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PENAEID PRAWNS OF CEYLON (CRUSTACEA DECAPODA, PENAEIDAE)

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With 3 text-figures

INTRODUCTION

Penaeid prawns form the basis of flourishing fisheries in South America, East Africa, India, Ceylon, Hong Kong, Indonesia and Australia. In some of these countries surveys are in progress to determine new prawn resources in the sea, since the demand for these crustaceans is unsatisfied. The scientific study of these animals has progressed considerably in most of these areas. Studies in the Indian region can be referred to in the works of Alcock, 1905, 1906; Bate, 1888; De Man, 1888, 1911; Henderson, 1893; Kemp, 1915 and Miers, 1884. Some of these authors have made passing references to the species present in Ceylon waters, but the only special study of the Ceylon species is that of Pearson (1905). Pearson's article, however, refers only to nine species, about half of them marine, while the commercially abundant species of lagoon waters have been neglected.

The present article deals with the taxonomic study of thirty-one species. The nomenclature has been critically revised in relation to recent changes and comparisons have been made with con-generic species from other parts of the Indo-Pacific.

The distribution of species in Ceylon waters is discussed in relation to its bearing on the hypothesis put forward by Hall (1958) on the distribution of Penaeidae in the Indo-Pacific region as well as in relation to environmental conditions.

The examined material is now placed in the collection of the Fisheries Research Station at Colombo and in the collection of Decapod Crustacea of

1) Formerly of the Fisheries Research Station, Colombo, Ceylon.

the Rijksmuseum van Natuurlijke Historie at Leiden. In the following text these collections are indicated with the abbreviations FRSC and RMNH respectively.

PENAEIDAE Rafinesque

For key to the subfamilies of the Penaeidae see Dall (1957 : 139).

SOLENO CERINAE Wood-Mason & Alcock

For key to the genera of Solenocerinae see Kubo (1949 : 207).

Solenocera subnuda Kubo

Description. — See Hall (1956 : 69, pl. 9 fig. 2, 3, as *S. kubo*), and Hall (1962 : 11, fig. 73).

Material examined. — East of Mullaitivu lighthouse, Ceylon, 13 fathoms, mud banks, trawled at night; FRSC No. 22, RMNH No. 19825.

Size. — Carapace length of males 19 and 20 mm, of females 19 and 26.5 mm.

Colour. — Brick red when alive.

Occurrence in Ceylon. — Not abundant.

Solenocera bedokensis Hall

Description. — See Hall (1962 : 13, fig. 78).

Material examined. — East of Mullaitivu lighthouse, Ceylon, 13 fathoms, mud banks, trawled at night; FRSC No. 23, RMNH No. 19834.

Size. — Carapace length of males 13 and 13.5 mm, of females 14.0 and 14.5 mm.

Colour. — Brick red when alive.

Occurrence in Ceylon. — Not abundant; trawled together with *Solenocera subnuda*.

PENAEINAE Rafinesque

For key to the genera of Penaeinae see Dall (1957 : 140).

Penaeus Fabricius

For key to the Indo-West Pacific species of *Penaeus* see Dall (1957 : 142).

Penaeus latisulcatus Kishinouye

Description. — See Kubo (1949 : 278, fig. 1Q, 7E, 15G-L, 20B, 24D, E, 39, 49J, 56, 58B, 67A-D, 73B, H, 77Q, 109, 111), Dall (1957 : 149, fig. 4), and Hall (1962 : 14, fig. 80).

Material examined. — Negombo lagoon near its mouth; FRSC No. 5, RMNH No. 19824.

Size. — Carapace length of male 29 mm, of female 33 mm.

Occurrence in Ceylon. — Not abundant. Found in estuaries near their connection with the sea, and in the sea.

Remarks. — The Ceylon specimens agree with the descriptions given by Kubo (1949) and Dall (1957) except in the following features:

1. In the Japanese (Kubo, 1949) and Ceylon specimens there is one tooth on the ventral surface of the rostrum while in the Australian specimens (Dall, 1957), there may be an extra tooth there.

2. In the Japanese specimens the adrostral sulcus is as wide as the post-rostral carina, in the Ceylon and Australian specimens the adrostral sulcus is slightly wider than the post-rostral carina.

3. In the Ceylon specimens the length of the post-rostral sulcus is slightly less than half the length of the carapace while in Japanese and Australian specimens the sulcus is slightly more than half the length of the carapace.

4. In the Ceylon specimens the third pereopod extends to the tip of the second or third segment of the antennular peduncle, in Japanese specimens the third pereopod extends to the tip of the first segment while in Australian specimens it extends to the tip of the second segment.

5. In Ceylon specimens, the relationship between the fourth and fifth pereopod is variable: generally, the fourth pereopod is shorter than the fifth by a dactyl, sometimes the fourth pereopod extends as far as the fifth. In Japanese specimens the fourth pereopod reaches as far as the fifth while in Australian specimens the fifth pereopod is shorter than the fourth by a dactyl.

***Penaeus canaliculatus* (Olivier)**

Material examined. — From estuaries round Ceylon close to their opening into the sea, as well as in the sea; FRSC No. 6, RMNH No. 19820.

Size. — Carapace length of male 18 mm and of females 20.5 and 24.0 mm.

Occurrence in Ceylon. — Not abundant.

Remarks. — This species is very similar to *P. latisulcatus* Kishinouye and *P. japonicus* Bate but can be readily distinguished from these by the absence of any spines or spinules on the telson. Moreover, the above species can be distinguished from *P. latisulcatus* by the absence of any bifid projection on the sternum between the fourth pair of pereopods in females and from *P. japonicus* by the fact that the fingers of the third pereopod are shorter than the palm.

Penaeus indicus H. Milne Edwards

Description. — See Kubo (1949: 311-313).

Material examined. — Komari lagoon, east coast of Ceylon; FRSC No. 1, RMNH No. 19819.

Size. — Carapace length of males 16 and 18 mm, of females 18.5 and 20 mm.

Occurrence in Ceylon. — Abundant in the lagoons and sea around Ceylon; prefers sand bottom and the shallow water of the sea of 2 to 6 fathoms.

Penaeus merguensis De Man

Description. — See Dall (1957: 160-162, fig. 8A-H).

Material examined. — Mutwal sea; FRSC No. 2, RMNH No. 19822.

Size. — Carapace length of males 33, 36 and 38 mm.

Occurrence in Ceylon. — Abundant in the sea on a mud and mud-sand bottom of 3 to 10 fathoms.

Penaeus semisulcatus De Haan

Description. — See Dall (1957: 154-157, fig. 6A-F).

Material examined. — Negombo lagoon near opening into the sea; FRSC No. 3, RMNH No. 19823.

Size. — Carapace length of males 16, 18 mm, of females 18.5 and 20 mm.

Occurrence in Ceylon. — Abundant in lagoons of high salinity (10-25 p.p. mille) and in the sea.

Penaeus monodon Fabricius

Description. — See Dall (1957: 152-154, fig. 5A-E).

Material examined. — Negombo lagoon; FRSC No. 4, RMNH No. 19821.

Size. — Carapace length of males 19.5, 25, 29 and 39 mm, of females 37 and 38 mm.

Occurrence in Ceylon. — In lagoons and in the sea around Ceylon.

Remarks. — Largest of the penaeid prawns in Ceylon waters but much less abundant than *P. indicus* and *P. semisulcatus*.

Metapenaeus Wood-Mason & Alcock

For key to the species of *Metapenaeus* see Dall (1957: 183-184).

Metapenaeus mutatus Lanchester

Description. — See Hall (1961: 86-87), and Hall (1962: 25, fig. 96-96B).

Material examined. — East of Mullaitivu lighthouse, Ceylon, 8-12 fathoms, mud banks, trawled at night; FRSC No. 11, RMNH No. 19813.

Occurrence in Ceylon. — Abundant in the sea off Mullaitivu.

Remarks. — The Ceylon specimens agree with the descriptions and illustrations given by Lanchester (1901) and Hall (1956, 1962) except in the points listed below:

1. In Lanchester's (1901) description the presence or absence of an ischial spine on the first pereopod of the female is not mentioned. In Hall's (1956) description it is stated that the ischium has no spine in either the male or the female while in Hall's (1961) description, it is stated that the ischium bears a distinct though minute spine. In the Ceylon specimens the ischium has a distinct though minute spine in both males and females.

2. In Lanchester's (1901) description, the question whether the rostrum is straight or sigmoid is not discussed. In Hall's (1956) description the rostrum is described as being somewhat sigmoid while in Hall's (1961) description the rostrum of the female is said to be almost straight, that of the male being somewhat sigmoid. In the Ceylon specimens the rostrum is somewhat sigmoid in both sexes.

3. In Lanchester's (1901) and Hall's (1961) descriptions and in the Ceylon specimens the disto-median protuberances of the petasma are directed laterally while in Hall's (1956) description these protuberances are stated to be directed antero-laterally.

