kubo, 1949, pp. 393–95. Liu, 1955, pp. 14–16. Dall, 1957, pp. 203–06. Cheung, 1960, p. 65 (key).

Material. Numerous specimens of both sexes, 22–91 mm; WESTERN AUSTRALIA: Shark Bay, Exmouth Gulf; NORTHERN TERRITORY: Off Darwin; QUEENSLAND: Bowen, Repulse Bay, Mackay, Keppel Bay, Heron I., Sandy Cape, Moreton Bay, Southport; NEW SOUTH WALES: Ballina, Evans Head, Yamba, Sydney Harbour; NEW GUINEA: Kinikini Bay, Yule I.; NEW BRITAIN: Wide Bay; comparative specimens from Japanese waters, and Mafia Archipelago, Tanganyika.

Distribution. From eastern Africa through Indian and Malaysian waters to Japan and Australia. Depth of occurrence 10–30 fm.

Discussion. *T. curvirostris* has been adequately described and figured, and the material examined has not offered any additional criteria for discussion. In spite of its apparently wide distribution, this species is not present in material collected for the present study from Indonesia, North Borneo, or the Philippines. Its occurrence in coastal waters of Northern Australia is also somewhat rare, a phenomenon which can possibly be explained by the preference of *T. curvirostris* for greater depths (DALL, 1957).

Trachypenaeus gonospinifer sp. nov.
(Figure 15; Plate 7 figs. 7, 8; Plate 12 fig. 7)

Material. NEW GUINEA: S. of Port Romilly, 7° 55′ S., 144° 48′ E., coll. Dr. A. M. RAPSON, 6.IV.1955, 7 fm, holotype ♀, 74 mm; Fly R.

estuary, off Kiwai I., 26.IV.1955, paratypes, 2 ♀♀, 62, 65 mm; Fly R. mouth, 6.IV.1955, paratype ♀ 68 mm; NORTHERN TERRITORY: Chambers Bay, 12° 12′ 8″ S., 131° 31′ 2″ E., coll. V. WELLS ("Paxie"), 7.XI.1959, 9 fm, grey mud, allotype ♂, 45 mm, paratypes 4 ♀♀, 34–39 mm, 2 ♀♀, 40, 58 mm.

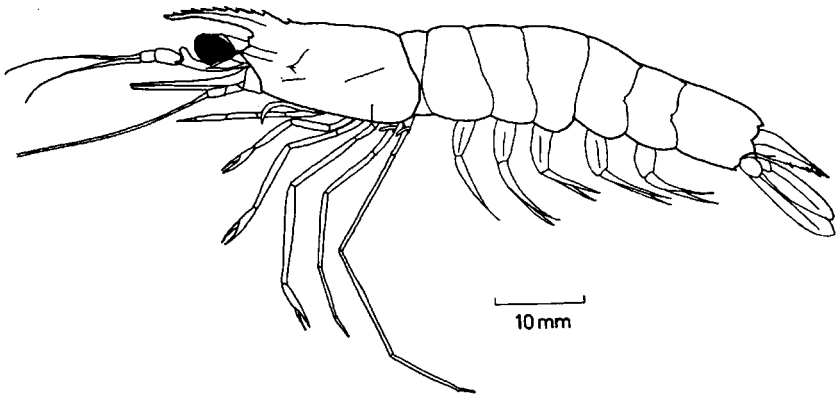

Fig. 15. *Trachypenaeus gonospinifer*, sp. nov., ♀, 74 mm, holotype.

Description. Base of rostrum ascending well above level of carapace, distal 1/2 recurved to horizontal position in both sexes and very slender; upper rostral margin distinctly convex; rostrum only slightly exceeding tip of basal antennular segment in ♂, reaching 1/3–2/3 2nd antennular segment in ♀; armed with 7–9 (usually 8) teeth + epigastric, the latter and the penultimate tooth on carapace. Adrostral carina slightly sigmoidal, ending below penultimate rostral tooth. Postrostral carina distinct but low, reaching to posterior margin of carapace. Longitudinal suture reaching almost to level of epigastric tooth at 1/5 carapace. An indistinct and short transverse suture at the bases of 3rd pereopods. A shallow postocular sulcus present below end of adrostral carina; orbital angle sharp; gastro-orbital carina and orbito-antennal sulcus absent. Cervical sulcus feeble and shallow. Antennal carina reaching 1/2 distance between tip of antennal and hepatic spines. A shallow sulcus below hepatic spine; branchiocardiac carina distinct, 1/3 length carapace. Pterygostomial angle sharp.

Antennular flagella subequal, upper flagellum longer than lower, 1 1/3 as long as peduncle, and about as long as carapace. Prosartema reaching as far as eye, stylocerite almost attaining 1/2 basal segment.

Scaphocerite exceeding antennular peduncle by 1/5 its length; carpocerite reaching 2/3 cornea.

Mandibular palp reaching base of carpocerite, distal segment 3/5 as wide as long, triangular, with distolateral margin straight. Incisor process

with 2 well separated teeth, molar process with 2 flat posterior teeth, and 2 rounded anterior tubercles. Maxillular palp unsegmented with 2 inner projections; the proximal rounded and setose, the distal acute and bearing 2–3 sharp spines; posterodistal surface with a row of 6 sharp spinules.

Third maxilliped reaching as far as, or slightly exceeding, tip of basal antennular segment; 1st pereopod exceeding tip of carpocerite by dactyl; 2nd reaching to tip of antennular peduncle, 3rd exceeding it by dactyl; 4th about as long as 2nd; 5th very long and slender, and exceeding tip of scaphocerite by at least $^1/_2$ propodus and dactylus. Basial spines on 1st and 2nd pereopod, and a small ischial spine on 1st. Mastigobranchiae on 1st–3rd pereopods.

A small and elongated median tubercle on 2nd abdominal somite, dorsal carina beginning from anterior margin of 3rd somite; 4th and 5th somites with posteromedian notch and 2 acute processes on either side; 6th somite with a small median tooth, and a pair of small lateral teeth below the rounded postero-inferior angle. Telson shorter than inner uropods, armed with 3 pairs of mobile spinules, the subapical set larger than the 2 preceding pairs.

Cardiac plate of gastric mill with 10–12 small indistinct spinules. Zygocardiac ossicle consisting of an upper portion, the 1st tooth large and triangular, followed by 3–4 flat-topped teeth, then a row of 6–8 small sharp teeth; below the 1st tooth a smaller conical tooth, and below this a cluster of 5–6 small spines; lower portion a large tooth, followed by a row of about 10 smaller teeth. Prepyloric ossicle with 12–14 teeth on either side.

The petasma is shown on Plate 7 figs. 7, 8. Distolateral projections very broad, lateral tips curving forward, anteromedian processes broadly triangular; distomedian projections curved ventrally, fully closing distal opening of petasma. Greatest width of petasma across distolateral projections in about anterior $^1/_3$ of its length, almost equal to length.

The thelycum is shown on Plate 12 fig. 7. Anterior plate broadly oval, representing the wide base of a large forwardly directed spine with slightly broadened and flattened apex; lateral plates heavily chitinized, with posterior semicircular rim extending anteriorly to enclose a shallow and smooth lunar depression. In fertilised females a pair of brownish spermatophores are implanted on either side of the lunar depression.

Colour in life. Not yet observed.

Distribution. To date known only from southern New Guinea, and the vicinity of Darwin, Northern Territory.

