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Mexico City, Mexico, 12-21 June 1967
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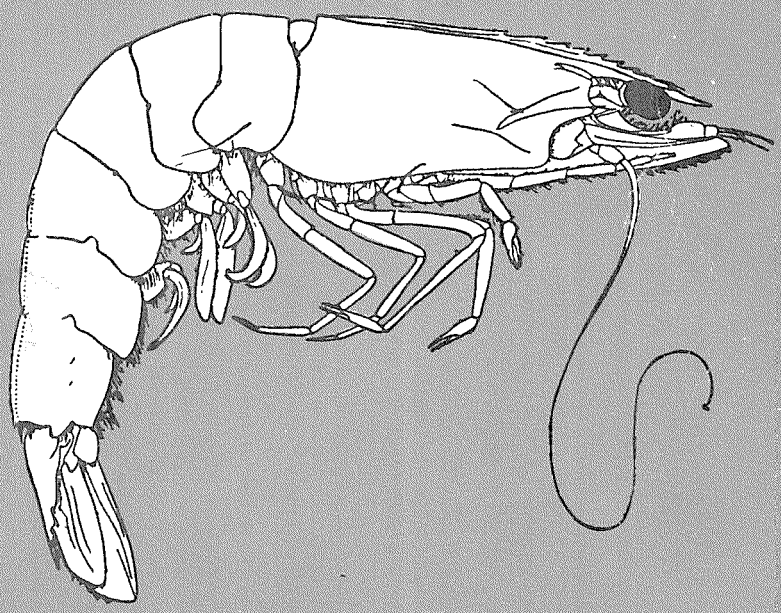

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SAST - Prawn

SYNOPSIS OF BIOLOGICAL DATA ON THE PENAEID PRAWN *Metapenaeus dobsoni* (Miers, 1878)

Exposé synoptique sur la biologie de *Metapenaeus dobsoni* (Miers, 1878)

Sinopsis sobre la biología del *Metapenaeus dobsoni* (Miers, 1878)

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1/ This synopsis has been prepared according to Outline Version No. 1 (H. Rosa, Jr., FAO Fish. Synops., (1) Rev.1, 1965).

* As no information was available to the author, these items have been omitted from the text.

1 IDENTITY

1.1 Taxonomy

1.1.1 Definition

Phylum Arthropoda
Class Crustacea
Subclass Malacostraca
Series Eumalacostraca
Superorder Eucarida
Order Decapoda
Suborder Natantia
Section Penaeidea
Family Penaeidae
Subfamily Penaeinae
Genus Metapenaeus Wood-Mason, 1891
Species Metapenaeus dobsoni (Miers, 1878)

1.1.2 Description

Genus Metapenaeus Wood-Mason, in Wood-Mason and Alcock, 1891, Ann.Mag.nat.Hist., (6) 8:271. Type species by original designation Penaeus affinis H. Milne Edwards, 1837. Gender: masculine. (See section 1.2.1 on the status of the generic name Mangalura Miers).

"Rostrum dorsally toothed only. Carapace without longitudinal or transverse sutures, orbital angle usually sharp. Postocular sulcus present, cervical sulcus well defined. Hepatic sulcus not well defined or absent behind level of hepatic spine, but pronounced in front with a well defined posteroinferior border, usually descending vertically from hepatic spine, then turning towards the pterygostomial angle. Antennal and hepatic spines pronounced. Pterygostomial angle blunt. Telson with deep dorsomedian sulcus, without fixed subapical spines, and with movable dorsolateral spines which may be microscopic and very numerous. First antennular segment without spine on ventral distomedian border. Antennular flagella shorter than carapace. Maxillary palp with 2 segments, distal small, basal with convex, foliaceous projections on inner and outer edges, and a long spine on inner edge. First to 3rd pereiopods with basial spines, no exopod on 5th. Ischium and merus of 5th pereiopod often modified in adult male. Petasma tubular with thickened median lobes; lateral lobes thicker than median, forming distolateral spout-like projections, each with a dorsal lobule produced posteriorly into an expanded, plate-like projection; median lobes with dorsal lobules produced into a thin recurved, plate-like or hood-like structure. Appendix masculina with a knob-like distal piece which bears either a deep posterodistal depression or is sculptured in some way. Thelycum composed of anterior median plate and 2 posterior lateral plates more or less enclosing posterior end of median plate; posterior plates often continuous across sternite. Zygocardiac ossicle with 2 rows of teeth which get progressively smaller. Pleurobranchiae on 3rd to 7th thoracic somites, a rudimentary arthrobranch on 1st, anterior and posterior arthrobranchiae on 2nd to 6th, and an anterior vestigial and a posterior fully developed arthrobranch on 7th thoracic somites; mastigobranchiae on 1st, 2nd, 4th-6th thoracic somites. Body usually with at least a few dorsal setose depressed areas, remainder of body surface varying from being completely glabrous to covered with close irregular setose depressed areas". (Dall, 1957).

Species Metapenaeus dobsoni (Miers, 1878)

The syntypes of the species are in the collection of the British Museum (Nat.Hist.), London.

Type locality: "Mangalur (Mangalore), west coast of India", (Miers, 1878).

The following description, with some modification, is from Alcock (1906). The species is illustrated in Fig. 1.

Body tomentose but tomentum less harsh and abundant and more patchy than in Metapenaeus monoceros. Rostrum extending a little beyond the tip of the antennular peduncle, with 8 or 9 dorsal teeth and having a well marked double curve. Anterolateral angles of carapace without spine. The post-rostral crest fades away well in front of the posterior border of the carapace. The antennal spine is not very strong and not continued backward as a strong ridge, so that the post-antennular sulcus is not so deep as in M. monoceros. The anterior abdominal terga are not, or only most obscurely, carinated.

The 5th abdominal somite about 2/3 length of the 6th, which is a little shorter than the telson. The telson shorter than the endopod of the uropod and without lateral marginal spines. The inner antennular flagellum longer than the outer, exceeding its peduncle in length.

All the legs are shorter and more ciliated than in M. monoceros and the chelae are weak. Strong spines present on the bases of all 3 pairs of chelipeds. In the male the basial spine on the 3rd pair is a long barb projecting considerably beyond the base of the merus. The last pair of thoracic legs do not nearly reach the middle of the antennal scale: in the male, owing to a twist in the ischium, the large tooth (completing the notch) at the proximal end of the merus is turned forwards and outwards; anterior to this tooth there may be a 2nd smaller tooth, but no row of denticles. In the adult female the last pair of thoracic legs is generally represented by a coxa, to which is articulated a horny stump. No exopod on the 5th pair of legs.