4. In Lanchester's (1901) and Hall's (1961) descriptions the relationship between the third maxillipede and the tip of the carpoperite is not discussed. In Hall's (1956) description and in the Ceylon specimens the third maxillipede extends to the tip of the carpoperite.

5. According to Lanchester (1901) the first pereopod barely extends to the eye-stalks; in Hall's (1956) description the first pereopod attains the same level as the third maxillipede while in Hall's (1961) description this question is not referred to. In the Ceylon specimens, the first pereopod attains the same level as the third maxillipede or reaches to the anterior surface of the eye.

6. According to Lanchester (1901) the second pereopod extends only to the middle of the scaphocerite. In Hall's (1956) description the second pereopod surpasses the carpoperite by the length of a finger. Hall (1961) does not refer to this question. In the Ceylon specimens, the second pereopod surpasses the carpoperite by the length of a finger and also extends well beyond the middle of the scaphocerite.

7. According to Lanchester (1901) the third pereopod extends only to the tip of the spine at the outer distal angle of the scaphocerite. In Hall's (1956) description the third pereopod is said to surpass the carpoperite by the entire chela, while in his (1961) description this question is not dis-

cussed. In the Ceylon specimens, the third pereopod surpasses the carapocerite by the entire chela and well surpasses the tip of the spine of the scaphocerite.

8. According to Lanchester (1901) the fourth pereopod is as long as the first pereopod. According to Hall's (1956) description, the fourth pereopod attains the same level as the third maxillipede or falls slightly short of it, while in his (1961) description this question is not referred to. In the Ceylon specimens the fourth pereopod is much longer than the first.

9. According to Lanchester (1901), the fifth pereopod surpasses the second by the length of a dactylus. In Hall's (1956) description, the distal three segments of the fifth pereopod are described as very slender and attaining the tip of the scaphocerite. There is no reference to this point in Hall's (1961) description. In the Ceylon specimens, the fifth pereopod surpasses the second pereopod by a dactylus length and three fourths of the length of the propodus and extends well beyond the tip of the scaphocerite.

Metapenaeus burkenroadi Kubo

Description. — See Kubo (1949: 92-93, fig. 1A-D).

Material examined. — Negombo Lagoon, FRSC No. 9, RMNH No. 19812.

Size. — Carapace length of males 9.5 and 9.5 mm, of females 16.5 and 17.5 mm.

Occurrence in Ceylon. — Found at mouths of lagoons on the south west coast of Ceylon but not in abundance. Abundant in high salinity lagoons of the northern coast of Ceylon like Jaffna. Has not been yet taken from the sea.

Remarks. — In the Ceylon specimens examined the relationship between the foremost rostral tooth and the penultimate is variable, for, in ten female specimens examined, in three specimens the distance between the foremost tooth and the tip of the rostrum was greater than that to the penultimate, in four specimens, the distance between the foremost tooth and tip was equal that to the penultimate, while in the remaining three the distance between the foremost tooth and tip was less than that to the penultimate. In ten male specimens examined, in three specimens the distance between the foremost rostral tooth and the tip was greater than that to the penultimate, in five specimens the distance between the foremost rostral tooth and tip was equal that to the penultimate, while in the remaining two the distance between the foremost rostral tooth and the tip was less than that to the penultimate.

The relationships among the three anterior teeth of the rostrum was also variable for, in ten female specimens examined, the distance between the first and second was equal to the distance between the second and third in four specimens, while in the rest the distance between the first and second was less than the distance between the second and third. In ten male specimens examined, the distance between the first and second was equal to the distance between the second and third rostral teeth in two specimens, while in the other eight specimens the distance between the first and second was less than the distance between the second and third teeth.

The dorsal pubescence bordering the post-rostral carina is also variable in Ceylon specimens, for, among all ten female specimens examined the pubescence was similar to that of *M. mastersii* (Haswell) (see Racek, 1957: 10, pl. 1) whereas among ten males, the pubescence was similar to that of *M. mastersii* in three specimens, while in the other seven the pubescence was similar to that of *M. burkenroadi*. The dorsal pubescence in Ceylon specimens is much less strong among males than in females.

The pleonic pubescence is also variable in Ceylon specimens. The first four abdominal somites may be slightly pubescent or entirely glabrous while the pubescence of the last two somites may be slight or strong. In all specimens, however, the first four abdominal somites are less pubescent than the last two. In one male specimen, all the pleonic somites were glabrous.

The features that are constant in Ceylon specimens are the following:

1. The longitudinal groove of the peduncles of the pleopods are shallow and slightly pubescent.
2. The lateral plates of the thelycum are flat with very slightly raised outer margins — the plates are glabrous while the ox-horn-like projections are pubescent. In this feature the Ceylon specimens resemble *M. dalli* Racek.
3. The tubercles of the median plate of the thelycum are almost equal in size and the anterior margin is either straight or slightly convex.
4. The disto-median projections of the petasma are diverging and laminate; not a single specimen of any size had the characteristic converging or parallel, tubular, disto-median projections of the petasma of *M. mastersii* (Haswell) described by Racek (1957: 12, pl. 1-2).

***Metapenaeus monoceros* (Fabricius)**

Description. — See Alcock (1906: 18-20, pl. 3 fig. 7-7C).

Material examined. — East of Mullaitivu lighthouse, Ceylon, mud bottom; FRSC No. 7, RMNH No. 19815.

Size. — Carapace length of male 22 mm, of female 31 mm.

Occurrence in Ceylon. — Not abundant, found together with *M. mutatus* and *M. ensis*. Immature forms found at entrance of lagoons into the sea.

Remarks. — The retrorse and introrse, hook-like spine in the last leg of the adult male in *M. monoceros* is much larger than that carried by the fifth leg of the male *M. ensis* (De Haan).

Metapenaeus ensis (De Haan)

Description. — See Hall (1958: 537-544), and Hall (1962: 22, fig. 90-90C).

Material examined. — Mullaitivu lagoon and east of Mullaitivu lighthouse; FRSC No. 8, RMNH No. 19817.

Size. — Carapace length of males 21 and 25 mm, of females 25 and 27 mm.

Occurrence in Ceylon. — Abundant in Mullaitivu lagoon and in the sea east of Mullaitivu lighthouse.

Metapenaeus dobsoni (Miers)

Description. — See Alcock (1906: 21-23, pl. 3 fig. 9-9D).

Material examined. — From lagoons around the coast of Ceylon and from the sea; FRSC No. 29, RMNH No. 19816.

Size. — Males with carapace length 16 and 16 mm, females with carapace length 18 and 25 mm.

Occurrence in Ceylon. — Most abundant prawn of the penaeid fauna of Ceylon though of small size. Especially abundant in the low salinity lagoons of the south-west, south and south-east sectors of Ceylon and in the sea off these lagoons. Rather rare in the high-salinity lagoons of the northern and north-eastern lagoons of Ceylon and in the sea off these lagoons.

Remarks. — Breeds in the shallow muddy regions of the sea at depths of 5 to 8 fathoms. Swarms in large schools at the surface of the sea on dark nights during breeding.

Metapenaeus elegans (De Man)

Description. — See Hall (1956: 84-86), and Hall (1962: 25, fig. 97-97b).

Material examined. — From lagoons in the south-west, south and south-east sectors of Ceylon; FRSC No. 12, RMNH No. 19818.

Size. — Males with carapace length 18.5 and 18.5 mm, females with carapace length 22.5 and 23.5 mm.

Occurrence in Ceylon. — Abundant in the low-salinity lagoons of Ceylon, rare in high-salinity lagoons, very rare in the sea.

Remarks. — Both sexes mature within the lagoons; females with very highly enlarged olive-green ovaries have been taken from the lagoons. Movement appears to be very reduced during full-moon nights and catches of this species with the use of traps is poor during such periods.

Metapenaeus lysianassa (De Man)

Description. — See Hall (1956: 82-86, fig. 93-93b).

Material examined. — From Jaffna lagoon; FRSC No. 10.

Size. — Male with carapace length 7 mm.

Occurrence in Ceylon. — Rare.

Metapenaeopsis Bouvier

For key to the species of *Metapenaeopsis* I may refer to Dall (1957: 167-168).

Metapenaeopsis hilarulus (De Man) (fig. 1 b, d)

Penaeopsis sp. (*hilarulus*) De Man, 1911: 70, 71, pl. 7 fig. 22.

Penaeopsis hilarulus Barnard, 1950: 595, fig. 108 g-l.

Metapenaeopsis mogiensis Hall, 1962: 35, fig. 120.

Description. — See Barnard (1950: 595-596).

Material examined. — From sea west of Mannar; RMNH No. 19811.

Size. — Males with carapace length 8.5, 9.0, 10.0, 10.0 mm, females with carapace length 10.0, 12.0 and 14.0 mm.