Discussion. At the time of the discovery of *T. gonospinifer* in material from New Guinea, which contained only female specimens, the assessment of the generic position of this species presented certain difficulties. The thelycum was then incomparable with that of any other species of the subfamily Penaeinae, and the apparent absence of mastigobranchiae on

the 3rd pereopods pointed to a relationship to the genus *Parapenaeopsis*, even though the carapace, the short longitudinal suture, and the telsonic armature were more reminiscent of *Trachypenaeus* spp. However, the subsequent collection of specimens of both sexes of our new species from waters off the Northern Territory revealed clearly that epipodites are present on the 3rd pereopods, and that the petasma, although slightly aberrant, is that of a typical *Trachypenaeus* sp.

Meanwhile, HALL (1962) recorded and illustrated a new *Trachypenaeus* sp., *T. sedili*, from Malaysian waters, of which the male is still unknown. Judging from that author's depiction of this species, the thelycum shows close affinities to that of *T. gonospinifer*, and so do the filiform 5th pereopods, and the sharply pointed and slender rostrum. Since *T. sedili* has not yet been described (HALL merely referred to an apparently still unpublished manuscript), its detailed comparison with our new species cannot be contemplated. However, *T. gonospinifer* appears distinctly different from *T. sedili* in the following criteria, assessed from HALL's drawings of the latter species:

Criterion	*T. gonospinifer*	*T. sedili*
Rostrum	Base distinctly elevated; distal 1/2 deflected to horizontal position; upper margin convex; reaching 2/3 2nd antennular segment.	Base not elevated; distal 1/3 slightly upcurved; upper margin slightly concave; reaching 1/2 3rd antennular segment.
Branchiocardiac carina	Distinct, 1/3 length carapace.	Not indicated in figure.
Antennulae	1 1/3 length peduncle, as long as carapace.	9/10 length peduncle, 6/10 length carapace.
5th pereopod	Exceeding scaphocerite by at least 1/2 propodus.	Attaining 7/10 of scaphocerite.
Anterior thelycal plate	Anterior spine prominent; plate not in contact with lateral plates.	Anterior spine small; plate partially obscured by lateral plates.
Lateral thelycal plates	Narrow, rim-like; seminal receptacle a smooth, almost circular depression.	Wider, leaf-shaped; seminal receptacle appears subdivided into lateral pockets.

In view of these differences, *T. gonospinifer* must be considered a distinct species, even though it has not yet been compared with the type material of *T. sedili*. It is very likely that the male of the Malaysian species will have a petasma similar to that of our new species.

Trachypenaeus fulvus Dall, 1957

Trachypenaeus fulvus Dall, 1957, pp. 106–09.
Trachypenaeus asper Kubo, 1949, pp. 395–98. Cheung, 1960, p. 65 (key). (Non *T. asper* Alcock, 1906).
Trachypeneus fulvus Hall, 1962, pp. 29–30.
Trachypeneus (Trachysalambria) curvirostris Racek, 1955, (Plate 7, figure 4 only).

Material. Numerous specimens of both sexes, 32–79 mm; WESTERN AUSTRALIA: Exmouth Gulf, Shark Bay; QUEENSLAND: Gulf of Carpentaria, Keppel Bay, Moreton Bay; NEW GUINEA: Orangerie Bay, Kinikini Bay, Yule I., W. of Mogubu; PHILIPPINES: Manila Bay; NORTH BORNEO: Marudu Bay, off Kudat.

Distribution. Malaysia (HALL) through Indonesian waters (KUBO) to the Philippines, and south to Australia (DALL, RACEK).

Discussion. All specimens from Australia fully agree with the description and illustrations of *T. fulvus* by DALL (1957), and differ from *T. "asper"* Kubo (1949) in all those points already discussed in DALL's paper. On the other hand, some specimens from New Guinea, and all from North Borneo and the Philippines examined have much longer pereopods and are thus fully comparable with those of KUBO's material of *T. "asper"*.

Detailed morphometrical studies, involving both these apparently constantly differing forms, have failed to establish specific differences. The thelycum and petasma, the appendix masculina, the rostrum, the abdomen, the length of the antennular flagella, and the structure of the carapace are indistinguishable. It is very likely that *T. fulvus*, a distinctly shallow-water species, will be found to display speciation trends in distant populations. This assumption appears supported by the fact that the "short-legged" form is restricted to Northern Australia, whereas the "long-legged" condition has an equatorial spread from Malaysia to the Philippines, and New Guinea.

In view of the conspicuous difference in pereopodal length, a subdivision of *T. fulvus* into two subspecies would already appear justified. However, the comparatively limited number of specimens of *T. "asper"* in the material examined does not as yet permit such a decision by the present authors, and further collections and morphometric studies are therefore desirable.

Trachypenaeus anchoralis (Bate, 1888)
(Plate 7 fig. 10; Plate 12 fig. 8)

Penaeus anchoralis Bate, 1888, pp. 258–61 (female only).
Trachypeneus anchoralis Alcock, 1906, p. 54. Schmitt, 1926, pp. 348–51.
Trachypeneus (Trachypeneus) anchoralis Racek, 1955, pp. 236–37; 1959, p. 10.
Trachypenaeus anchoralis Dall, 1957, pp. 209–11 (non de Man, 1911, pp. 88–90).

Material. Numerous specimens of both sexes, 38–104 mm; WESTERN AUSTRALIA: Shark Bay, Exmouth Gulf; NORTHERN TERRITORY: Chambers

Bay; QUEENSLAND: Gulf of Carpentaria, Princess Charlotte Bay, Townsville, Repulse Bay, Keppel Bay, Heron I. Depth of occurrence 7–29 fm.

Distribution. Apparently endemic to Australia, ranging from northern Western Australia to about Keppel Bay, Queensland.

Discussion. *T. anchoralis* has been adequately described and figured by SCHMITT (1926) and DALL (1957), and the examination of the present material has not offered additional criteria for discussion. However, the petasma and the thelycum of this species have been photographed, in order to augment the drawings of the two authors mentioned above.

DALL (1957, p. 224) drew attention to the apparently restricted distribution of this species to Australian waters, but considered it possible that it may yet be found in Indonesian seas. However, *T. anchoralis* is not present in the voluminous material collected for the present study from Indonesia and New Guinea, and therefore must still be considered as a species endemic to northern Australia.

Trachypenaeus granulosus (Haswell, 1879)
(Plate 3 fig. 4; Plate 7 fig. 9; Plate 13 fig. 1)

Penaeus granulosus Haswell, 1879, p. 41; 1882, p. 202 (female only).
Trachypeneus granulosus Schmitt, 1926, pp. 351–53.
Trachypeneus (Trachypeneus) granulosus Racek, 1959, pp. 10, 11.
Trachypenaeus granulosus Dall, 1957, pp. 211–13.
Trachypenaeus salaco de Man, 1907, p. 135; 1911, pp. 90–92.
? *Trachypeneus pescadoreensis* Schmitt, 1931, pp. 265–68. Hall, 1962, p. 29.

Material. QUEENSLAND: Princess Charlotte Bay, coll. "Challenge", 22.III.1958, mud and weed, 11 fm, ♂, 51 mm, ♀, 53 mm (first discovery in commercial trawl); Gulf of Carpentaria, coll. "Rama", October–December 1963, 5–7 fm, mud, 12 ♀♀, 78–90 mm, 3 ♂♂, 40–49 mm; Albany Passage, coll. M. WARD, September 1928, 9–12 fm, 1 ♂, 36 mm.

Distribution. Eastern Malaya through Indonesia to northern Australia.