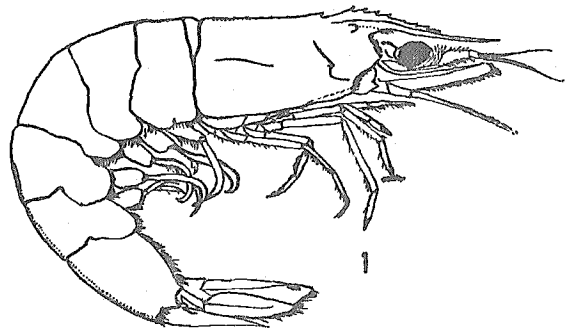

Fig. 1 Metapenaeus dobsoni.

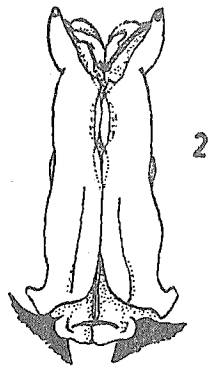

Fig. 2 Petasma.

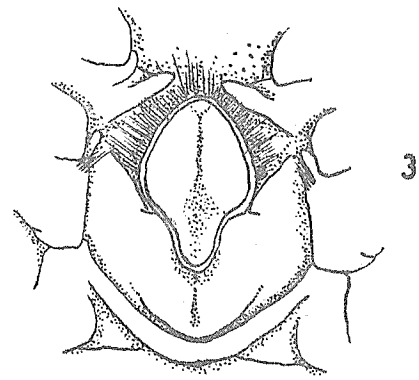

Fig. 3 Thelycum.

(from Hall, 1962)

The petasma (Fig. 2) is quite symmetrical. In the adult it consists of 2 rigid segments tightly folded in all their length, interlocked all along their anterior margin, and in close apposition along a great part of their posterior margin, so as to form a compressed tube. Distally the tube ends in a pair of simple distomedian spouts; and where the spouts originate there are 4 papillae or short filaments, 2 anterior and 2 posterior.

The thelycum (Fig. 3) consists of a broad concave median tongue, not embraced by any lateral processes of the penultimate thoracic sternum, but more or less ensheathed posteriorly in a salient horse-shoe-shaped process formed by union of the lateral lobes of the organ itself.

The species rarely exceeds 125 mm in total length.

Colouration: According to Kemp (1915) "In life P. dobsoni is semi-transparent; the pigment spots scattered on the carapace and abdomen are for the most part red, but tend to a browner shade on the rostrum and to a greenish tone on the posterior edges of each of the abdominal pleura. The antennules, antennae and antennal scales are dotted with red. There is a double row of reddish spots on the telson, the margins being greenish. Both uropods are red at the tip, the exopod being also bordered with red externally".

Regarding the dorsal carination of the abdominal segments of the species, Hall (1962) observed "the first 3 abdominal segments have a very low carina dorsally, distinguishable primarily because it is glabrous and stands out against the setose depressed areas which lie on each side. Only from about the middle of the 4th segment backwards is the carina elevated appreciably".

In impregnated females the thelycum is obscured by a pair of white conjoined pads. According to Racek and Dall (1965) "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"

For artificial key to the species of Metapenaeus see section 1.1.2 of the synopsis on Metapenaeus monoceros by George (1970), or Racek and Dall (1965:56-58).

1.2 Nomenclature

1.2.1 Valid scientific names

Metapenaeus dobsoni (Miers, 1878)
Mangalura dobsoni (Miers, 1878)

Opinion 864 of the International Commission on Zoological Nomenclature (1969) gives the generic name Metapenaeus Wood-Mason, 1891, precedence over Mangalura Miers, 1878. The type species of Mangalura is Penaeus dobsoni Miers, 1878. Racek and Dall (1965) quote an unpublished proposal by Burkenroad that Metapenaeus and Mangalura should be recognized as separate genera, in which case the present species would be known as Mangalura dobsoni. In this synopsis, however, Metapenaeus and Mangalura are regarded as subjective synonyms, making the valid name of the species Metapenaeus dobsoni.

1.2.2 Synonyms

Objective synonymy

Penaeus dobsoni Miers, 1878, Proc.zool. Soc.London, 1878: 302, 307 (original combination).

Mangalura [dobsoni] Miers, 1878, Proc.zool. Soc.London, 1878: 303.

Metapenaeus dobsoni (Miers) Nobili, 1903, Boll.Mus.Zool.Anat.comp.Torino, 18(447):3

Penaeopsis dobsoni (Miers) De Man, 1911, Siboga Exped., 39a:60

Subjective synonymy

No synonyms known.

1.2.3 Standard common names - vernacular names

On the southwest coast of India, in Malayalam, the name "thelly chemmeen" is applied to the smaller sizes caught from the estuaries and backwaters, and "Poovaalan chemmeen" or "Kadal chemmeen" to the bigger sizes caught from the sea. On the east coast of India, on the Bengal coast, this and related species are known as "chingri".

1.3 General variability

1.3.1 Subspecific fragmentation (races, varieties, hybrids)

No subspecies of M. dobsoni are recognized. A variety, var. choprai, was described by Nataraj (1942) from the coast of Kerala, southwest India.

2 DISTRIBUTION

2.1 Delimitation of the total area of distribution and ecological characterization of this area

The general distribution of the species is Indian waters through Malaysia and Indonesia to Philippines Is. Under the FAO areas code (see Holthuis and Rosa, 1965), the distribution covers land areas 422, 424 and 437, and water areas ISW and ISEW.

It is a marine and brackish water form.

In Indian waters the species is present in the juvenile stages in most of the estuaries and backwaters along the coastline and the adults in inshore areas up to 20 fm (36.6 m) depth with muddy bottom. It is more common along the southwest coast of India, where it contributes to a major fishery. In areas outside India it is also reported from estuaries, lagoons and shallow bays. It is abundant in lagoons around the coast of Ceylon and from the sea (De Bruin, 1965).