Occurrence in Ceylon. — Entirely marine, rare. Caught by the author while diving with aqua-lung at night at depth of six fathoms west of Mannar.

Remarks. — De Man (1911) described a species of *Penaeopsis* differing from *Parapenaeus mogiensis* Rathbun (1902), the most striking differences being the structure of the thelycum, particularly the divergent median teeth between the fourth pair of pereopods and the transverse median ridges between the fifth pair of pereopods. De Man suggested that the name "*P. hilarulus*" should be applied to this species, if and when it was shown to be certainly different from *P. mogiensis* (Rathbun). He compared the specimens of "*P. hilarulus*" with the description of *M. mogiensis* given by Alcock (1906) and pointed out that, „the thelycum much agrees with Alcock's fig. 15b, but the anterior of the two laminae between the bases of the feet of the 5th pair bears only one tooth at its outer angles. The divergent median teeth between the legs of the 4th pair show a somewhat other form than in Alcock's figure".

Schmitt (1926) could see no reason for regarding De Man's "*P. hilarulus*"

a separate species — the only major difference between Rathbun's and De Man's descriptions being the rudimentary nature of the spines between the second pereopods in Rathbun's specimens. Schmitt also stated that the thelycum of *P. mogiensis* displayed considerable variation.

Barnard (1950) described a species, *Penaeopsis hilarulus* De Man, in which the thelycum was a replica of De Man's illustration. Barnard, however, stated that "the lack of information, however, on other features, such as details of the petasma, appendix masculina on pleopod 2, inner flagellum of ant. 1 ♂, prevent a proper comparison and verdict of the identity of the various specimens".

Dall (1957) in his description of *M. mogiensis* (Rathbun) considered "hilarulus" a synonym of "mogiensis" while Hall (1961) saw no reason why "hilarulus" should be regarded a species distinct from "mogiensis". Hall's (1962: 222, fig. 120-120B) illustrations undoubtedly represent "*M. hilarulus*".

Several specimens of *Metapenaeopsis* were obtained in Ceylon waters. Of these, there were some female specimens whose thelyca resembled "mogiensis" and others that resembled "hilarulus". Closer examination of these specimens revealed other differences as well — the most striking being the absence of a groove on the third abdominal carina in specimens with thelyca resembling the "hilarulus" type and the presence of a distinct groove on the third abdominal carina of specimens resembling the "mogiensis" type. Further examination has established the two species to be distinct. The form "hilarulus" is, therefore, regarded as a separate species.

M. mogiensis resembles *M. hilarulus* in the following features:

1. The tip of the rostrum extends just behind or up to the middle of the second segment of the antennular peduncle.
2. The ratio of the antennular length to the carapace length is 1 : 4.
3. The epigastric spine is situated a quarter of the distance of the carapace from the anterior border of the carapace.
4. The ratio of the length to the breadth of the sixth abdominal somite is 2.1 or $< 2 : 1$.
5. Spines are present on the sternum between the second pereopods of the female.

M. mogiensis differs from *M. hilarulus* in the following features:

1. The number of rostral teeth in *M. mogiensis* is 6-8 + 1, in *M. hilarulus* 7-8 + 1.
2. The rostrum is tilted upwards in *M. mogiensis* but only slightly so in *M. hilarulus*.

3. A round dot without tomentum is clearly visible on the postero-dorsal region of the carapace of female specimens of *M. hilarulus*, it is not distinct in *M. mogiensis*.

4. Terminal filaments are present in the left hinged lobe of the petasma of *M. mogiensis*. They are absent in *M. hilarulus*.

5. A clear groove is present on the third abdominal carina of *M. mogiensis*, a bare stripe without a groove is present in *M. hilarulus*.

6. The pair of spines in the excavation between the fourth pair of pereopods of the female is small and pointed at the tip in *M. mogiensis*, it is large and not pointed at the tip in *M. hilarulus*.

7. In *M. mogiensis* the anterior border of the sternum between the fifth pair of pereopods of the female bears four protuberances, the median two are incurved and enclose the teeth present between the fourth pair of pereopods. In *M. hilarulus* the anterior border of the sternum between the

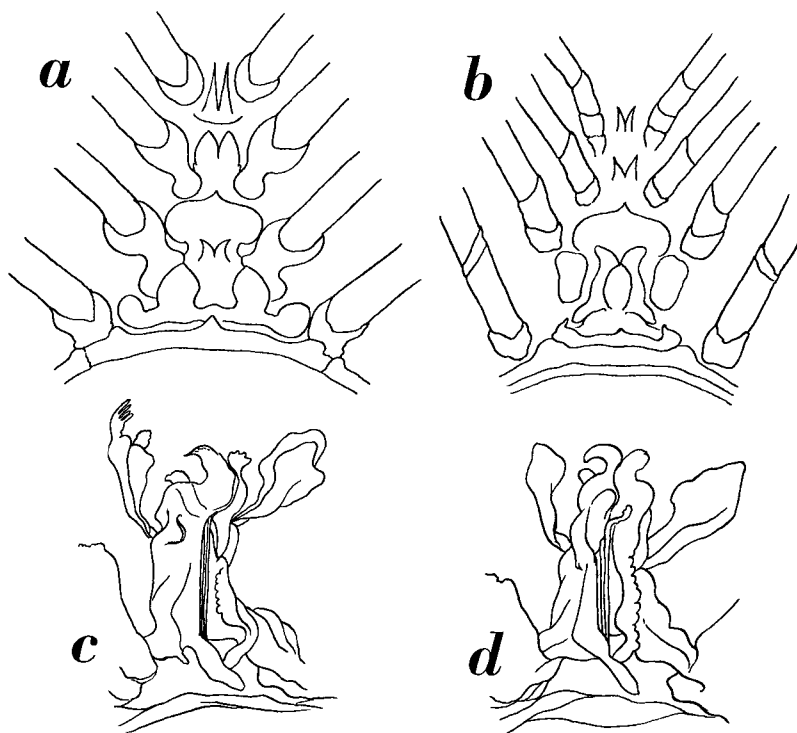


Fig. 1. a, c. *Metapenaeopsis mogiensis* (Rathbun); b, d, *Metapenaeopsis hilarulus* (De Man). a, b, thelycum; c, d, dorsal view of petasma. a-d, $\times 5$.

fifth pair of pereiopods of the female bears two small protuberances laterally and does not enclose the pair of teeth between the fourth pair of pereiopods.

The shape of the thelycum of *M. hilarulus* cannot be considered a juvenile feature as compared to *M. mogiensis*, since specimens of *M. hilarulus* ranging from 3.9 to 6.2 cms in total length had identical structures.

***Metapenaeopsis mogiensis* (Rathbun) (fig. 1a, c)**

Description. — See Dall (1957: 172-174).

Material examined. — East of Mullaitivu lighthouse, off Mannar, mud-sand substratum, 6 fathoms; FRSC No. 14, RMNH No. 19805.

Size. — Males with carapace length 10.0, 11.0, 11.0, 12.0, 13.0 mm, females with carapace length 8.0, 9.0, 10.0, 10.5, 11.0, 11.5, 12.0, 12.0, 12.0, 12.0, 12.0, 13.0, 13.0, 13.0, 15.0, 15.0, 17.5, 17.5, 17.5, 18.0 and 19.0 mm.

Occurrence in Ceylon. — Entirely marine, not abundant.

***Metapenaeopsis stridulans* (Wood-Mason)**

Description. — See Alcock (1905: 27, pl. 5 fig. 14-14D), Hall (1961: 105-109, pl. 21 fig. 21, 23).

Material examined. — East of Mullaitivu lighthouse; FRSC No. 15, RMNH No. 19808.

Size. — Males with carapace length 14.0, 14.0 mm, females with carapace length 16.0, 18.0 mm.

Occurrence in Ceylon. — Most abundant penaeid of the prawn fauna of Mullaitivu mud-banks at depths of 8 to 13 fathoms. Entirely marine.

Remarks. — Two hundred specimens (a hundred of each sex) were examined and the number of stridulating ridges on the right and left side of the carapace were counted. It was seen that there was some slight variation in the number of ridges constituting the stridulating organ, but in nearly 70 % of both sexes there are five ridges on both right and left sides, the range in the number of ridges being 4 to 6. The carapace length of the two hundred individuals varied from 13 to 15 mm among males and from 14 to 20 mm among females.

On the left hinged lobe of the petasma (which is larger than the right hinged lobe) there are several prominent apical filaments varying from 7 to 12 in number. A single apical filament is present on the right hinged lobe, this (as stated by Hall, 1961) is so minute that it can be easily overlooked.