Discussion. In spite of the paucity of specimens examined, *T. granulosus* has been adequately defined by SCHMITT (1926) and DALL (1957), so that its detailed redescription is unnecessary. Although DALL demonstrated the identity of the males of this species with those described by DE MAN (1907, 1911) as *T. salaco*, HALL (1962) associated DE MAN'S species, together with females from Malaysian waters, with the rather insufficiently known Formosan species *T. pescadoreensis* Schmitt, of which the male has not as yet been found. Judging from HALL'S illustrations, the thelycum and petasma of his Malaysian specimens would appear slightly different from these structures in *T. granulosus*, but the Malaysian as well as the Australian specimens lack the conspicuous longitudinal ridge on the anterior thelycal plate which SCHMITT (1931) showed to be a typical feature of *T. pescadoreensis*. The present authors consider it unlikely that SCHMITT, who only a few years earlier reviewed the Australian material of *T. granulosus*, could have erred in considering the Formosan

specimen distinct from HASWELL's species. However, without a re-examination of the type specimen of *T. pescadoreensis* it is impossible to decide whether its distinguishing criteria are of specific or subspecific nature.

In view of the rather scattered occurrence of *T. granulosus* in Australian waters, it seems reasonable to assume that this species will ultimately be found to display pronounced speciation trends in distant populations. The slightly differing shape of the petasmata of *T. granulosus*, *T. salaco*, and HALL's *T. pescadoreensis* from Malaysia, as well as the transition of thelycal characters in the Australian, Formosan, and Malaysian specimens of this group, appears to substantiate this assumption. These slight differences in secondary sexual characters are the following:

Criterion	*T. granulosus* (Haswell)	*T. salaco* de Man	*T. pescadoreensis* Schmitt	*T. pescadoreensis* Hall
Distolateral petasmal projections	Anterolaterally usually without wing-like flaps on outer curvature; anteromedian margins strongly reflected, forming sharp triangular prominence.	Anterolaterally with small wing-like flaps on outer curvature; anteromedian margins strongly reflected, forming sharp triangular prominence.	(Male unknown)	Anterolaterally with larger wing-like flaps on outer curvature; anteromedian margins slightly reflected, or merely angular.
Anterior thelycal plate	Slightly concave, without or with indistinct longitudinal ridge; posterior extension slightly projecting ventrally.	(Female unknown)	Flattish, with prominent longitudinal ridge; posterior extension slightly projecting ventrally.	Slightly concave, with indistinct longitudinal ridge; posterior extension forming a large ventral projection.

Should these slight differences be considered of specific nature, the males of *T. salaco* could not be associated with either *T. granulosus*, or *T. pescadoreensis* Hall, and the latter would then have to be redescribed as a distinct species, while the female of *T. salaco* would remain unknown. On the other hand, the much less pronounced differences in thelycal structures of the three species, of which females have been recorded, seem to emphasise their subspecific nature, as well as the closer relationship of HALL's Malaysian specimens to *T. granulosus* than to the true *T. pescadoreensis* from Formosan waters. The present authors are as yet unable to attempt a revision of this group of species, and the collection of many more specimens of *T. granulosus* and its allied species appears highly desirable.

The petasma and thelycum of *T. granulosus* from Australian waters

have been photographed in order to augment the drawings of these structures by SCHMITT (1926) and DALL (1957).

Genus **Parapenaeopsis** Alcock

Parapeneopsis Alcock, 1901, p. 14; 1906, pp. 34–35. Burkenroad, 1934*b*, pp. 58–59.
Parapenaeopsis de Man, 1911, pp. 92–93. Balss, 1914, p. 14; 1925, p. 229. Kubo, 1949, pp. 368–70. Barnard, 1950, p. 604. Liu, 1955, p. 16. Dall, 1957, pp. 213–14.

Type-species by original designation: *Penaeus styliferus* H. Milne Edwards, 1837.

The above references provide adequate information on the generic definition of *Parapenaeopsis*. For the differentiation of the hitherto-known species of this genus the reader is particularly referred to the key to all Indo-Pacific species (DALL, 1957, pp. 214–15), as well as to the recent work of HALL (1962, pp. 26–29).

During the present investigations only the following 7 previously known species of *Parapenaeopsis* were found to occupy the general region studied: *P. stylifera* (H. Milne Edwards), *P. cornuta* (Kishinouye), *P. sculptilis* (Heller), *P. hardwickii* (Miers), *P. gracillima* Nobili, *P. hungerfordi* (Alcock), and *P. tenella* (Bate). Of these *P. stylifera* is present as the subspecies *P. stylifera coromandelica* (Alcock), while *P. cornuta* is represented by both its subspecies *P. cornuta cornuta* (Kishinouye), and *P. cornuta maxillipedo* (Alcock). An additional species, *P. arafurica* sp. nov. from waters of northern Australia and New Guinea, will be described below. *P. venusta* de Man, the male of which has recently been recorded by HALL (1962), is not present in the material examined, although it has been recorded by DALL (1957) from the Australian region.

The interspecific relationships within this genus can hardly be accentuated by using secondary sexual characters only. Both subspecies of *P. stylifera*, although having typical petasmata and thelyca, possess a telsonic armature of fixed spines, and can thus readily be distinguished from the remainder of the genus. *P. hungerfordi* possesses rather atypical outer genitalia, yet is fully comparable in all other criteria with its congeners. *P. gracillima* displays some unusual and aberrant morphological criteria, but its thelycum, and particularly its petasma, are characteristic for the genus. The grouping of *Parapenaeopsis* spp., as given hereunder, is therefore not to be interpreted as an intentional or significant arrangement.

Parapenaeopsis stylifera coromandelica Alcock, 1906
(Plate 8 fig. 1; Plate 13 fig. 2)

Parapeneopsis stylifera var. *coromandelica* Alcock, 1906, p. 37.
Parapeneopsis coromandelica Hall, 1962, p. 27.

Material. Numerous specimens of both sexes, 76–117 mm: INDONESIA: Tjilatjap (Java), Padang (Sumatra), eastern Borneo (Kalimantan), leg. G. KHOE SIAUW HWIE, August 1962.

Description. Rostrum sigmoidal, distal 1/2 styliform and edentate, strongly upcurved, in both sexes much overreaching tip of antennular peduncle; dorsally armed with 4–6 teeth + epigastric. Adrostral carina ending about half way between epigastric and penultimate tooth, sulcus shallow. Postrostral carina distinct, almost reaching to posterior margin of carapace, with a pitted area about half way between epigastric tooth and posterior margin of carapace.

Orbital spine small, postocular sulcus moderately deep, at angle 45° to rostrum. Longitudinal suture becoming indistinct posteriorly, reaching 2/3 carapace. Cervical sulcus shallow and short, not quite reaching longitudinal suture. Antennal spine prominent, antennal carina ending below hepatic spine. Hepatic sulcus pronounced, slightly more than 1/3 length carapace, sinuous, attaining horizontal position in its anterior 1/4; hepatic carina distinct only for lower 1/2 sulcus, commencing from below hepatic spine and reaching to the sharp pterygostomian angle. Branchiocardiac sulcus barely perceptible, or absent.

Antennular flagella subequal, 1.8 length peduncle, and slightly longer than carapace in both sexes.

Third maxilliped surpassing carpocerite by dactyl; 1st pereopod reaching to base of carpocerite, 2nd to tip of carpocerite; 3rd exceeding carpocerite by chela, 4th slightly exceeding carpocerite; 5th attaining 2/3 2nd antennular segment. Mastigobranchiae and basial spines on 1st 2 pereopods.

Abdominal carination beginning from posterior 1/3 of 3rd somite, carina on 6th ending in a sharp spine; dorsal sulcus absent. A pair of lateral cicatrices on 6th abdominal somite only. Telson with 1–2 pairs of conspicuous subapical fixed spines; when 2 pairs are present, the distal set about twice the length of the preceding; proximal 7/10 of telson unarmed.