2.2 Differential distribution

2.2.1 Areas occupied by eggs and other juvenile stages: annual variations in these patterns, and seasonal variations for stages persisting over two or more seasons

Eggs and larvae of M. dobsoni are common at the surface and near the bottom in depths ranging from 2 to 13 fm (3.6 to 23 m) near estuaries between Quilon and Mangalore on the southwest coast of India (Menon, 1952; George, 1962). De Bruin (1965) reported the species as breeding in shallow muddy regions of the sea in Ceylon at depths of 5 to 8 fm (9 to 14 m). According to Menon (1952) the period of occurrence of the eggs and larvae is fairly long, from September to April.

The early postlarval stages migrate into the various estuaries and backwaters along the Indian coast and the juvenile stages are abundant in these environments throughout the year and contribute to a good fishery. In the Cochin backwaters, according to Menon (1955), "migration, it would appear, commences when they are probably in the second (postlarval) stage and quite a large proportion passes into such brackish water areas before they reach a length of about 7 mm". He also observed that May to December is the period when the postlarvae are present in large numbers in these backwaters. George (1962) observed the presence of fairly large numbers of these postlarvae in the same backwater plankton in almost all the months of the year, with 2 peaks, one in the months June through August and the other in November.

Juveniles are present in the backwaters throughout the year and in Cochin backwaters they form a major part of the commercial catch in most months (Menon, 1955; Menon and Raman, 1961).

2.2.2 Areas occupied by adult stages: seasonal and annual variation of these

Adults are most abundant in the Cochin area from May-June to September-October (Menon, 1955; George, 1961). In the mechanized prawn fishery of the region adults are common in the months October-November to June-July, the percentage of the species increasing as the season advances (George, Raman and Nair, 1968b). In some years there is some variation in this pattern. The species is abundant in all parts of the Chilka Lake at all seasons of the year (Kemp, 1915).

2.3 Behaviouristic and ecological determinants of the general limits of distribution and of the variations of these limits and of differential distribution

In the inshore waters of southwest India, concentrations of prawns of this species are found in the vicinity of mud banks, where accumulations of mud occur in patches during the monsoon season. George (1961) has shown that these mud banks, locally called "chaakara", have a definite influence on the landings of prawns. He noticed decreased oxygen content of the water, lower temperature, higher salinity and increase of pH, in comparison with surrounding areas. These mud banks form in different areas along the coast in different years.

According to George (1962) the peak periods in the recruitment of postlarvae of the species into the backwaters of Cochin are June to August and November, and these are months of low salinity.

3 BIONOMICS AND LIFE HISTORY

3.1 Reproduction

3.1.1 Sexuality (hermaphroditism, heterosexuality, intersexuality)

M. dobsoni is heterosexual, as is true of all penaeid prawns. There is no report of hermaphroditism in this prawn.

3.1.2 Maturity (age and size)

Rao (1968) gives the minimum size at maturity for the species as 64 mm in total length, and that is estimated as belonging to the late 0-yr class. By studies on the diameter of ova and other observations he classified the different maturity stages as 'immature', 'early maturing', 'late maturing', 'mature' and 'spent-recovering'.

3.1.3 Mating (monogamous, polygamous, promiscuous)

No information is available on the mating habits of the species. As in other prawns it is promiscuous. There is evidence of mating taking place in the inshore waters of the southwest coast of India. At copulation, the male leaves a white pad on the thelycum of the female as a stopper, with the spermathecae underneath. Impregnated females are found in large numbers in the catches during the breeding season.

3.1.4 Fertilization (internal, external)

As in the case with other penaeid prawns, fertilization is external, taking place at the time of spawning.

3.1.5 Fecundity

Estimates of fecundity for the species by Rao (1968) range between 34,500 and 159,000 eggs. According to him the number of eggs produced differs according to the size of the prawn in linear logarithmic form and the formula is:

$$\text{Log } F = -07175 + 2.8473 \log L$$

where F is the fecundity (number of eggs) and L is the total length in mm.

3.1.6 Spawning

From the presence of eggs and larvae in the plankton of Calicut waters, Menon (1952) reported a spawning season from September to April with a peak from September to December or January. On the other hand, indirect evidence of the presence of postlarvae in the backwaters of Cochin suggests that maximum numbers spawn from May to December (Menon, 1955). Similar indirect evidence of the presence of early postlarvae in Cochin backwaters and also the maturity conditions of adult females in the inshore fishery led George (1962) and George et al. (1968b) to conclude that the species breeds almost throughout the year with peaks in June through August and in November-December. Kesteven and Job (1957) also recorded year-round breeding for the species. Rao (1968) using the maturity conditions of the prawns, also concluded that the species breeds throughout the year, but he recorded one more peak spawning period, in April.

Making use of the data on the monthly distribution of late maturing and mature females in Cochin, Rao (1968) deduced that a typical female spawns 5 times during its life time.

3.1.7 Spawning grounds

Menon (1952 and 1965) studying the breeding of the species in the waters of Calicut on the southwest coast of India, observed that many breeding females liberate their eggs in the inshore waters, within or slightly beyond the 12 to 13 fm (22 to 23 m) line. Penaeid eggs are generally believed to be demersal, but during Menon's studies, large numbers of eggs of M. dobsoni were found in plankton collections taken at all depths from bottom to surface. It is probable that spawning takes place near the bottom, and the eggs are sufficiently buoyant to be stirred up by disturbances caused by currents or waves. Later studies at Cochin (George, et al., 1968b) confirmed that the species spawns inside the 15 fm (27 m) contour. In Ceylon, according to De Bruin (1965), it spawns in shallow muddy regions at depths of 5 to 8 fm (9 to 14 m).

3.1.8 Egg: structure, size, hatching type, parasites and predators

The most highly developed ovarian eggs are recorded by Rao (1968) as measuring 0.32 mm. Measurements of various stages of maturing eggs are also given by him. Eggs in different stages of development have been figured by Menon (1952) (Fig. 4, 5). According to him "both the early embryos and the fully developed nauplii do not fill the eggs completely, a wide space, the perivitelline space, being left around them. The embryo is closely invested by a thin embryonic membrane which ruptures later and the nauplius comes to lie within the egg membrane with the appendages partly straightened out so as to occupy the entire space inside". The eggs measure 0.35 to 0.44 mm.