In the thelycum of this species, a pair of large slender pointed processes is present on the sternum between the second pair of pereopods; a pair of prominent blunt processes is present on the sternum between the third pair of pereopods, they are more highly developed than in *M. durus* Kubo. The anterior border of the thelycal plate is straight or slightly convex, the sides of this plate curve inwards posteriorly; the anterior sternal ridge lying between the fifth pair of pereopods has a pair of anteriorly directed processes, the anterior border of the median process is slightly convex, the lateral processes are triangular. The median process is broader than long.

Metapenaopsis toloensis Hall

Description. — See Hall (1962: 33-35, fig. 119-119D).

Material examined. — East of Mullaitivu lighthouse, 13 fathoms, mud substratum; FRSC No. 16, RMNH No. 19809.

Size. — Males with carapace length 14.0, and 15.0 mm, females with carapace length 13.5, and 16.0 mm.

Occurrence in Ceylon. — Quite abundant off Mullaitivu, entirely marine.

Remarks. — The Ceylon specimens were compared with *Metapenaopsis durus* Kubo, *Metapenaopsis durus* sensu Dall and *Metapenaopsis toloensis* Hall. They were found to have greater affinities with the latter two descriptions as can be seen below:

1. In Ceylon specimens the rostrum extends slightly beyond the tip of the second segment of the antennular peduncle and is slightly upcurved; in *M. durus* (Kubo, 1949), the rostrum hardly extends to the middle of the second segment of the antennular peduncle and is considerably upcurved; in *M. durus* (sensu Dall, 1957), the rostrum extends almost to the tip of the third segment of the antennular peduncle and is strongly upcurved; in *M. toloensis* Hall, 1962, the rostrum is shorter than in Dall's (1957) description, it is considerably upcurved in large specimens while in small specimens it is almost straight.

2. The antennular flagella in Ceylon specimens are a little more than one fourth of the length of the carapace; in *M. durus* Kubo, 1949, the flagella are about half the length of the carapace; in *M. durus* (sensu Dall, 1957) the flagella are a little more than one-fourth the length of the carapace while in *M. toloensis* Hall, 1962, they are one fourth the length of the carapace.

3. The scaphocerite in Ceylon specimens is 2.2 to 2.8 times as long as broad at the base; in *M. durus* Kubo, 1949, the scaphocerite is thrice as

long as broad at the base; in Dall's (1957) description of *M. durus* there is no reference to this character, while in *M. toloensis* (Hall, 1962) the scaphocerite is not more than 2.5 times as long as broad at its base.

4. In Ceylon specimens the inner antennular flagellum has a spine at its base in male specimens; there is no reference to this feature in the descriptions of *M. durus* Kubo, 1949, *M. durus* (sensu Dall, 1957) and *M. toloensis* Hall, 1962.

5. In the Ceylon specimens there are 16 to 23 stridulating ridges; in *M. durus* Kubo, 1949, there are 28 to 35 ridges; in *M. durus* (sensu Dall, 1957) there are 14 to 18 ridges while in *M. toloensis* Hall, 1962, there are 15 to 20 ridges.

6. In Ceylon specimens the third maxillipede extends to the tip of the second or third segment of the antennular peduncle; in *M. durus* Kubo, 1949, it extends to or beyond the tip of the first segment of the antennular peduncle; in *M. durus* (sensu Dall, 1957) it extends to the base or middle of the second segment of the antennular peduncle while in *M. toloensis* Hall, 1962, it reaches, almost reaches or slightly exceeds the tip of the third segment of the antennular peduncle.

7. In Ceylon specimens the first pereopod extends to the tip of the carpocerite; in *M. durus* Kubo, 1949, it extends to the anterior end of the basicerite; in *M. durus* (sensu Dall, 1957) it extends to the middle of the carpocerite while in *M. toloensis* Hall, 1962, it extends to the proximal end in small specimens while in large specimens it extends to the distal end of the carpocerite.

8. In Ceylon specimens the second pereopod exceeds the carpocerite by an entire chela, in *M. durus* Kubo, 1949 it extends to the tip of the carpocerite; in *M. durus* (sensu Dall, 1957) it exceeds the carpocerite by a dactylus while in *M. toloensis* Hall, 1962, it attains the proximal margin of the carpocerite in small specimens while in large specimens it exceeds the tip of the carpocerite by the entire chela.

9. In Ceylon specimens the third pereopod extends almost as far as the third maxillipede or the tip of the second segment of the antennular peduncle; in *M. durus* Kubo, 1949, it extends as far as the third maxillipede; in *M. durus* (sensu Dall, 1957) it exceeds the first segment of the antennular peduncle by the dactylus while in *M. toloensis* Hall it extends to the middle of the second segment of the antennular peduncle but falls considerably short of the third maxillipede.

10. In Ceylon specimens the fourth pereopod extends to the tip of the carpocerite and the coxal plates are large; in *M. durus* Kubo it extends as far as the first leg and the coxal plates are large; in *M. durus* (sensu

Dall, 1957) it extends as far as the first leg and the coxal plates are small whereas in *M. toloensis* Hall it is as in Kubo's and Dall's descriptions: the coxal plates are large.

11. In Ceylon specimens the fifth pereopod surpasses the carpoperite by the dactylus; in *M. durus* Kubo, it extends to the distal end of the carpoperite; in *M. durus* (sensu Dall, 1957) and in *M. toloensis* Hall it exceeds the carpoperite by half a dactylus length.

12. In Ceylon specimens the abdominal carina is poorly developed on the second and the anterior quarter of the third segment, the carina is prominent on its posterior three-fourths: the groove on the posterior three-fourths gets wider in a posterior direction; the carina is prominent on the fourth, fifth and sixth segments; spines are present at the posterior ends of the fifth and sixth segments while sub-carinae are present on the fourth segment; in *M. durus* Kubo the abdominal carina starts posterior to the first segment, it is defined on the second and most pronounced on the third segment, the groove on the third segment gets wider posteriorly, the fifth segment ends in a spine like the sixth and there is no sub-carina. In *M. durus* (sensu Dall, 1957) the abdominal carina starts from the posterior half of the second segment; there is a well-defined sulcus on the third segment; the carina is prominent on the fourth, fifth and sixth segments; in *M. toloensis* Hall the dorsal carina of the third segment attains its maximum width a little before its posterior end and the carina is defined but without a groove for a short distance anterior to the elevated posterior part; sub-carinae are present on the fourth segment.

13. In Ceylon specimens a pair of reduced processes is present between the third pereopods of the female; there is no reference to this feature in Kubo's (1949) description of *M. durus* Kubo; in *M. durus* (sensu Dall, 1957) there are no appreciable processes, while in *M. toloensis* Hall, 1962, no reference to these processes is made in the original text while there are indications of a pair of processes in the illustration.

14. In Ceylon specimens the thelycum is very similar to those shown in the illustrations of *M. durus* Kubo, 1949, *M. durus* (sensu Dall, 1957) and *M. toloensis* Hall, 1962.

15. In Ceylon specimens the right hinged lobe of the petasma is leaf-shaped and has three small apical processes, sometimes these processes may be absent. The right half of the petasma is divided distally into a large median process and small lateral processes. The left hinged lobe is club-shaped and is larger than the right with many small apical outgrowths. In *M. durus* Kubo, 1949, the right disto-ventral projection of the petasma is leaf-shaped with three spiniform processes; the left disto-ventral projec-

tion is markedly developed with about fifteen pointed outgrowths on its margin. In Dall's (1957) description of *M. durus* there is no reference to the petasma while in *M. toloensis* Hall, 1962, the left lobe of the petasma has a group of four filaments which do not project distally, the filaments are subdivided into several lobules; a semi-circular group of much smaller filaments is also present on the left lobe and these are arranged around the anterior and outside margins of the tip.

***Metapenaopsis mannarensis* sp. nov. (fig. 2)**

Material examined. — Off Mannar at depth of six fathoms, mud-sand sub-stratum; RMNH No. 21236 (holotype), 21237 (paratypes), 19810 (paratypes).

Size. — Males with carapace length 12.0, 12.5, 13.0, 13.0 mm, females with carapace length 13.5, 14.5, 15.0, 15.0, 15.0 mm.

Occurrence in Ceylon. — Rare, entirely marine.

Description. — The rostrum which has 7 or 8 teeth inclusive of the epigastric, is nearly horizontal, the anterior portion projects slightly upwards. The tip of the rostrum extends up to or slightly beyond the anterior border of the first segment of the antennular peduncle.

The epigastric spine is situated at a quarter of the distance from the anterior border of the carapace. The post-rostral carina is absent. The stridulating organ is absent. The hepatic spine lies just below the epigastric tooth.

The antennules are half or a little less than half the length of the carapace. In males (not in females) two small spines are present on a swollen basal projection of the inner antennular flagellum, the anterior of these spines is the smaller.

The third maxillipede extends beyond the carpocerite by the length of the dactylus plus half the propodus. The first pereopod extends to the middle of the carpocerite. The second and third pereopods extend beyond the carpocerite with the entire chela. The fourth pereopod extends beyond the tip of the first pereopod with the dactylus and half the propodus.