The petasma (Plate 8 fig. 1) reaches bases of 3rd pereopods; distolateral projections slender, horn-like, and straight, directed anterolaterally at 45° to petasmal axis, with ventral openings; distomedian projections small and curved ventrally. Proximal lateral enlargements of petasma of moderate size and evenly rounded.

The thelycum is shown on Plate 13 fig. 2. Anterior thelycal plate slightly concave and square, with rounded anterolateral corners; in fully mature females its anterior margin occasionally trilobed; posterior extension a slender, stem-like process. Lateral plates subrectangular, fused posteriorly, each with an anteromedian indentation, corresponding to a knob-like posterior process of the anterior plate.

Colour in life. Not yet observed.

Distribution. East coast of India (ALCOCK) through Malaysian waters (HALL) to Indonesia.

Discussion. *P. stylifera coromandelica* apparently has never been completely described, though ALCOCK (1906) provided useful drawings of his "variety", and pointed to the fact that it differs from *P. stylifera* (Milne Edwards) in telsonic armature. HALL (1962) considered this

difference as sufficient for specific discrimination, and raised ALCOCK's "variety" to specific rank. Our specimens examined are fully comparable with ALCOCK's illustrations of *P. s. coromandelica*, and differ from the true *P. stylifera* not only in the reduced, though more conspicuous, telsonic armature, but also in the smaller number of rostral teeth. Since all other morphological criteria are in complete agreement in both these forms, and the petasmata and thelyca are indistinguishable, the specific separation of ALCOCK's "variety" from MILNE EDWARDS' species cannot be attempted. However, the present authors are fully aware that these two forms represent distinct, and geographically separated, races, and consider it necessary to retain their taxonomic distinction at an infraspecific level. Consequently, the two subspecies *P. stylifera stylifera* (Milne Edwards), and *P. stylifera coromandelica* (Alcock) are herewith proposed.

Parapenaeopsis cornuta cornuta (Kishinouye, 1900)
(Plate 8 fig. 2; Plate 13 fig. 3)

Penaeus cornutus Kishinouye, 1900, p. 23.
Parapenaeopsis cornuta de Man, 1911, p. 93.
Parapenaeopsis cornutus Maki and Tsuchiya, 1923, pp. 43–44. Kubo, 1949, pp. 374–78. Dall, 1957, pp. 215–17. ?Cheung, 1960, p. 67 (key).
Parapeneopsis cornuta Racek, 1959, p. 10.

Material. 31 ♀♀, 8 ♂♂, 58–112 mm; WESTERN AUSTRALIA: Exmouth Gulf; QUEENSLAND: Gulf of Carpentaria, Townsville, Keppel Bay, Sandy Cape; NEW SOUTH WALES: off Ballina (1 ♀); INDONESIA: Tjilatjap (Java).

Distribution. Hong Kong (CHEUNG) to Japan (KISHINOUYE, MAKI and TSUCHIYA, KUBO); southern Java (DE MAN) to tropical Australia (DALL, RACEK).

Discussion. *P. cornuta* (Kishinouye) and *P. maxillipedo* Alcock are listed in previous literature as two distinct species, differing from each other primarily by the absence or presence of a basial spine on the ♀ 3rd pereopod. ALCOCK (1906), in describing *P. maxillipedo*, already expressed some doubts as to the possibility of its specific separation from *P. cornuta*, but to-date the status of ALCOCK's species remained unchallenged.

The examination of specimens of both these "species" during the present study demonstrated beyond doubt that their specific separation is unjustified. Morphometric studies revealed that the secondary sexual characters of *P. maxillipedo* are identical with those of *P. cornuta*, and that the few additional criteria, listed by DALL (1957) as distinguishing features, are subject to variation in distant or isolated populations. The gastric mill formulae fail to aid in the distinction of the two "species", a fact which is evident from the discrepancies, also listed by DALL, between Australian and Japanese specimens of *P. cornuta*. Although the

basial spine on the ♀ 3rd pereopod is quite distinct in specimens of this complex from Malaysia, the Philippines, and New Guinea, as well as absent in most specimens from northern Australia, some Australian specimens display a minute basial spine, and in Indonesian material this spine is vestigial.

Furthermore, even the racial discrimination of these two forms appears unsupported by a distinct distributional pattern, such as available for the *P. stylifera* complex. Clear-cut distributional barriers, separating the two "species" from each other are lacking, although the female condition of *P. maxillipedo* appears to have an equatorial spread, whereas the condition of *P. cornuta* seems to be confined to the Japanese and Australian regions. Even though these two species are undoubtedly conspecific, the present authors prefer not to obscure the existing slight discrepancies by relegating *P. maxillipedo* to a mere synonym of *P. cornuta*, and treat their material as belonging to 2 subspecies, *P. cornuta cornuta* (Kishinouye), and *P. cornuta maxillipedo* (Alcock). This arrangement, however, is unable to improve the difficult distinction of males, and further studies of this species complex are highly desirable.

P. cornuta (Kishinouye) has been adequately described by previous authors, and the reader is particularly referred to the papers by KISHINOUYE (1900), KUBO (1949), and DALL (1957).

Parapenaeopsis cornuta maxillipedo Alcock, 1906

Parapeneopsis maxillipedo Alcock, 1906, pp. 40–41. Hall, 1962, p. 26.
Parapenaeopsis maxillipedo Kubo, 1949, pp. 380–81. Dall, 1957, p. 217.
?*Parapenaeopsis cornutus* Cheung, 1960, p. 65 (key).

Material. 14 ♀♀, 6 ♂♂, 62–121 mm; QUEENSLAND: Princess Charlotte Bay (1 ♀); NEW SOUTH WALES: off Tweed Heads (1 ♀); NEW GUINEA: W. of Mogubu, Jokea, off Fly R. mouth; NORTH BORNEO: Sandakan area; PHILIPPINES: Manila Bay.

Distribution. Equatorial spread from the west coast of India (ALCOCK) through Malaysia (HALL) to the Philippines and New Guinea.

Discussion. As already mentioned in the discussion of the foregoing subspecies, the condition of the basial spine on the ♀ 3rd pereopod in *P. c. maxillipedo* does not appear to be a constant feature. This spine is conspicuous only in specimens from Malaysia and the Philippines, as well as in the majority of those from New Guinea. In some New Guinea females, as in the 2 specimens hitherto recorded from eastern Australia, this spine is much reduced, though clearly perceptible.

For the detailed description of *P. maxillipedo* (Alcock), treated here as a subspecies of *P. cornuta*, the reader is referred to ALCOCK (1906). KUBO (1949) and DALL (1957) listed some structural differences between *P. maxillipedo* and *P. cornuta*, which may be helpful in future revisions.

Parapenaeopsis sculptilis (Heller, 1862)
(Plate 3 fig. 5; Plate 8 fig. 3)

Penaeus sculptilis Heller, 1862, p. 528; 1865, p. 122. Miers, 1880, p. 457.
Parapenaeopsis sculptilis Nobili, 1903, p. 5. Balss, 1914, p. 11. Boone, 1935, pp. 80–84. Kubo, 1949, pp. 389–91. Dall, 1957, pp. 217–20.
Parapeneopsis sculptilis Burkenroad, 1934*b*, pp. 59–60. Racek, 1959, pp. 10, 12, 14.
Peneopsis (printing error) *sculptilis* Alcock, 1906, pp. 37–38.
?*Parapeneopsis sculptilis* var. *cultrirostris* Alcock, 1906, p. 39.
?*Parapenaeopsis cultrirostris* Kubo, 1949, pp. 378–80 (not figure 137).
Parapeneopsis affinis Hall, 1962, p. 27.