Once the fully developed nauplii are seen inside the eggs, hatching normally takes place in 1 or 2 hr. Menon (1952) observed, however, that some eggs fail to hatch; he states that "when the inshore water was extremely turbid

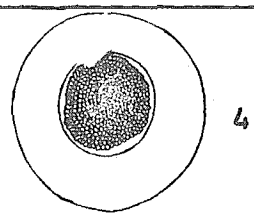

Fig. 4 Egg

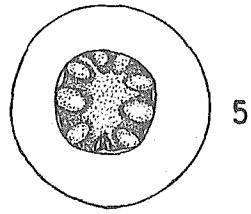

Fig. 5 Egg

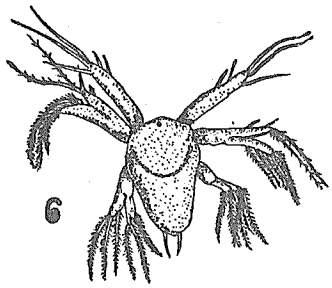

Fig. 6 Nauplius I

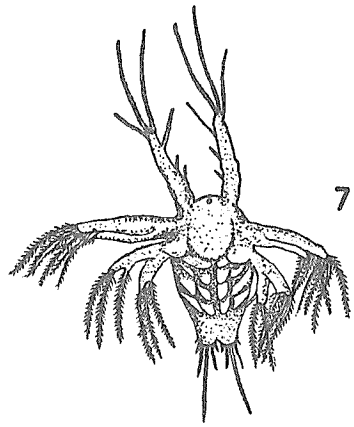

Fig. 7 Nauplius II

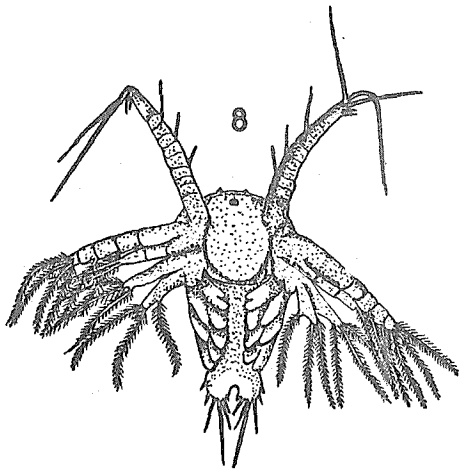

Fig. 8 Nauplius III

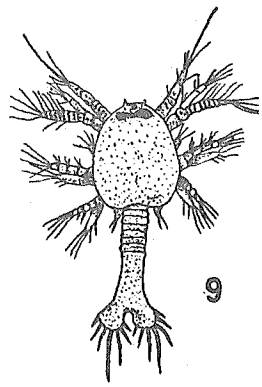

Fig. 9 Protozoea I

(from Menon, 1952)

due to rains and stormy weather, it was noticed that while some of the eggs kept overnight hatched normally many did not hatch at all. In the latter set, however, the embryos continued to develop and in the course of the day had changed into protozoeae that were alive and showing movements though still enclosed within the embryonic membranes. They continued to live for a few hours, but later died, having failed to break the egg membranes. Though eggs were plentiful, larvae were surprisingly few in plankton on those days, showing thereby that either the vast majority of eggs perished without hatching or that the nauplii into which they hatched died soon afterwards".

No information is available on parasitic infection of the eggs.

3.2 Larval history

3.2.1 Account of embryonic and juvenile life (prelarva, larva, postlarva, juvenile)

Except for the figures (Fig. 4, 5) given by Menon (1952) of the embryo immediately after completion of segmentation, there is no account of embryonic development of the species available.

Menon (1952; 1965) has given the complete larval history of the species. Detailed descriptions of the naupliar, protozoeal, mysis and postlarval stages are furnished by him and his figures are reproduced here in Fig. 6 to 14. The larvae acquire most adult characters in the course of 21 moults. Three nauplii, 3 protozoeae, 3 mysis and 13 postlarval stages have been described by him, and the development of the various appendages is traced through the different stages. Mohamed, Rao and George (1968) described the first postlarva.

According to Menon (1952) the naupliar stages do not feed, nutriment being provided by the yolk material inside the body. Unlike the nauplii, the protozoeal stages feed actively. He observed that in the laboratory they thrived well on diatoms and other phytoplankton mixed with microscopic animal forms. Small postlarvae also thrived well on plankton containing a high proportion of algal constituents.

Rearing experiments by Menon (1952) show that the nauplius phase in the life history lasts from 24 to 36 hr. After the last mysis stage, moulting occurred at intervals of 2 days at first and subsequently at intervals of 3 to 6 days. It took approximately 7 wk for the 1st postlarva to reach the 13th stage, in which the rostrum had the full dentition and the rudiments of secondary sex characters were present.

As in other penaeids, the eggs are shed in the water and the larval stages are planktonic. The adults do not care for the eggs or young.

Since the larvae are planktonic some amount of predation by plankton feeding animals is bound to occur, but no large scale predation is reported. There is no information regarding parasites.

3.3 Adult history

3.3.1 Longevity

From data derived from rearing experiments and length frequency studies, Menon (1955) concluded that prawns of this species live for about 3 yr. According to George et al. (1968b) only 2 age groups are represented in the catches of the mechanized vessels off Cochin, thus suggesting that the species may live for 2 yr only.

3.3.2 Hardiness

M. dobsoni can only survive a minimum of handling.

3.3.3 Competitors

M. dobsoni is found in schools along with several other species in the fishing grounds of the southwest coast of India, and all of these species undoubtedly compete for food.

3.3.4 Predators

Penaeids in general are preyed upon by the demersal fishes of the area where they exist. There are records of 'penaeids', 'prawns', etc. as forming a major item of food for several species of demersal fish.

3.3.5 Parasites and diseases

An isopod bopyrid parasite has been seen in the gill chamber and also attached to the appendages of occasional specimens. There is no information available on diseases.

3.3.6 Greatest size

Alcock (1906) recorded the species as rarely exceeding 4.5 in (114 mm) in length. Menon (1955) reported that "the largest females obtained so far measured 124 mm while males measured only 111 mm, though an exceptional specimen caught at West Hill was as much as 118 mm in length". Panikkar and Menon (1956) also recorded 4.0 to 4.5 in (102 to 114 mm) as the maximum length to which it grows. George et al. (1968b) observed the 125 to 130 mm group as the maximum size of females obtained in the trawl fishery of Cochin.