A carina is present on the anterior border of the third segment and continues posteriorly, ending in a small spine at the posterior end of the sixth abdominal segment. No sulcus or bare stripe is present on the carina of the third abdominal segment. The sixth abdominal segment is generally less than twice the depth near the posterior end, it is rarely equal to just twice the depth.

The telson is not grooved. It has a pair of fixed sub-apical spines and

three pairs of movable spines, the anterior-most pair being the smallest.

In the female of this species, there is a pair of long slender processes on the sternum between the coxae of the second pair of pereiopods. A pair of

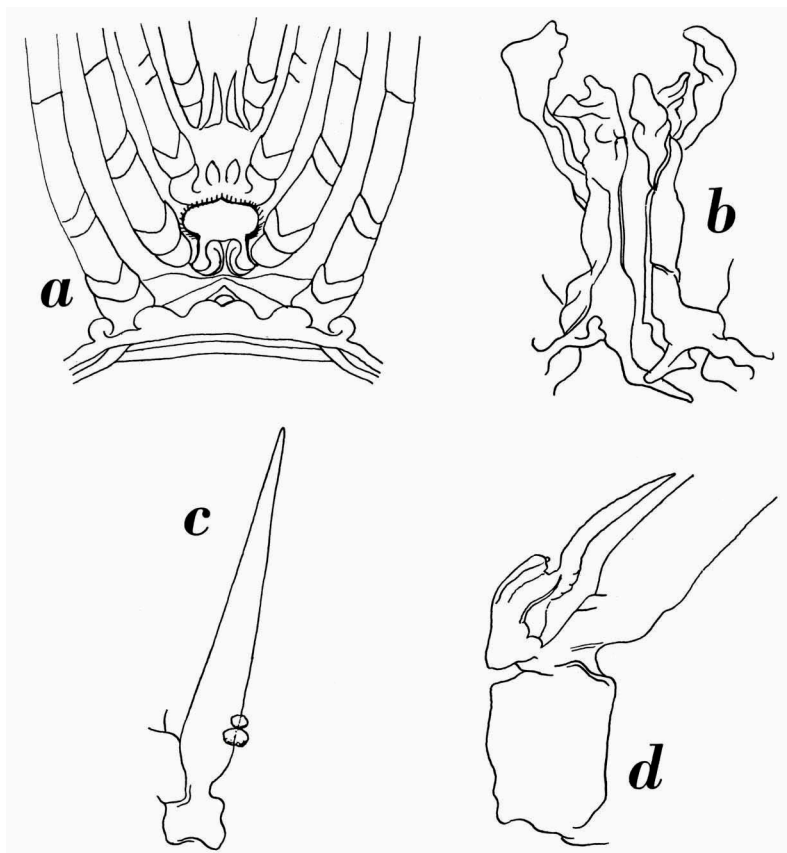


Fig. 2. *Metapenaeopsis mannarensis* sp. nov. a, thelycum; b, dorsal view of petasma; c, inner antennular flagellum; d, second pleopod of male with appendix masculina. a-d, $\times 5$.

blunt processes (much smaller than in *M. mogiensis*) is present between the coxae of the third pereiopods. There are no median processes on the sternum between the fourth and fifth pair of pereiopods. There is no median tubercle on the posterior transverse sternal ridge between the fifth pereiopods.

The petasma, as in all species of *Metapenaeopsis*, is asymmetrical; the left hinged lobe is much stouter and a little longer than the right hinged lobe.

There are no apical outgrowths on either the right or the left hinged lobes.

This species is quite different from the established species of *Metapenaeopsis*. Unfortunately, it has not been possible to trace the literature pertaining to the little known and doubtful species referred to by Dall (1957: 166). It appears to be related to *M. incomptus* Kubo, from which it differs in the following features:

1. In *M. mannarensis* the antennular flagella are half or a little less than half the length of the carapace, in *M. incomptus* the flagella are a quarter of the length of the carapace.

2. A pair of very small blunt processes between the coxae of the third pair of pereopods of the female is present in *M. mannarensis*. In *M. incomptus* a pair of abruptly pointed and antero-ventrally directed outgrowths is placed between the third pair of pereopods of the female.

3. The rostrum of *M. mannarensis* has 7 or 8 teeth exclusive of the epigastric, in *M. incomptus* there are 6 or 7 teeth exclusive of the epigastric.

4. In *M. mannarensis* the rostrum extends to the end of the first segment or slightly beyond the first segment of the antennular peduncle, in *M. incomptus* the rostrum extends to one third of the second segment of the antennular peduncle.

5. In *M. mannarensis* the abdomen is dorsally carinated posterior to the second abdominal segment; in *M. incomptus* the abdomen is dorsally carinated posterior to the first abdominal segment.

6. In *M. mannarensis* the third maxillipede extends a little beyond the antennal scale, in *M. incomptus* the third maxillipede extends to the tip of the antennal scale. In *M. mannarensis* the right and left hinged lobes of the petasma are without apical filaments, of *M. incomptus* nothing is known about this feature.

Trachypeneus Alcock

For key to the species of *Trachypeneus* see Dall (1957: 203) and Hall (1962: 180).

Trachypeneus salaco De Man

Trachypeneus salaco De Man, 1907: 135; De Man, 1911: 90, pl. 9 fig. 29.

Trachypeneus pescadorensis Schmitt, 1931: 265, pl. 32, fig. 2-4; Hall, 1962: 29, fig. III-III B.

Trachypeneus granulosus Hall, 1961: 100, pl. 19 fig. 15.

Trachypeneus furcilla Hall, 1961: 102, pl. 20 fig. 16-17.

Description. — See De Man (1911: 90-92), Hall (1962: 29, fig. III-III B).

Material examined. — East of Mullaitivu lighthouse, mud bottom, 10-13 fathoms; FRSC No. 25, RMNH No. 19797.

Size. — Males with carapace length 12.0, 14.5 mm, females with carapace length 18.0, 22.0 mm.

Occurrence in Ceylon. — Abundant at depths of 10 to 13 fathoms east of Mullaitivu lighthouse, not found in lagoons.

Remarks. — Breeds at depths of 10 to 13 fathoms. The Ceylon specimens agree in most respects with the descriptions given by De Man (1911) for the species *Trachypeneus salaco*, although there are the following minor differences:

1. The rostrum in males extends beyond the middle of the second segment of the antennular peduncle or up to its tip, whereas in females, it extends to the tip of the third segment; the number of rostral teeth is 9-10 + 1.

2. A short longitudinal fissure is present on the carapace, this may be hidden by the dense pubescence.

3. The carapace together with the rostrum measures a little more than one-third the entire length.

4. In males the sixth abdominal somite is slightly less than half that of the carapace while in females it is only a little more than one-third.

5. The fifth pereopod extends beyond the antennal scale by the dactylus and one-third of the propodus.

6. In small males the lamina of the horn of the petasma arising from the anterior margin may be ovoid and the tooth arising from the margin of the median fissure may be absent. In large males, the lamina is triangular and a distinct tooth is present. The thelycum of the Ceylon specimens is exactly similar to that of *T. pescadoreensis* (cf. Hall, 1961: pl. 19 fig. 15). Moreover, the posterolateral margins of the anterior median plate of the thelycum do not overlap the median posterior projection of that plate. As in Hall's (1961: 100) description a minute ischial spine is found on the first pereopod. A pair of prominent movable spines is present on the telson, anterior and posterior to which are three pairs of minute spines. Hall (1961: 103) found only two pairs anterior to the large spine in the telson of his *T. furcilla*.

Hall (1962: 29) in his description of *T. pescadoreensis* stated, "the posterior projection [of the anterior median plate of the thelycum] does not extend to the posterior margin of the posterior plate: it is turned ventrally through 90°". In Ceylon specimens, however, the posterior extension of that plate is not turned through 90° but extends slightly posteriorly and appears to fuse with the anterior projection arising from the posterior plate. As

in Hall's description, the longitudinal ridge on the anterior thelycal plate, described in *T. pescadoreensis* Schmitt is not evident in the specimens at hand. The differences in the descriptions of *T. furcilla* Hall, 1961, *T. pescadoreensis* by Hall, 1962, *T. granulatus* by Hall, 1961 and *T. pescadoreensis* Schmitt, 1931 from *T. salaco* De Man are probably intra-specific variations.

Trachypeneus curvirostris (Stimpson)

Description. — See Dall (1957: 203-206, fig. 22A-F).

Material examined. — East of Mullaitivu lighthouse, mud-bottom, 10-13 fathoms; FRSC No. 24, RMNH No. 19798.

Size. — Males with carapace length 12.5, 14.0 mm, females with carapace length 12.0, 20.5 mm.