Material. Numerous specimens of both sexes, 68–162 mm; NORTHERN TERRITORY: Chambers Bay, Darwin ("Paxie"); QUEENSLAND: Gulf of Carpentaria ("Rama"), Truant I. ("Paxie"), Princess Charlotte Bay, Keppel Bay ("Challenge"), Mackay; MALAYSIA: Penang, North Borneo; INDONESIA: Kroja, Tjilatjap (Java); NEW GUINEA: Orangerie Bay, off Parama I., off Fly R. mouth.

Distribution. West coast of India to Hong Kong (ALCOCK), through Malaysian waters (BURKENROAD, BOONE, KUBO, HALL) and Indonesia (HELLER, MIERS) to tropical Australia (DALL, RACEK) and New Guinea.

Discussion. This common and widely distributed tropical species has been extensively discussed in previous literature, and the reader is particularly referred to KUBO (1949) and DALL (1957). The status of ALCOCK's (1906) *P. sculptilis* var. *cultrirostris*, however, still remains somewhat obscure. KUBO (1949) raised this "variety" to specific rank, but DALL (1957) synonymized both ALCOCK's "variety" and KUBO's species *P. cultrirostris* with *P. sculptilis*, pointing to the fact that the cultrate condition of the rostrum is invariably found in males of the latter species after copulation. HALL (1962) questioned the correctness of DALL's identification, and suggested that the exact shape of the cultrate rostrum, as depicted by ALCOCK, is only comparable with that displayed by some mature males of *P. hardwickii*. It is unlikely that this difference of opinion could ever be eliminated without a direct comparison of ALCOCK's type specimens of *P. s. cultrirostris* with the males of both *P. sculptilis* and *P. hardwickii*. As can be expected from the structural similarities of the rostrum in these two species, the cultrate condition in males of both display close affinities. In 27 "cultrate" males of *P. sculptilis* in our material, the rostrum (Plate 3 fig. 5) fully agrees with the illustrations of ALCOCK (1906) and DALL (1957), and is distinctly different from the structure depicted by HALL (l.c., fig. 105*c*). On the other hand, 2 "cultrate" males of *P. hardwicki* examined would appear indistinguishable from those of *P. sculptilis* if this criterion only were used for their separation from the latter species. In view of these similarities it is possible that ALCOCK's material of *P. s. cultrirostris* in the Indian Museum also consists of males of both species mentioned, even though they could now readily be distinguished from each other by their secondary sexual characters.

Parapenaeopsis hardwickii (Miers, 1878)
(Plate 8 fig. 4; Plate 13 fig. 4)

Penaeus hardwickii Miers, 1878, p. 300.
Parapeneopsis sculptilis var. *hardwickii* Alcock, 1906, p. 39.
Parapeneopsis hardwickii Burkenroad, 1934*b*, pp. 60–64. Hall, 1962, pp. 26–27.
Parapenaeopsis hardwickii Kubo, 1949, pp. 385–89 (not figure 140). Dall, 1957, p. 214 (key). Cheung, 1960, p. 65 (key).
?*Parapeneopsis sculptilis* var. *cultrirostris* Alcock, 1906, p. 39.
?*Parapeneopsis cultrirostris* Kubo, 1949, pp. 378–80 (not figure 137).

Material. NORTH BORNEO: Tawau area, caught with tidal net "togoh", 3–5 fm, coll. CHIN PHUI KONG, 18.XII.1959, 9 ♂♂, 21 ♀♀, 59–73 mm.

Description. Rostrum sigmoidal, distal $^1/_2$ or more styliform and edentate, strongly upcurved; in ♀ at least $^1/_4$ of rostrum extending beyond tip of antennular peduncle; rostrum in mature ♂ often cultrate, and not extending beyond 2nd antennular segment; dorsally armed with 7–8 teeth + epigastric. Adrostral carina ending about half way between epigastric and penultimate tooth, sulcus shallow. Postrostral carina distinct, almost reaching posterior margin of carapace, with a broadly open sulcus.

Orbital spine not much more than a sharp angle, postocular sulcus moderately deep, at angle 40° to rostrum. Longitudinal suture reaching about $^8/_{10}$ carapace, distinct in its entire length. Cervical sulcus shallow and short, not quite reaching longitudinal suture. Antennal spine prominent, antennal carina reaching to $^2/_3$ distance between hepatic and antennal spines. Hepatic sulcus pronounced, somewhat more than $^1/_3$ length carapace, slightly sinuous; hepatic carina distinct only for lower $^1/_2$ sulcus, commencing from base of hepatic spine, and reaching to the vicinity of the sharp pterygostomian angle. Branchiocardiac sulcus barely perceptible.

Antennular flagella not sexually dimorphic, slightly longer than their peduncle, which is 0.6 length of carapace.

Third maxilliped surpassing carpocerite by dactyl; 1st pereopod not quite reaching to base of carpocerite, 2nd surpassing it by dactyl; 3rd as long as outer maxillipeds, 4th reaching to base of carpocerite, 5th attaining anterior margin of cornea. Mastigobranchiae and slender basial spines on 1st 2 pereopods.

Abdominal carination beginning from anterior $^8/_{10}$ of 3rd somite, carina on 6th ending in a sharp spine; dorsal sulcus absent. Two lateral cicatrices on 4th and 5th somites, 3 on 6th somite. Telson armed with 3–5, usually 4, pairs of mobile spines, of which the apical set is the largest.

The petasma is shown on Plate 8 fig. 4; distomedian projections not extending beyond tips of distolateral projections, about as long as wide, their anterolateral margins distinctly crenulated; distolateral projections pointing laterally; proximal lateral enlargements of petasma very large

and rounded. The sterna between the ♂ 4th and 5th pereopods often developed into a structure similar to the thelycum of mature ♀♀.

The thelycum is shown on Plate 13 fig. 4. Anterior plate slightly concave, wider than long, anteriorly and posterolaterally rounded; sternal plate between 5th pereopods flat, with a pair of anterolateral tooth-like processes directed anteriorly, and a convex anteromedian margin bearing a transverse row of long setae.

Colour in life. Not yet observed; the coloration of freshly preserved specimens has been commented on by BURKENROAD (1934*b*).

Distribution. East coast of India (ALCOCK) through Malaysia (BURKENROAD, HALL) to southern China (KUBO, CHEUNG).

Discussion. The specimens examined during the present study fully agree with the detailed descriptions of *P. hardwickii* by BURKENROAD (1934*b*) and KUBO (1949), as well as with the illustrations of this species by HALL (1962). KUBO's texts to his figures 137 and 140 are obviously misplaced and should be exchanged with each other, since the female of *P. hardwickii* is shown in place of the male of *P. cultrirostris*, and *vice versa*.

P. hardwickii is very closely related to *P. sculptilis*, but can be distinguished from the latter by a number of criteria, as already discussed by BURKENROAD (1934*b*). Helpful distinguishing criteria, apart from the quite distinct secondary sexual characters, are the lengths of the rostrum and the antennular flagella, the structure of the postrostral sulcus, and the telsonic armature. The malformation of the ♂ rostrum into a dagger-like stump is a feature which is shared by both *P. hardwickii* and *P. sculptilis*, and further studies are necessary before it can be decided with which of these species ALCOCK's (1906) *P. sculptilis* var. *cultrirostris* is synonymous.

Parapenaeopsis arafurica sp. nov.