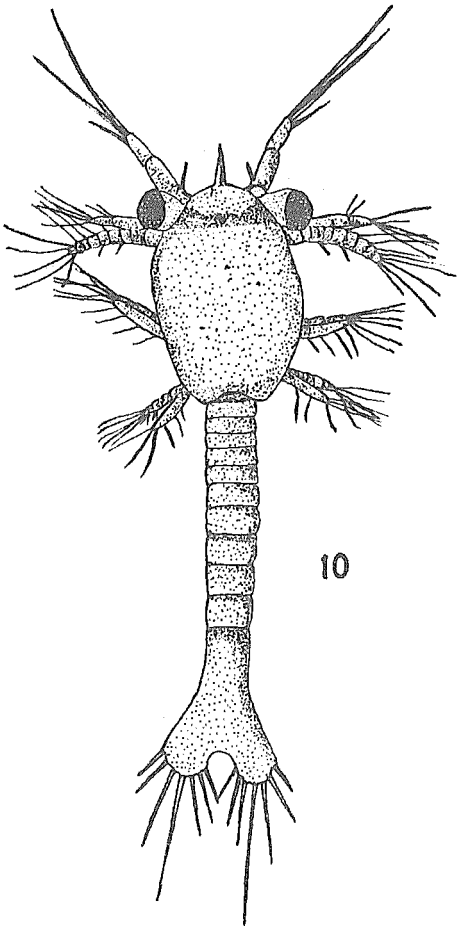

Fig. 10 Protozoea II.

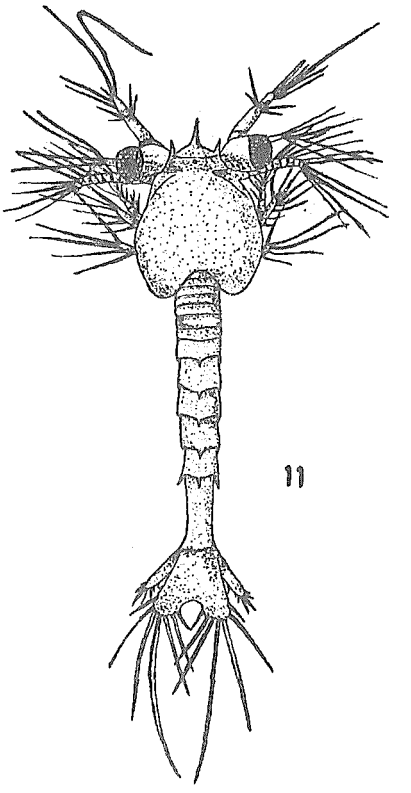

Fig. 11 Protozoea III.

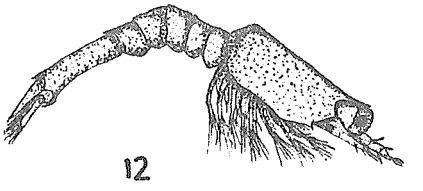

Fig. 12 Mysis I.

(from Menon, 1952)

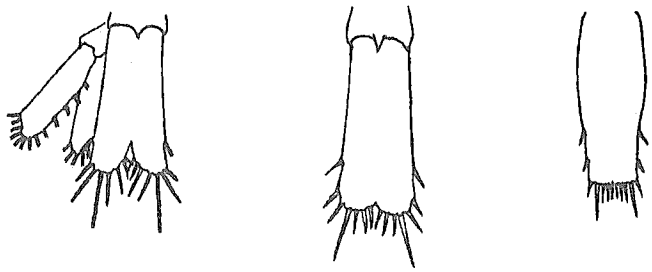

Fig. 13 Telson of Mysis I, II and III.

Fig. 14 Postlarva I.

(from Menon, 1952)

3.4 Nutrition and growth

3.4.1 Feeding (time, place, manner, season)

Panikkar and Menon (1956) stated that feeding prawns of this species prefer areas with a muddy bottom. No data are available on any seasonal difference in feeding, time of feeding, etc.

3.4.2 Food (type, volume)

After examining the stomach contents of numerous individuals of this species varying in length from 21 to 88 mm, Menon (1952) reported that "the food in general consists of varying amounts of organic matter mixed with sand and mud. Fragments or entire bodies of small animals and algae including diatoms compose the organic matter, of which the proportion of vegetable constituents has been found to be less in the larger individuals. In some specimens measuring 21 to 45 mm in length examined on 22 November 1949 and 6 December 1949, the stomachs were practically full of fragments of the alga Cladophora mixed with mud and some diatoms, no recognizable animal remains being present. Individuals measuring 65 to 75 mm contained only a few fragments of the same alga. The animal matter largely consists of entire or partly digested bodies of the following groups (no attempt was made to determine their identities more exactly): Foraminifera, Copepoda, Nematoda, Amphipoda and Gastropoda. Besides Cladophora a number of genera of diatoms also were frequently present. The more common of them are Fragilaria, Cosoinodiscus, Pleurosigma, Navicula and Cyclotella". Panikkar and Menon (1956) emphasized the importance of both planktonic diatoms and bottom detritus in the food, but Hall (1962) is of the opinion that "Penaeidae in general cannot be considered plankton feeders".

3.4.3 Relative and absolute growth patterns and rates

Laboratory rearing experiments of juveniles were carried out by Menon (1952) and his results are tabulated in Table I.

TABLE I

Growth rates of M. dobsoni in rearing experiments

Initial size (mm)	Period (days)	Final size (mm)	Increase in size (mm)
3.5	81	41.0	37.5
3.5	81	47.0	43.5
3.5	152	43.0	39.5
3.5	76	38.0	34.5
18.0	213	65.0	47.0

Using the length-frequency method in the catches of the species from Calicut, Menon concluded that a length of 60 to 80 mm is attained in 7 or 8 mo. Menon (1954; 1955) and Menon and Raman (1961), studying the length-frequency curves of the species in the backwater catches, observed that the vast majority of prawns of this species do not grow beyond 60 to 65 mm in the backwaters. Table II shows the length of the species during 1st, 2nd and 3rd yr of their lives, as given by Menon (1955).

TABLE II

Length of year classes of M. dobsoni

Sex	1st yr	2nd yr	3rd yr
M	About 70 mm	About 90-95 mm	About 110 mm
F	" 75 - 80 mm	" 100-105 mm	" 120 mm

George et al. (1968b) studying the catches of the mechanized fishery of Cochin, showed a growth of 20 mm in males and 25 mm in females during a period of 6 to 7 mo in the 1st yr.

The fact that females of M. dobsoni show a faster rate of growth than males has been recorded by Menon (1955, 1955a, 1957), George (1961) and George et al. (1968b). The higher growth rate in the females becomes apparent before reaching a length of about 50 mm.