Occurrence in Ceylon. — Rare, east of Mullaitivu lighthouse, trawled at night together with *T. salaco* and *T. sedili*. Not found in lagoons.

Remarks. — The Ceylon specimens agree in most respects with the description given by Dall (1957). However, in specimens ranging from 42 to 67 mm in total length, the rostrum is straight and not curved as illustrated by Dall.

Trachypeneus sedili (Hall) (fig. 3)

Description. — See Hall (1961: 100-102, pl. 20 fig. 18, 19).

Material examined. — East of Mullaitivu lighthouse, mud bottom, 10-13 fathoms; FRSC No. 26, RMNH No. 19806.

Size. — Males with carapace length 11.0, 12.5 mm, females with carapace length 16.0, 17.0 mm.

Occurrence in Ceylon. — Rare, east of Mullaitivu lighthouse, mud-bottom, 10-13 fathoms, trawled at night together with *T. salaco* and *T. curvirostris*. Not found in lagoons.

Remarks. — The rostrum of the specimens described by Hall (1961) is markedly upcurved. In the Ceylon specimens, this is so only in females; in males the rostrum is straight. In many respects, the Ceylon specimens are very similar to the Singapore specimens described by Hall. The telson has four spines and numerous spinules which are, however, visible only under very high magnification. The median groove of the telson is lined by numerous hook-like spines. Between this median groove and the posterolateral border of the telson there are numerous straight spinules while outside of the row of straight spinules, numerous hook-like spinules are present.

Hall described only female specimens. Males of this species are now

reported for the first time. Though the endopodite of the second pleopod is very similar to that of *T. curvirostris* (Stimpson), the petasma shows characteristic differences, especially the disto-lateral projections which curve anteriorly.

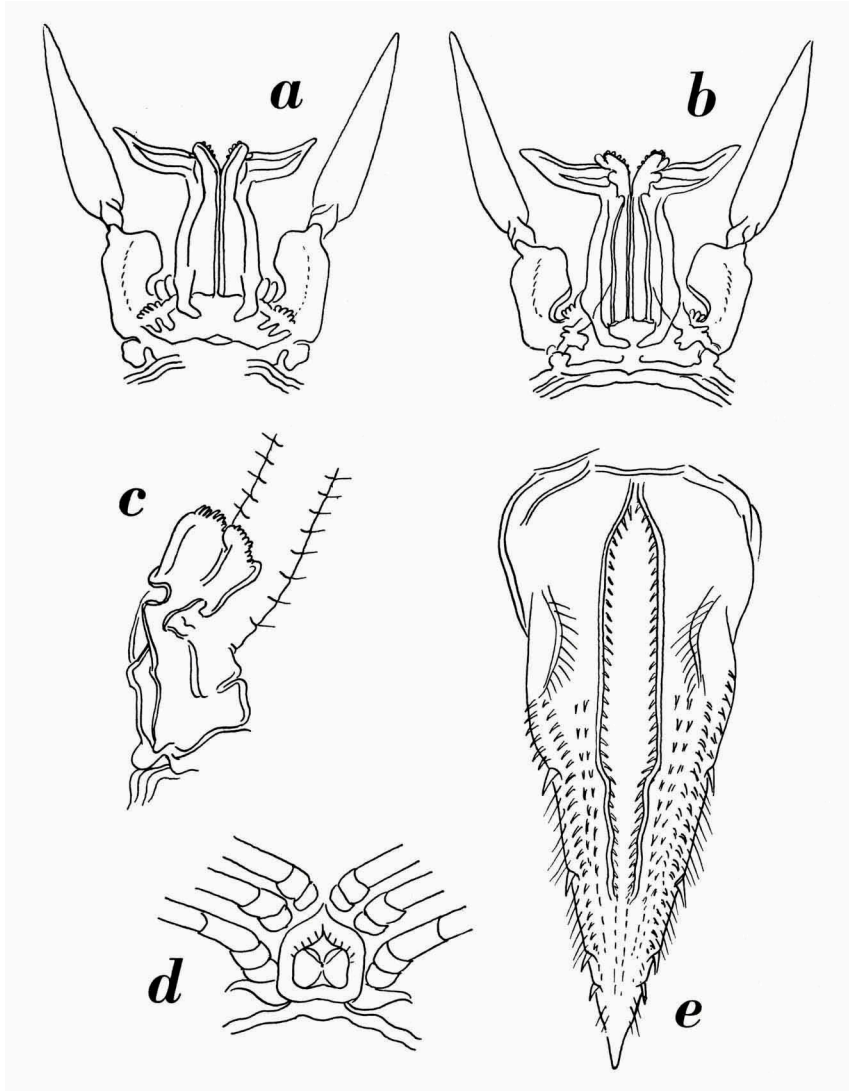


Fig. 3. *Trachypena sedili* Hall. a, dorsal view of petasma; b, ventral view of petasma; c, second pleopod of male with appendix masculina; d, thelycum; e, dorsal view of telson. a-d, $\times 5$, e, $\times 10$.

Atypopeneus Alcock

For a key to the species of *Atypopeneus* I may refer to Dall (1957: 199).

Atypopeneus stenodactylus (Stimpson)

Description. — See Alcock (1906: 45-46, pl. 9 fig. 29-29A), and Hall (1962: 207, fig. 99-99B).

Material examined. — East of Mullaitivu lighthouse, mud-banks, 10-13 fathoms; FRSC No. 28, RMNH No. 19804.

Size. — Males with carapace length 10.5, 11.5 mm, females with carapace length 16.0, 17.0 mm.

Occurrence in Ceylon. — Abundant on mud banks east of Mullaitivu lighthouse at depths of 11 to 13 fathoms. Among males ranging from 40 to 42 mm in total length and females ranging from 52 to 58 mm in total length, the post-rostral carina extends almost to the posterior border of the carapace. In females the third maxillipede extends to or surpasses slightly the tip of the antennal scale, while in males the third maxillipede extends slightly below or up to the tip of the antennal scale. A feeble dorsal carina (more prominent in females than in males) is present on the fourth, fifth and sixth abdominal segments.

Parapeneopsis Wood-Mason

For a key to the species of *Parapeneopsis* I may refer to Dall (1957: 214-215).

Parapeneopsis maxillipedo Alcock

Description. — See Alcock (1906: 40-41, pl. 8 fig. 24-24B).

Material examined. — Mutwal Sea, Colombo, mud banks (FRSC No. 20, RMNH No. 19802) and mud banks east of Mullaitivu lighthouse.

Size. — Males with carapace length 12.0, 13.0 mm, females with carapace length 17.5, 18.0 mm.

Occurrence in Ceylon. — Found on mud banks in the sea at depths of 5 to 6 fathoms, not common, not found in lagoons.

Remarks. — In all specimens examined, exclusive of one which had 7 + 1 rostral teeth, there were 8 to 10 rostral teeth exclusive of the epigastric. The relationship between the tip of the rostrum and the antennular peduncle is variable but the rostrum does not extend beyond the tip of the third segment of the antennular peduncle in any of the specimens examined.

This species resembles *P. cornuta* (Kishinouye) very closely, but *P. maxillipedo* Alcock attains a much larger size than the former. The latter

grows as long as 80 mm whereas the former does not seem to grow much larger than 50 mm in Ceylon waters. In *P. cornuta*, specimens as small as 26 mm in total length had well developed petasmata, whereas in the latter, specimens as large as 40 mm had the petasma lobes free.

Among the differences between the two species the following should be noted:

1. In *P. maxillipedo* there are 8 to 10 rostral teeth, whereas in *P. cornuta* there are 6 or 7 teeth.

2. In *P. maxillipedo* the third pereiopods of both sexes have basal spines, whereas in the Ceylon specimens of *P. cornuta* the third pereiopods are without basal spines in both sexes.

3. In *P. maxillipedo* a tuft of setae is present behind the posterior plate of the thelycum, whereas in the Ceylon specimens of *P. cornuta*, this tuft is absent.

4. In *P. maxillipedo* the telson does not have small spines on its disto-lateral border, whereas in the Ceylon specimens of *P. cornuta* there are four pairs of small spines on its disto-lateral border.

Hall (1961: 89) stated that Alcock's *P. maxillipedo* might be considered a geographical variety of *P. cornuta* (Kishinouye). The above facts do not support this hypothesis, but on the contrary, indicate that they are distinct species.

Parapeneopsis cornuta (Kishinouye)

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

Parapeneopsis cornutus Kubo, 1949: 374-378; Dall, 1957: 215-217, fig. 26A-F.

Description. — See Kubo (1949: 374), and Dall (1957: 215-217, fig. 26A-F).

Material examined. — Negombo lagoon; FRSC No. 21, RMNH No. 19799.

Size. — Males with carapace length 29-37 mm, females with carapace length 26.0-47.0 mm.