(Figure 16; Plate 8 figs. 6, 7; Plate 13 fig. 5)

Material. NEW GUINEA: off Fly R. mouth, Papua, coll. Dr. A. M. RAPSON, 25.IV.1955, mud, holotype ♂, 52 mm (carapace 12.5 mm), allotype ♀, 71 mm (carapace 17 mm), paratypes 4 ♂♂, 48–58 mm, 1 ♀, 69 mm; Gulf of Papua, 8° 16′ S., 144° 12′ E., 6.IV.1955, 2 ♂♂, 52, 54 mm; Fly R. estuary, near Kiwai I., 26.IV.1955, 2 ♂♂, 53 mm, 1 ♀, 74 mm (parasitised by Bopyrid); near N. entrance to Fly R., 7.IV.1955, 10 ♂♂, 43–54 mm, 1 ♀, 51 mm. NORTHERN TERRITORY: Chambers Bay, 12° 02′ S., 131° 31′ E., coll. V. WELLS ("Paxie"), 7.XI.1959, grey mud, 9 fm, 2 ♂♂, 41, 49 mm, 3 ♀♀, 58–78 mm.

Description. Rostrum slender and sigmoidal, distal $^2/_3$ styliform and edentate; in immature specimens of both sexes up to about 45 mm in length, the rostrum is 1.1 to 1.2 length carapace, exceeding tip of antennular peduncle by 0.2–0.3 its length; in mature ♀ the rostrum is

0.9 length carapace, and exceeding the antennular peduncle by 0.2 its length; in all mature ♂♂ the rostrum is more slender than in ♀♀, about equal to, or short of, the antennular peduncle, the tip invariably showing slight malformation. Rostrum dorsally armed with 4–5 teeth, epigastric absent. Adrostral carina ending at $^1/_2$ distance between hepatic spine and margin of carapace. Postrostral carina a broad, barely perceptible dorsal ridge, ending at about 0.8 length carapace, and with a distinct hump at almost $^1/_2$ carapace, probably marking the position of the absent epigastric spine.

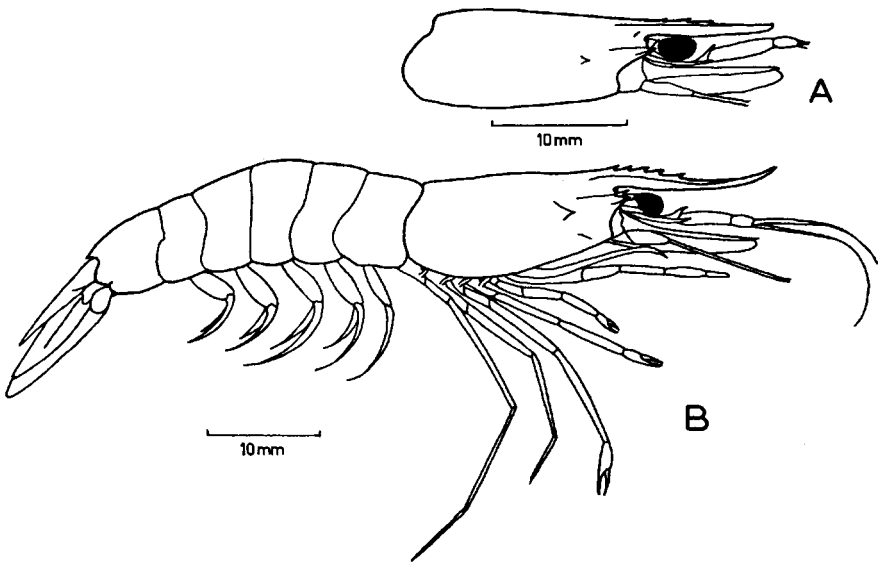

Fig. 16. *Parapenaeopsis arafurica*, sp. nov.
A, cephalothorax of holotype; B, ♀, 71 mm, allotype.

Longitudinal suture reaching level of hepatic spine, transverse suture apparently absent. Postocular sulcus present, orbital and pterygostomian angles sharp. Antennal carina ending barely $^1/_4$ distance between antennal and hepatic spines; cervical and orbito-antennal sulci barely defined; a shallow branchiocardiac sulcus present. Hepatic sulcus shallow, running downwards at 45° angle, and beginning below tip of hepatic spine; hepatic carina feebly developed, about 0.05 length carapace.

Antennular flagella subequal, upper 1.2 length lower, and 1.5 length peduncle. Prosartema reaching about $^2/_3$ eye, stylocerite barely exceeding $^1/_3$ 1st antennular segment. Scaphocerite reaching from $^1/_2$ to tip of antennular peduncle, carpocerite reaching as far as eye.

Mandibular palp reaching base of carpocerite, distal segment subrectangular, without a distolateral depression. Incisor process with a cleft, forming 2 angular teeth; molar process rectangular, with sharp posterior ridge. Maxillular palp unsegmented, broadened distally, with

tuft of about 5 spines on the inner corner, and a row of 6 spines on the posterolateral margin.

Third maxilliped reaching to tip of 2nd antennular segment, the ♂ dactyl distinctly curved; first pereopod exceeding base of carpocerite by $^1/_2$ dactyl, 2nd reaching as far as, or slightly exceeding, carpocerite; 3rd reaching from $^1/_2$ to tip of 2nd antennular segment, 4th exceeding 1st antennular segment by dactyl, 5th exceeding 3rd pereopod by dactyl. Mastigobranchiae absent from pereopods, a weak spine on basis and ischium of 1st pereopod only.

Cardiac plate of gastric mill with 10–12 small, indistinct spinules. Zygocardiac ossicle consisting of an upper portion, the 1st tooth large and triangular, followed by 3–4 flat-topped teeth, then a row of 6–8 small sharp teeth; below the first tooth a smaller conical tooth, and below this a cluster of 5–6 small spines; lower portion a large tooth, followed by a row of about 10 smaller teeth. Prepyloric ossicle with 12–14 teeth on either side.

Abdominal carination beginning on anterior margin of 4th somite, carina on 6th ending in a sharp spine. A pair of lateral cicatrices on 6th somite. Length of telson $^8/_{10}$ length of inner uropod; telson without perceptible mobile spines, but often with 3 lateral pairs of vestigial sockets for the insertion of such spines.

The petasma (Plate 8 figs. 6, 7) proximally narrow, widening towards the distolateral projections, with rounded proximal enlargements of moderate size. Distomedian projections very prominent, arising from a tubular ventral base, and with a flattened anterior margin; each projection laterally divided into a ventral inwardly curved hook, and a dorsal finger-like process. Distolateral projections slightly curved, flattened, and bluntly triangular. Greatest width of petasma 0.85 length, width of distomedian projection 0.5 length petasma. Endopod of ♂ 2nd pleopod arising from middle of proximal segment, turning abruptly posteriorad, bearing an elongate distal process, which runs back to a forwardly directed dorsal lobe.

The thelycum is shown on Plate 13 fig. 5. Anterior plate concave, slightly wider than long, with an evenly rounded anterior margin, and sharply rounded posterolateral corners; a tongue-like posterior extension, bearing an irregular clump of long setae, and fitting into the U-shaped indentation of the posterior sternal plate between the 5th pereopods; the latter with convex anteromedian margin, and a forwardly directed spine on each anterolateral corner.

Colour in life. Not yet observed.

Distribution. Hitherto known only from the type locality in Papua, and the vicinity of Darwin, Northern Territory.