3.4.4 Relation of growth to feeding, to other activities and to environmental factors

Reviewing the growth rate obtained in the laboratory rearing experiments, Menon (1952) commented that "apart from food and other factors governing growth, it is very likely that the limited space available in the vessel in which the rearing experiments were conducted may retard growth markedly after a certain size is reached". This might also explain the difference noticed in the average growth rates obtained in different experiments (see section 3.4.3). It is clear from the length-frequency studies that the juveniles in the backwater environment exhibit a quicker growth rate than those in a fully marine environment (Menon, 1955; George et al., 1968b). This may be attributed to feeding and environmental factors.

Hall (1962) gives the relationship between length and weight as

$$W = 0.7691\ C^{2.736}$$

3.5 Behaviour

3.5.1 Migration and local movements

As in most other penaeids, the life cycle of the species is completed in 2 types of environment, (i) the brackish water of estuaries and lakes connected with the sea and (ii) the sea. The entire course of larval development is passed in the sea. Migration into the backwaters commences at the late mysis or early postlarval stages. Very rarely a few late larval stages have also been encountered in the backwater plankton of Cochin. According to Menon (1955) a large proportion of the young specimens enter the backwater areas before they reach a length of about 7 mm. During the breeding period successive batches of these young enter the backwaters. The maximum size of the species attained in the backwaters does not exceed 80 mm in length. Kemp (1915) recorded that specimens from the Chilka Lake examined by him did not exceed 75 mm in length. The migration back to the sea seems to take place after this size is attained. The largest specimens, measuring about 125 mm, are found only in the sea. Breeding takes place only in the sea and the cycle is repeated after breeding.

Menon (1957) recorded that in the inshore waters of Cochin a high percentage of females of the larger size groups move out of the 10 fm (18 m) zone, probably into deeper waters, and reappear in the zone after about a year. George, Banerji and Mohamed (1968) suggested that prawns of this species may move from the regular trawl fishing zone of 5 to 15 fm (9 to 27 m) to very near the shore; here they may concentrate in the mud bank areas during the upwelling taking place during the monsoon period.

In the Godvari estuarine system on the east coast of India, Subramanyam (1965) studied the migratory pattern of the species in and out of the estuary. He found emigration and immigration of the species to be greater at new moon than at full moon. A period of intense emigration was observed by him in January, February and May.

The percentage ratios of migratory prawns of this species at changing tides according to him are 36.48 at low tide (day), 29.00 at low tide (night), 27.52 at high tide (dawn) and 7.00 at high tide (dusk).

3.5.2 Schooling

Panikkar and Menon (1956) observed that "during the monsoon months of June to August on the Malabar coast shoals approach the shore so as to make it possible for fishermen to use the cast net for catching them". The shoals referred to are mostly constituted by the species M. dobsoni. Large concentrations of these prawns are known to occur in the mud bank areas along the southwest coast of India. De Bruin (1965) mentioned that in Ceylon waters the species swarms in large schools at the surface of the sea on dark nights during breeding.

3.5.3 Reproductive habits

See sections 3.1.1 to 3.1.7.

4 POPULATION (STOCK)

4.1 Structure

4.1.1 Sex ratio

Menon (1955; 1957) has described in detail the sex ratio in the catches of the species from the backwaters and other coastal areas of Cochin and has related the differences in the representation of the sexes to the migrations of females (see section 3.5.1). He noted some variation from year to year both in the size composition of the stocks and in the sex ratios within the different size groups. Average figures for the 4 years 1952 to 1955 are given in Table III.

George and Rao (1967) statistically analyzed the data on the sex ratio of M. dobsoni and other prawns in the catches of the trawl fishery of Cochin for 1962 and 1963 (Table IV). They found that in this species the distribution of the sexes varies significantly from month to month. It is suggested by them that the differential sex ratios may be the result of breeding migrations of females.

4.1.2 Age composition

Menon (1957) reported 3 year classes in the inshore fishery of the Cochin and Calicut region, with lengths of up to 80 mm, 80 to 100 mm, and above 100 mm respectively (see Table III). George (1961) also recorded 3 year classes in the catches from the inshore waters at Alleppey, Chellanam and Narakkal along the southwest coast of India. However, George et al. (1968b) recorded only 2 year classes in the offshore trawl fishery of Cochin.

4.1.3 Size composition

In the paddy field prawn fishery of Cochin the juveniles of the species form the major component of the catches and it is the early 0 year group which is represented. According to Menon (1954) sizes up to 61 to 65 mm are encountered. In the stake net catches of the backwaters of the same region the modal frequency varies between 41 to 45 mm and 56 to 60 mm (Menon and Raman, 1961). According to them the maximum sizes obtained belong to the 86 to 90 mm group, the proportion of which never exceeded 3 percent in any month.

TABLE III

Sex ratio of age groups of M. dobsoni from backwater and sea catches of Cochin (from Menon, 1957)

Age groups	Sex ratio (%) M	Sex ratio (%) F	% of total M	% of total F
Backwater catches (0 yr)	50.0	50.0	-	-
All sizes (0 to 3 yr) from sea	51.4	48.6	-	-
Up to 80 mm (1st yr) from sea	48.6	51.4	58.5	65.5
80 mm to 100 mm (2nd yr) from sea	74.4	25.6	28.9	10.5
Over 100 mm (3rd yr) from sea	35.7	64.3	12.6	24.0

TABLE IV

Sex ratio of M. dobsoni in the trawl fishery of Cochin during 1962 and 1963 (after George and Rao, 1967)

Months	Sample size	% males	Sample size	% males
January	993	43	1,047	49
February	1,057	44	1,222	35
March	1,743	32	997	39
April	919	45	1,009	38
May	1,127	48	1,069	43
June	846	65	50	78
November	271	55	167	59
December	390	63	196	48

For the size composition of the inshore catches as well as the catches of the mechanized fishery of the adults see sections 4.1.1 and 4.1.2, and Table III.

4.3 Natality and recruitment

4.3.2 Natality rates

George (1962; 1967) tried to correlate the natality and recruitment of the post-larvae into the backwaters of Cochin and the subsequent population contributing to the fishery of both backwater and marine environments. He expressed the opinion that this factor could possibly be used as an index to predict the fishery.