Occurrence in Ceylon. — Found at mouths of estuaries but rarely in the sea, not common.

Remarks. — Many specimens of both sexes were examined and, in all but one, there were 6 or 7 rostral teeth exclusive of the epigastric. In the exceptional specimen there were 9 rostral teeth.

The relationship between the tip of the rostrum and the antennular peduncle is variable. In three females ranging from 26 to 32 mm in carapace length the tip of the rostrum extended a little beyond the end of the first segment, in nine specimens ranging from 30 to 33 mm in carapace length

the tip of the rostrum extended to the middle of the second segment, in eighteen specimens ranging from 30 to 45 mm in carapace length the tip of the rostrum extended beyond the middle of the second segment, whereas in four specimens ranging from 40 to 47 mm in carapace length the tip of the rostrum extended to the tip of the second segment. In one male specimen the tip of the rostrum extended to the end of the first segment of the antennular peduncle, in seven specimens ranging from 27 to 33 mm in carapace length the tip of the rostrum extended a little beyond the middle of the first segment, in eight specimens ranging from 31 to 38 mm in carapace length the tip of the rostrum extended to the middle of the second segment, whereas in one specimen with carapace length 37 mm the tip of the rostrum extended to the middle of the second segment of the antennular peduncle.

In general the Ceylon specimens agree with the descriptions given by Kubo (1949) and Dall (1957) but are different in the following features:

1. There is no feeble transverse sulcus at 9/10 of the post-rostral carina in contrast to Kubo's description. This agrees with Dall's description.

2. The first and second pereopods have well developed basal spines but the third pereopod of both sexes does not possess even the vestige of a basal spine.

3. The telson of both sexes does not have sub-apical fixed spines but there are four pairs of small spines on the disto-lateral border, the last being the largest. Kubo does not refer to the armature of the telson. Dall states that the telson is unarmed.

4. The thelycum and petasma are in very close agreement with the descriptions given by Kubo and Dall, but a median tuft of setae is not present behind the posterior plate of the thelycum in Ceylon specimens.

Parapeneopsis uncta Alcock

Parapeneopsis uncta Alcock, 1906: 39, pl. 8 fig. 25-25A.

Parapeneopsis probata Hall, 1961: 96, pl. 19 fig. 11-13.

Description. — See Alcock (1906: 39-40, pl. 8 fig. 25-25A).

Material examined. — Mutwal Sea; FRSC No. 19, RMNH No. 19801.

Size. — Males with carapace length 53.0-83.0 mm, females with carapace length 48.0-99.0 mm.

Occurrence in Ceylon. — Hitherto found only in the sea, not common.

Remarks. — Hall (1961) described a new species *P. probata*, which differed from *P. uncta* Alcock in the following respects:

1. The rostrum had a styliform tip.
2. The rostrum was usually markedly sigmoidal — especially in adult females.
3. The rostrum surpassed the tip of the antennular peduncle in the adult female; Alcock had only four specimens to base his description on and it is possible that none was an adult male.
4. The antero-inferior angles of the carapace were markedly dentiform.
5. The telson was slightly larger than the sixth abdominal somite and well surpassed the middle of the inner uropods.
6. The second leg of the female bore a stout spine while a small or very minute spine may be borne by this leg in the male and juvenile female.

Nineteen male specimens resembling *P. uncta* Alcock very closely were obtained in Ceylon waters. Of these, the young individuals were found to have a styliform tip while the older forms did not. Of the nineteen individuals, eleven, ranging from 53.0 to 67.0 mm in total length, did not have a styliform tip while seven individuals ranging from 56.0 to 83.0 mm in total length did have a styliform tip. In twenty one females, ranging from 45.0 to 101.0 mm in total length, the rostrum had a styliform tip without any exception. In young male individuals and in all females examined, the rostrum was therefore definitely sigmoidal but in old males the rostrum had a different form. The almost straight downward-sloping rostrum of old males appears to be an adult instar attained ultimately by all males as originally suggested by Burkenroad (1934) for *P. sculptilis* (Heller).

In Ceylon specimens there is great variation in the relationship between the tip of the rostrum and the antennular peduncle for in eleven male specimens ranging from 53.0 to 83.0 mm in total length, the tip of the rostrum extended beyond the tip of the first antennular segment, in two female specimens of 48.0 and 69.0 mm in total length the tip of the rostrum extended beyond the tip of the first segment, in eleven female specimens ranging from 45.0 to 99.0 mm in total length, the tip of the rostrum extended beyond the tip of the second segment, while in six female specimens ranging from 78.0 to 101.0 mm in total length, the tip of the rostrum extended up to the tip of the third segment of the antennular peduncle. Females ranging from 75.0 to 101.0 mm in total length were found to be gravid. Even in adult females, therefore, the tip of the rostrum may not surpass the tip of the third segment of the antennular peduncle.

In Ceylon specimens, the tip of the telson well surpasses the middle of the inner uropods but, though the telson is generally very slightly longer than the sixth abdominal somite, the telson is as long as or slightly shorter than the sixth abdominal somite in some individuals.

In some females, the second pereopod has a stout basal spine almost equal in size to the basal spine of the first pereopod. In others (adults, as judged by the well-developed condition of the ovaries) the basal spine of the second leg is very small. Invariably, in males this basal spine is absent or, very rarely, very minute.

Considering the extreme variation in the characteristics used to separate *P. probata* from *P. uncta*, it is very likely that the form described as a new species by Hall is synonymous with *P. uncta* Alcock.

Parapeneopsis tenella (Bate)

Penaeus tenellus Bate, 1888: 270; Kishinouye, 1900: 22.

Parapeneopsis tenellus Kubo, 1949: 371; Dall, 1957: 221, fig. 29 A-G.

Parapeneopsis tenella Hall, 1961: 89; Hall, 1962: 26, fig. 100-100B.

Description. — See Kubo (1949: 371-374), and Dall (1957: 221-223, fig. 29A-E).

Specimens examined. — East of Mullaitivu lighthouse; FRSC No. 17, RMNH No. 19803.

Size. — Female with carapace length 16.0 mm.

Occurrence in Ceylon. — Very rare, trawled at night on Mullaitivu mud banks at 13 fathoms. Probably a deep water form or one that is pelagic at night.

Remarks. — The Ceylon specimens agree very closely with the description of *P. tenellus* given by Dall (1957) but exhibit the following differences:

1. In Ceylon specimens the rostrum extends to or exceeds the tip of the third segment of the antennular peduncle, whereas in the Australian specimens it extends almost to the tip of the second segment of the peduncle.

2. In Ceylon specimens the adrostral carina ends at 1/10 the distance from the anterior border of the carapace, whereas in the Australian specimens the carina ends at 1/4 the distance from the anterior border of the carapace.

3. The antennular flagella are slightly less than half the length of the carapace in Ceylon specimens, whereas in Australian specimens the flagella are half the length of the carapace.

4. In Ceylon specimens the second pereopod extends to the middle or the tip of the carpocerite, whereas in Australian specimens the second pereopod extends to the middle of the carpocerite.

5. In Ceylon specimens the third pereopod extends to or exceeds by its dactylus the base of the dactylus of the third maxillipede, whereas

in Australian specimens the third pereiopod extends to the base of the dactyl of the third maxillipede.

6. In Ceylon specimens the fourth pereiopod extends to the middle of the second segment of the antennular peduncle, whereas in Australian specimens the fourth pereiopod extends as far as the tip of the first segment of the antennular peduncle.

7. In Ceylon specimens the fifth pereiopod extends to the tip of, or exceeds by a dactylus length, the third segment of the antennular peduncle, whereas in Australian specimens the fifth pereiopod extends to the tip of the second segment of the antennular peduncle.

Only female specimens were obtained in Ceylon waters. The thelycum of these specimens resemble very closely the description given by Dall (1957) and the illustration by Hall (1962).

Parapeneopsis coromandelica Alcock

Description. — See Alcock (1906: 37).

Material examined. — West of Mutwal, Negombo and Chilaw; FRSC No. 18, RMNH No. 19796.

Size. — Males with carapace length 13.0 and 15.0 mm, females with carapace length 15.5 and 17.5 mm.

Occurrence in Ceylon. — Very abundant in the sea off Mutwal, Negombo and Chilaw at depths of 4 to 6 fathoms, not found in lagoons.

Parapeneopsis nana Alcock

Description. — See Alcock (1906: 41-42, pl. 8 fig. 26-26B).

Specimens examined. — In the sea west of Mutwal; FRSC No. 13, RMNH No. 19800.

Size. — Males with carapace length 10.5 and 12.0 mm, females with carapace length 11.0 and 12.0 mm.

Occurrence in Ceylon. — Rather rare, found in the sea and at mouths of lagoons at depths of 4 to 6 fathoms.

Parapenaeus Smith

For a key to the species of *Parapenaeus* I may refer to Dall (1957: 179).