Discussion. While the general structure of the thelycum of *P. arafurica* is quite typical for the genus, the petasma cannot be compared with that of any other hitherto-known species of *Parapenaeopsis*. The absence

of mastigobranchiae on the 1st 2 pereopods is a feature shared by 4 other species, i.e. *P. hungerfordi*, *P. venusta*, *P. tenella*, and *P. acclivirostris*, of which the last two also lack an epigastric spine. In view of the absence of mastigobranchiae on the 3rd pereopods *P. arafurica* must be considered a *Parapenaeopsis* sp., although the atypical petasma, as well as the relatively short longitudinal suture, are features with a closer resemblance to those usually found in *Trachypenaeus*. This emphasises the insufficiency of the only clearly visible distinguishing criterion for generic determination, i.e. the presence or absence of epipodites on the 3rd pereopods, and further detailed studies of all species of *Trachypenaeus* and *Parapenaeopsis* are highly desirable.

Parapenaeopsis gracillima Nobili, 1903
(Plate 8 figs. 8, 9; Plate 13 fig. 6)

Parapenaeopsis gracillima Nobili, 1903, p. 4. Balss, 1914, p. 12. De Man, 1924, p. 40. Boone, 1935, pp. 84–91. Kubo, 1949, pp. 384– 85. Dall, 1957, p. 214 (key).
Parapeneopsis gracillima Hall, 1962, p. 26.
Parapenaeopsis dofleini Balss, 1913, p. 234.

Material. INDONESIA: Kuala Putran, Palembang, coll. 28.I.1955, 1 ♀, 57 mm; Sumatra, coll. 1957, 2 ♀♀, 78, 80 mm; MALAYSIA: "East coast of Malaya", coll. D. STEAD, 1922, 1 ♂, 49 mm.

Description. Rostrum of ♀ with strongly elevated base, and a posterior convex crest, anterior $^1/_3$–$^1/_2$ styliform and edentate, and distinctly recurved; reaching to tip of 2nd antennular segment, dorsally armed with 5 teeth; epigastric spine absent. Rostrum of the only ♂ examined wide and short, distinctly ascending, and almost straight; barely attaining $^1/_2$ of cornea, armed with 5 teeth; epigastric spine absent. Adrostral carina in both sexes ending at $^1/_2$ distance between hepatic spine and anterior margin of carapace. Postrostral carina broad but distinctly elevated, almost reaching to posterior margin of carapace.

Longitudinal suture reaching half way between hepatic spine and posterior margin of carapace; a distinct transverse suture at bases of 3rd pereopods. Postocular sulcus short but distinct, orbital and pterygostomian angles sharp. Antennal carina indistinct and broad, ending barely $^1/_4$ distance between antennal and hepatic spines; cervical and orbito-antennal sulci barely perceptible; a shallow branchiocardiac sulcus present. Hepatic sulcus tomentose and obscured, running downward at 45° angle and beginning below tip of hepatic spine; hepatic carina feeble and short.

Antennular flagella subequal, upper 1.1 length lower, and 2.2 length of carapace. Scaphocerite 2.5 times as long as wide, narrowing distally; carpocerite overreaching eye by $^1/_4$ its length.

Third maxilliped exceeding tip of carpocerite by dactylus; 1st pereopod exceeding tip of basicerite by dactylus, 2nd attaining tip of carpocerite; 3rd reaching to tip of antennular peduncle, 4th exceeding it by $^1/_2$

dactylus; 5th reaching beyond tip of scaphocerite at least by dactylus. First 2 pereopods with mastigobranchiae, basial and ischial spines absent on all pereopods.

Abdominal carination beginning on anterior margin of 4th somite, carina on 6th ending in a sharp spine; 2–3 pairs of lateral cicatrices on 6th somite only. Length of telson 0.55 length of inner uropod; telsonic spines absent.

The petasma is shown on Plate 8 figs. 8, 9. Distolateral projections long and slender, directed anterolaterally, deviating from longitudinal axis of petasma at 30°. Distomedian projections small, recurved ventrally. Petasma proximally with small rounded enlargements, and a pair of prominent and sharply triangular lateral processes.

The characteristic and large thelycum is shown on Plate 13 fig. 6. Anterior plate up to 3 times as wide as long, with a slightly 3-lobed anterior margin, and a stem-like posterior extension; the latter embraced by a U-shaped anteromedian incision of the posterior sternal plate between the 5th pereopods.

Colour in life. Not yet observed.

Distribution. Malaysia to Indonesia.

Discussion. The few females examined during the present study agree in all major details with the descriptions of *P. gracillima* by NOBILI (1903) and KUBO (1949). Some minor discrepancies in BALSS' (1914) definition of this species were already discussed by KUBO (l.c., p. 385). HALL (1962), who was the first to record the apparently elusive male of *P. gracillima*, depicted a petasma which differs from that of our only male by its slightly wider shape, and strongly diverging distolateral projections. Since HALL's description of the male condition apparently has not yet been published, a comparison of other male criteria cannot be contemplated.

The paucity of specimens ever collected tends to create the impression that *P. gracillima* is a rare species. However, it seems more likely that it is not a true bottom dweller, and thus unobtainable in quantities by conventional trawling methods. This assumption is supported by various morphological features, in particular the well-developed pleopods, and the filiform last two pairs of pereopods.

Parapenaeopsis hungerfordi Alcock, 1905

(Plate 8 fig. 5; Plate 13 fig. 7)

Parapeneopsis hungerfordi Alcock, 1905, p. 530. Burkenroad, 1934*b*, pp. 67–70. Hall, 1962, p. 26.

Parapenaeopsis hungerfordi Balss, 1924, pp. 44–45. Yu, 1935, p. 166. Kubo, 1949, pp. 381–85. Dall, 1957, p. 215 (key). Cheung, 1960, p. 65 (key).

Material. 39 ♀♀, 9 ♂♂, 62–104 mm; NORTH BORNEO: Sandakan Harbour, Tawau area, Labuan; INDONESIA: Eastern Borneo; depth of occurrence 3–7 fm.

Description. Rostrum slightly sigmoidal, distal $^1/_4$ to $^1/_3$ styliform and edentate, posterior armed portion not conspicuously elevated; in ♀ exceeding the antennular peduncle by about $^1/_8$ rostral length, in ♂ slightly shorter; dorsally armed with 6–7 teeth + epigastric. Adrostral carina ending half way between epigastric and penultimate tooth, sulcus indistinct. Postrostral carina distinct, almost reaching posterior margin of carapace, with a wide and moderately shallow sulcus, which is slightly constricted in its midsection as well as in its posterior $^1/_8$.

Orbital spine small but distinct, postocular sulcus shallow, at an angle 40° to rostrum. Longitudinal suture reaching past the transverse suture, which is in level with the bases of the 3rd pereopods. Cervical sulcus ill-defined and short. Antennal spine prominent, antennal carina reaching to $^1/_2$ distance between hepatic and antennal spines. Hepatic sulcus distinct, somewhat more than $^1/_3$ length carapace, slightly sinuous; hepatic carina distinct only for lower $^1/_2$ sulcus; pterygostomian angle sharply rounded. Branchiocardiac sulcus fairly well defined, branchiocardiac carina broad and inconspicuous.

Antennular flagella about $^1/_2$ length of peduncle in ♀, only slightly longer in ♂. Prosartema not quite reaching anterior margin of cornea, stylocerite slightly exceeding $^1/_2$ of basal segment.

Third maxilliped exceeding carpocerite by dactyl, 1st pereopod not quite attaining anterolateral margin of carapace; 2nd reaching to tip of basicerite, 3rd exceeding carpocerite by chela; 4th attaining $^1/_2$ carpocerite, 5th extending as far as 3rd pereopod. First 2 pereopods with long and slender basial spines, and without mastigobranchiae.

First abdominal tergum with a faint longitudinal median depression; a blunt and faint carina on 3rd; 4th–6th abdominal somites with a sharp dorsal carina, that on the 6th ending in a sharp spine. A pair of lateral cicatrices on 4th and 5th somite, 3 pairs on 6th. Telson $^7/_{10}$ length of inner uropods and unarmed.