4.4 Mortality, morbidity

4.4.1 Rates of mortality

The total instantaneous mortality rate of the species in the trawl fishing ground off Cochin has been worked out by Banerji and George (1967). They calculated the total instantaneous mortality rate of the species by 2 methods: 1) where age determination is possible, using the formula $\log_e (n_t/n_{t+1})$, and 2) where age cannot be determined accurately, employing the formula $i = \frac{K(\ell_\infty - \bar{\ell})}{(\bar{\ell} - \ell')}$ Estimates of instantaneous mortality rates for the seasons 1957-58 to 1962-63 by these methods are given in Table V. George, Banerji and Mohamed (1968) also estimated the instantaneous mortality of the species.

TABLE V

Estimates of instantaneous mortality rate of *M. dobsoni* for 1957-58 to 1962-63 (Banerji and George, 1967)

Season	Estimate by 1st method	Estimate by 2nd method
1957-58	4.62	3.33
1958-59	5.68	5.57
1959-60	1.47	5.47
1960-61	1.20	3.96
1961-62	3.72	2.61
1962-63	..	3.31
Average	3.56	4.04

5 EXPLOITATION

5.1 Fishing equipment

5.1.1 Fishing gear

Seine nets of different sizes are the main gear employed in the fishing of this and other prawns in the inshore waters along the southwest coast of India (Menon, 1955; George, 1961). Operated from indigenous craft, this net is locally called "thangu vala". Shore seines locally called "kamba vala" or "kara madi" are also operated in this area for prawn fishing (Nayar, 1958; George, 1961).

In the backwater and lake fishery of this region the stake net, the Chinese dip net, the cast net and the drag net are the important gear in use for catching these prawns (Panikkar, 1937; Gopinath, 1953; Menon, 1955; Panikkar and Menon, 1956). An ingenious method of fishing locally known as "changala paachil" is also in use in these waters (Gopinath, 1953). A variety of wall nets are also used in some shallow areas.

In the mechanized fishery for prawns from the offshore waters, conventional shrimp trawls of various sizes are in use. In Cochin waters 2 or 4 seam trawls, varying from 13 to 18 m in headline length and with mesh sizes of 76 mm, 50 mm, 38 mm and 25 mm for wing, body, throat, and codend respectively, are the main gear used by the smaller vessels (George et al., 1968b). Bigger trawls are operated by a few larger boats.

In the paddy field prawn fishery conical nets fixed on rectangular frames are operated in sluice gates, as described by Panikkar (1937), Menon (1955a) and Gopinath (1956).

Devices like long fences with rings of traps at the inner ends are employed in catching these prawns on the east coast of India.

5.1.2 Fishing boats

On the west coast of India, in the indigenous inshore fishery, the traditional dugout canoe is the boat used in the operation of the boat seines. On the south west coast, south of Trivandrum, and on the east coast the catamaran is used.

Most of the power-operated boats on the southwest coast of India are 7 to 11 m in length and have 10 to 30 bhp engines. There are also some slightly bigger types of shrimp trawlers (George et al., 1968b).

5.2 Fishing areas

5.2.1 General geographic distribution

The main fishing areas are in southwest India and Ceylon.

5.2.3 Depth ranges

Juveniles are fished in the backwaters and estuaries, including paddy fields, in shallow waters ranging from 1 to 15 m.

Young adults and adults are caught at sea in depths of up to 20 fm (36 m). In the trawl fishery of Cochin, George et al. (1968b) report a concentration of the species in the 7 to 8 fm (12 to 15 m) depth area.

5.3 Fishing seasons

5.3.1 General pattern of fishing season

In the paddy fields of southwest India and in the Collair Lake, the prawn fishery is seasonal, while in the backwaters of the same area it continues almost throughout the year (Menon, 1955). In the adjacent marine areas it is largely seasonal (Panikkar and Menon, 1956). In the coastal waters of Ceylon, M. dobsoni is fished in most months of the year (De Bruin, 1965).

5.3.2 Duration of fishing season

See section 5.3.3.

5.3.3 Dates of beginning, peak and end of season

In the paddy fields of Kerala prawns are fished from the middle of November to the middle of April; in the Collair Lake, from May to December (Menon, 1955). The marine fishery in southwest India coincides with the monsoon period, usually from June to September (Panikkar and Menon, 1956).

Tables VI and VII show variations from month to month in the percentage of M. dobsoni in the prawn catches of Kerala. Table VI refers to the fishery for juvenile prawns in paddy fields and backwaters and shows M. dobsoni to be the dominant species from August to April. Table VII refers to the inshore marine fishery and illustrates that the percentage of M. dobsoni in any month may vary considerably from year to year (Menon, 1955). The offshore fishery in this area extends from about November to June, with a peak in the 2nd half of this period (George et al., 1968b).

TABLE VI

Showing the percentage values (numerical) of M. dobsoni in the monthly prawn catches from paddy fields and backwaters (from Menon, 1955). Dashes indicate no record available

Year	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
1951-52	-	74.6	81.6	80.8	79.2	84.5	-	-	47.0	74.8	75.4	91.3
1952-53	87.9	82.3	89.8	89.5	67.1	45.7	42.1	29.6	46.6	66.5	71.3	80.8

TABLE VII

Showing the monthly average percentage values of M. dobsoni in the marine prawn catches at Narakkal (from Menon, 1955)

Year	April	May	June	July	Aug.	Sept.	Oct.
1952	74.0	41.6	38.5	79.6	55.8	8.2	-
1953	-	26.3	55.3	24.0	33.5	51.0	16.2

5.3.4 Variation in time or duration of fishing season

The marine prawn fishery in southwest India shows local variations in the times of beginning and ending, and in some cases it may start or finish up to 2 mo earlier or later than the average dates given in section 5.3.3 (George, 1961).

In the Collair Lake the season extends from May to December.

5.3.5 Factors affecting fishing season

The formation of mud banks, locally called "chaakara" is noticed to influence the inshore fishery of Malabar coast. Here intensive fishing for prawns, particularly this species, is found to commence only with the formation of these mud banks. Other factors suggested to have some influence on fishing in the backwaters of Kerala are rainfall and lunar periodicity (Menon and Raman, 1961).

5.4 Fishing operation and results

5.4.1 Effort and intensity

George (1961), studying the prawn catches, mostly contributed by this species, from three centres along the Kerala coast during the years 1956 to 1960, used the total effort and intensity of fishing to establish a relationship between catch per man-h and recruit sizes.

In the trawl fishery of Cochin, George et al. (1968b) observed the effort and intensity of fishing through the years 1958 to 1963 and reached the conclusion that there is no overfishing in the area. (See Table VIII).