Parapenaeus longipes Alcock

Parapenaeus longipes Alcock, 1905: 525; Alcock, 1906: 33, pl. 6 fig. 18-18B.

Description. — See Alcock (1906: 33, pl. 6 fig. 18-18B).

Material examined. — East of Mullaitivu lighthouse; FRSC No. 27, RMNH No. 19814.

Size. — Male with carapace length 12.5 mm, females with carapace length 14.0 and 15.0 mm.

Occurrence in Ceylon. — Found so far only off Mullaitivu at a depth of 12 fathoms, rare.

Remarks. — The specimens at hand resemble very closely the descriptions and illustrations given by Alcock (1906).

DISTRIBUTION OF INDO-PACIFIC PENAEBIDAE

Hall (1958) considered that the Malayan Peninsula/Sumatra land-mass separated the two species *Metapenaeus monoceros* (Fabr.) to the west and *Metapenaeus ensis* (De Haan) to the east. To quote Hall, "The Malacca Strait provides access to each side of this dividing line, yet, in the light of the work on the Indo-West Pacific Penaeidae which is in hand, I am becoming increasingly convinced that this Strait in some way forms a barrier to the north and west and to the south and east, and that this particular case is nothing more than a typical example of the segregation of similar but not identical forms which I am finding increasingly common". However, *Metapenaeus ensis* (De Haan) has been recently discovered in Ceylon waters and of the thirty-one species referred to in this paper, twenty-two have been found east of the Malacca Strait. The species are *Penaeus indicus*, *P. merguensis*, *P. latisulcatus*, *P. monodon*, *P. semisulcatus*, *Metapenaeus ensis*, *M. mutatus*, *M. burkenroadi*, *M. elegans*, *Atypopeneus stenodactylus*, *Metapenaeopsis mogiensis*, *M. hilarulus*, *M. toloensis*, *M. stridulans*, *Parapeneopsis tenella*, *P. cornuta*, *P. maxillipedo*, *P. uncta*, *Solenocera subnuda*, *Trachypeneus curvirostris*, *T. salaco* and *T. sedili*. Moreover, some of the species present in Ceylon waters have also been reported in areas as distant as Japan and Australia. They are: *P. latisulcatus*, *P. semisulcatus*, *Metapenaeus ensis*, *Metapenaeopsis mogiensis*, *M. toloensis*, *M. hilarulus*, *Parapeneopsis tenella*, *P. cornuta* and *Trachypeneus curvirostris*. These facts throw considerable doubt on the validity of Hall's hypothesis regarding the distribution of the Penaeidae, since identical species are found in India, Malaya, Formosa, Japan, Philippines, Indonesia and Australia.

The study of the marine species of Penaeidae in Indian and Malayan waters has not been very intensive. Therefore, accurate generalizations concerning the overall distribution of the marine species cannot be made. However, recent work on the distribution of penaeid species in the inland

lagoon waters of Ceylon (De Bruin, unpublished) has some bearing on the relative abundance of species of Penaeidae (especially of the genus *Metapenaeus*) in the Jurong prawn ponds of Singapore as reported by Hall (1962: 78). The study of the relative abundance of penaeid species in the inland lagoon waters of Ceylon, especially that of the genus *Metapenaeus*, shows striking differences between the relative abundance of species of the southern, south-western and south-eastern sectors on the one hand and the northern and north-eastern regions on the other hand. In the former, the numerically most abundant species are *Metapenaeus dobsoni* and *Metapenaeus elegans*. *Metapenaeus burkenroadi*, *M. ensis* and *M. mutatus* are scarce in these lagoons and, when present, are restricted to the mouths of the estuaries where the salinity throughout the year, except during the S. W. Monsoon, is higher than 10 p.p. mille. In the northern and north-eastern lagoons, on the other hand, *M. dobsoni* and *M. elegans* (forms that are abundant in waters of as low salinity as 3 p.p. mille on the S.W. coast) are either absent or very scarce, while *M. burkenroadi*, *M. ensis* and *M. mutatus* are abundant. The key to the discontinuous distribution of the genus *Metapenaeus* appears therefore, to lie in the salinity tolerances of the individual species. It cannot be due to food preferences, since, according to Hall (1962: 66) *M. ensis*, *M. elegans* and *M. mutatus* are vegetarian while "*M. mastersii*" [= *M. burkenroadi*] and *M. lysianassa* are omnivorous.

The interesting fact is that the abundant species of *Metapenaeus* in the prawn ponds of Singapore (ponds which are not subject to flooding by rivers and where the salinity is higher than 20 p.p. mille except during the north-east monsoon) and in lagoons of the northern and north-eastern regions of Ceylon are *M. ensis*, "*M. mastersii*" [= *M. burkenroadi*] and *M. mutatus*. In spite of Hall's contention that the Malacca Strait forms a barrier in the distribution of the Penaeidae, the affinities of the *Metapenaeus* fauna of Ceylon are with that of the Singapore prawn ponds and this seems to be due to similar salinity tolerances of the individual species of the two regions.

SUMMARY

Thirty-one species of the family Penaeidae are reported from Ceylon waters, many of which form the basis of flourishing fisheries in lagoons and in the sea. The species are *Penaeus latisulcatus* Kishinouye, *P. canaliculatus* (Olivier), *P. indicus* Milne-Edwards, *P. merguensis* De Man, *P. semisulcatus* De Haan, *P. monodon* Fabricius, *Metapenaeus mutatus* Lanchester, *M. dobsoni* (Miers), *M. ensis* (De Haan), *M. elegans* (De

Man), *M. lysianassa* (De Man), *M. monoceros* (Fabricius), *M. burkenroadi* Kubo, *Metapenaeopsis hilarulus* (De Man), *M. mogiensis* (Rathbun), *M. stridulans* (Wood-Mason), *M. toloensis* Hall, *M. mannarensis* sp. nov., *Trachypeneus salaco* De Man, *T. curvirostris* (Stimpson), *T. sedili* Hall, *Atypopeneus stenodactylus* (Stimpson), *Parapeneopsis maxillipedo* Alcock, *P. cornuta* (Kishinouye), *P. uncta* Alcock, *P. coromandelica* Alcock, *P. nana* Alcock, *P. tenella* (Bate), *Parapeneus longipes* Alcock, *Solenocera subnuda* Kubo and *Solenocera bedokensis* Hall. Of these species, the following are new records for the Indian Ocean: *P. latisulcatus*, *M. ensis*, *M. elegans*, *M. burkenroadi*, *M. hilarulus*, *M. toloensis*, *M. mannarensis*, *T. salaco*, *T. sedili*, *P. cornuta*, *P. tenella* and *S. bedokensis*.

Of the thirty-one species reported from Ceylon waters, twenty-two have been discovered in areas east of the Malacca Strait. The species are *P. indicus*, *P. merguensis*, *P. latisulcatus*, *P. monodon*, *P. semisulcatus*, *Metapeneus ensis*, *M. mutatus*, *M. burkenroadi*, *M. elegans*, *Atypopeneus stenodactylus*, *Metapenaeopsis mogiensis*, *M. hilarulus*, *M. toloensis*, *M. stridulans*, *Parapeneopsis tenella*, *P. cornuta*, *P. maxillipedo*, *P. uncta*, *Solenocera subnuda*, *Trachypeneus curvirostris*, *T. salaco* and *T. sedili*. Moreover, some of these species have also been reported in areas as distant as Japan and Australia. They are *P. latisulcatus*, *P. monodon*, *P. semisulcatus*, *M. ensis*, *M. mogiensis*, *M. toloensis*, *M. hilarulus*, *P. tenella*, *P. cornuta* and *T. curvirostris*. These facts throw considerable doubt on the validity of Hall's hypothesis regarding the distribution of the Penaeidae since identical species are found in India, Malaya, Formosa, Japan, Philippines, Indonesia and Australia.

In the lagoons of the northern and north-eastern sectors of Ceylon the most abundant species of the genus *Metapeneus* are *M. burkenroadi*, *M. ensis* and *M. mutatus*. *M. dobsoni* and *M. elegans* (forms which are abundant in waters of salinity as low as 3 p.p. mille on the west coast) are either absent or extremely scarce. In the southern, south-western and south-eastern lagoons of Ceylon, *M. dobsoni* and *M. elegans* are most abundant while *M. ensis*, *M. mutatus* and *M. burkenroadi* are very scarce and are restricted to the mouths of the estuaries where the salinity throughout the year (except during the south-west monsoon) exceeds 10 p.p. mille. In spite of Hall's contention that the Malacca Strait forms a barrier in the distribution of the Penaeidae, the affinities of the penaeid fauna of northern Ceylon are with that of the Singapore prawn ponds (ponds in which the salinity is higher than 20 p.p. mille except during the north-east monsoon). This seems to be due to similar salinity tolerances of the corresponding species of the two regions.

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