The petasma (Plate 8 fig. 5) is quite an unusual structure. Distolateral projections semirectangular in outline, their median margins more or less parallel and closely adjoining; each projection with a ventral spinous process, arising from anterolateral corner and pointing at 45° towards the midline of the petasma; and with a dorsal, outwardly directed, fleshy lobe. Distomedian projections extremely small, as in most species of this genus.

The thelycum (Plate 13 fig. 7) consists of an elongated median plate, which is longitudinally grooved, and posteriorly of 2 convoluted lateral plates, which actually represent a posterolateral extension of the anterior plate.

Colour in life. Not yet observed.

Distribution. Hong Kong (Alcock, Balss, Cheung) and Amoy (Yu) through Malaysian waters (Burkenroad, Hall) to northern Indonesia.

Discussion. In regard to their secondary sexual characters, our

specimens fully agree with the descriptions of *P. hungerfordi* by all previous authors, even though some other criteria seem to be subject to variation in this species. The antennules of our specimens, for example, are much shorter than those described by KUBO (1949); however, their length is fully comparable with that given by BURKENROAD (1934*b*) and illustrated by HALL (1962) for Malaysian specimens. Other apparently variable characters are the length of the pereopods, the shape of the 1st and 2nd pleonic terga, and the distinctness of the branchiocardiac sulcus. In view of the relatively compact distribution of *P. hungerfordi*, these slight discrepancies in its previous descriptions are most unlikely to be explained by speciation trends in distant populations, and further detailed morphometric studies are desirable.

Parapenaeopsis tenella (Bate, 1888)
(Plate 8 fig. 10; Plate 13 fig. 8)

Penaeus tenellus Bate, 1888, pp. 270–71. Kishinouye, 1900, p. 22.
Penaeus (*Parapenaeopsis*) *tenellus* de Man, 1907, pp. 435–36, 454.
Parapenaeopsis tenella de Man, 1911, pp. 9, 92. Balss, 1914, p. 11. Yoshida, 1941, pp. 15–16.
Parapenaeopsis tenellus Kubo, 1949, pp. 371–74. Liu, 1955, pp. 16–17. Dall, 1957, pp. 221–23.
Parapeneopsis tenella Hall, 1962, p. 26.
Penaeus crucifer Ortmann, 1890, p. 451.

Material. 12 ♂♂, 27 ♀♀, 36–44 mm; NORTHERN TERRITORY: Chambers Bay ("Paxie"); QUEENSLAND: Gulf of Carpentaria ("Rama"), Princess Charlotte Bay ("Challenge"); NEW GUINEA: off Kea Kea Creek, off Fly R. mouth, Hercules Bay. Depth of occurrence 3–9 fm.

Distribution. Southern Japan to northern Australia, northern China to Malaysia.

Discussion. *P. tenella* is a well-described species, and the reader is particularly referred to KUBO (1949), LIU (1955), and DALL (1957). This species is very closely related to *P. acclivirostris* (Alcock), two African specimens of which were also examined during the present study. These two species can readily be distinguished from each other by their secondary sexual characters. *P. acclivirostris* displays a rather slender and narrow petasma, which lacks the large wing-like lateral outgrowths present in *P. tenella*, and the distolateral projections in the former are considerably shorter, as well as strongly reflected. The thelycum of the female of *P. acclivirostris* examined fully agrees with the drawing of ALCOCK (1906), and lacks the posterior extension, present in *P. tenella*, as demonstrated by DALL (1957).

HALL (1962) extended the distribution of *P. tenella* to Malaysia, and during the present investigation this species was found to occur off the Northern Territory, as well as in waters of New Guinea. Owing to its

small size, this species is likely to escape the mesh of conventional otter trawls, and future more careful and efficient collecting methods may yet disprove the theory of present authors, that its distribution is discontinuous. DE BRUIN (personal communication) recently recorded *P. tenella* from Ceylonese waters. From his studies, which will be published soon, it can be assumed that the vicinity of Palk Strait could well be the zoogeographic boundary, separating the eastern species *P. tenella* from its western congener *P. acclivirostris*. Future comparative studies, involving both these species, are therefore desirable.

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EXPLANATION OF THE PLATES

PLATE 1

Fig. 1. *Penaeus japonicus* Bate, ♂, 139 mm.
Fig. 2. *Penaeus longistylus* Kubo, ♂, 148 mm.
Fig. 3. *Metapenaeopsis novaeguineae* (Haswell), ♀, 96 mm.
Fig. 4. *Metapenaeopsis rosea*, sp. nov., ♀, 106 mm, paratype.

PLATE 2

Fig. 1. *Metapenaeopsis crassissima*, sp. nov., ♀, 89 mm.
Fig. 2. *Metapenaeopsis lamellata* (de Haan), ♀, 97 mm.
Fig. 3. *Metapenaeopsis insona*, sp. nov., holotype.
Fig. 4. *Penaeus mastersii* Haswell, neotype.

PLATE 3

Fig. 1. *Metapenaeus ensis* (de Haan), cephalothorax of lectotype.
Fig. 2. *Metapenaeus ensis* (de Haan), thelycum of lectotype.
Fig. 3. *Metapenaeus papuensis*, sp. nov., cephalothorax of ♀, 95 mm.
Fig. 4. *Trachypenaeus granulosus* (Haswell), ♀, 90 mm.
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PLATE 4

Fig. 1. Petasma of *Metapenaeopsis novaeguineae*, ventral view.
Fig. 2. Petasma of *Metapenaeopsis novaeguineae*, dorsal view.
Fig. 3. Petasma of *Metapenaeopsis palmensis*, ventral view.
Fig. 4. Petasma of *Metapenaeopsis palmensis*, dorsal view.
Fig. 5. Petasma of *Metapenaeopsis crassissima*, ventral view.
Fig. 6. Petasma of *Metapenaeopsis crassissima*, dorsal view.
Fig. 7. Petasma of *Metapenaeopsis rosea*, ventral view.
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Fig. 9. Petasma of *Metapenaeopsis barbata*, ventral view.
Fig. 10. Petasma of *Metapenaeopsis barbata*, dorsal view.
Fig. 11. Petasma of *Metapenaeopsis acclivis*, ventral view.
Fig. 12. Petasma of *Metapenaeopsis acclivis*, dorsal view.

PLATE 5

Fig. 1. Petasma of *Metapenaeopsis dura*, ventral view.
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PLATE 6

Fig. 1. Petasma of *Metapenaeus papuensis*, ventral view.
Fig. 2. Petasma of *Metapenaeus papuensis*, dorsal view.
Fig. 3. Petasma of *Metapenaeus insolitus*, ventral view.
Fig. 4. Petasma of *Metapenaeus insolitus*, dorsal view.
Fig. 5. Petasma of *Metapenaeus demani*, ventral view.
Fig. 6. Basial spine on ♂ 3rd pereopod of *Metapenaeus dobsoni*.
Fig. 7. Petasma of *Metapenaeus intermedius* from North Borneo, ventral view.
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Fig. 11. Petasma of *Metapenaeus brevicornis*, ventral view.

PLATE 7

Fig. 1. Petasma of *Metapenaeus tenuipes*, ventral view.
Fig. 2. Petasma of *Metapenaeus eboracensis*, ventral view.
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Fig. 5. Petasma of *Atypopenaeus bicornis*, ventral view.
Fig. 6. Petasma of *Atypopenaeus bicornis*, dorsal view.
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Fig. 5. Thelycum of *Metapenaeus demani*.
Fig. 6. Thelycum of *Metapenaeus intermedius* from Japan.
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