5.4.3 Catches

The total catches of this and other species at the inshore fishing centres Alleppey, Chellanam and Narakkal on the Kerala coast have been given by George (1961). Wide fluctuations in these catches were noticed by him in the years 1956 to 1960. Menon and Raman (1961) gave total catches of prawns at two centres in the Cochin backwaters. The trawl catches of Cochin for the years 1957 through 1963, given

by George et al.(1968b), also show year to year fluctuations. The total catch figures of boats operated by the Indo-Norwegian Project and the Deep Sea Fishing Station of the Government of India are given by them. The total catch figures of this particular species in this fishery for 1957 to 1963 (Table VIII) are given by Banerji (1965) and Banerji and George (1967).

Subramanyam (1965) gave the total catches of the species, along with other species, for new moon and full moon periods separately, in the Godavari estuarine system on the east coast of India. He also gave high tide and low tide catches of these prawns.

Annual reports of the Indo-Norwegian Project show the total catches of this species caught by their mechanized boats, at different centres on both coasts of India.

5.5 Fisheries management and regulations

On the southwest coast of India the only regulation now in existence is in respect of the paddy field fishery in which this is the most important species. The fishery is allowed to operate from the middle of November to the middle of April only. According to Panikkar and Menon (1956) "this is done not so much in the interest of the fishery as in that of rice cultivation". They are of the opinion that "the methods of fishing now in vogue do not involve the destruction on any appreciable scale of prawn fry and leave sufficient numbers of breeding females to replenish the stock. The fear of depletion has not therefore arisen anywhere and thus no serious problem in management, requiring regulation of the fishery, has confronted the Governments of the various States".

There is a licensing system for the cast net, stake net and Chinese net fishery and paddy field fishery of the backwaters of the southwest coast of India.

5.6 Fish farming, transplanting and other intervention

There is no farming or culture of this species anywhere. Trapping of adolescent stages, mostly this species, is prevalent in the extensive rice fields of coastal areas of Kerala in South India (Panikkar, 1937; Menon, 1955a; Gopinath, 1956; Panikkar and Menon, 1956; Kesteven and Job, 1957; George, Mohamed and Pillai, 1968a). A few decades ago actual culturing by rearing young prawns for 2 or 3 mo, used to be in vogue there, but the current practice seems to be only to trap the shrimps in the paddy fields with the incoming tide, after the annual crop of rice, and to fish them during favourable low tides at night. Soon after the rice cultivation, in about October, blocks of individually owned fields are leased to prawn fishermen for about 5 mo. The dykes are strengthened and sluice gates installed. The flow of water in and out of these fields is regulated through these sluices. The water is let in at high tide and out at low tide. During favourable low tides at night, a conical bag-net is fixed at the opening of the sluice. While letting in water at high tide and while fishing, a lamp is hung at the mouth of the gate. In these fishing processes very little attention to the stock is called for, although during the few hours or days that the trapped shrimps remain in the field they utilize the food organisms within the field and grow to a certain extent.

TABLE VIII

Trawler catches of Metapenaeus dobsoni off Cochin (Banerji, 1965)

Year	Catch (kg) C	Effort (Tr.hour) E	$U = \frac{C}{E}$
1957-58	99,301	2,734	36.32
1958-59	146,768	3,526	41.63
1959-60	67,320	3,958	17.01
1960-61	40,073	2,611	15.35
1961-62	174,121	4,547	38.29
1962-63	50,349	3,793	13.27

6 REFERENCES

Alcock, A., 1906 The prawns of the Peneus group. In Catalogue of the Indian decapod Crustacea in the collection of the Indian Museum, Calcutta. Part 3, Macrura. Fasc.1, 55 p.

Banerji, S.K., 1965 A note on the production trend of marine shrimps in India. Fish.Tech., 2(1):43-7

Banerji, S.K. and M.J. George, 1967 Size distribution and growth of Metapenaeus dobsoni (Miers) and their effect on the trawler catches off Kerala. Symp.Ser.mar. biol.Ass.India, 2(2):634-48

Dall, W., 1957 A revision of the Australian species of Penaeinae (Crustacea, Decapoda: Penaeidae). Aust.J.mar.freshwat.Res., 8(2):136-231

De Bruin, G.H.P., 1965 Penaeid prawns of Ceylon (Crustacea, Decapoda, Penaeidae). Zoöl. Meded., Leiden, 41(4):73-104

De Man, J.G., 1911 The Decapoda of the Siboga Expedition. Part I, Family Penaeidae. Siboga Exped., 39a:131 p.

George, M.J., 1961 Studies on the prawn fishery of Cochin and Alleppey coast. Indian J. Fish., 8(1):75-95

_____, 1962 On the breeding of penaeids and the recruitment of their postlarvae into the backwaters of Cochin. Indian J.Fish., 9(1):110-6

_____, 1967 Postlarval abundance as a possible index of fishing success in the prawn Metapenaeus dobsoni (Miers). Indian J.Fish., (1963), 10A(1):135-9

_____, 1970 Synopsis of biological data on Metapenaeus monoceros (Fabricius). FAO Fish.Rep., (57)Vol.4 : 1539-57

George, M.J. and P.V. Rao, 1967 Distribution of sex ratios of penaeid prawns in the trawl fishery of Cochin. Symp.Ser.mar.biol.Ass.India, 2(2):698-700

George, M.J., S. K. Banerji and K. H. Mohamed, 1968 Size distribution and movement of the commercial prawns of the southwest coast of India. FAO Fish.Rep.,(57) Vol.2:265-84

George, M.J., K. H. Mohamed and N. N. Pillai, 1968a Observations on the paddy-field prawn filtration of Kerala, India. FAO Fish.Rep., (57) Vol.2:427-42

George, M.J., K. Raman and P.K. Nair, 1968b Observations on the offshore prawn fishery of Cochin. Indian J.Fish., (1963), 10A(2):460-99

Gopinath, K., 1953 Some interesting methods of fishing in the backwaters of Travancore. J.Bombay nat.hist.Soc., 51:466-71

_____, 1956 Prawn culture in the rice fields of Travancore-Cochin, India. Proc. Indo-Pacif.Fish.Coun., 6(3):419-25

Hall, D.N.F., 1962 Observations on the taxonomy and biology of some Indo-West Pacific Penaeidae (Crustacea, Decapoda). Fish.Publs.colon.Aff., 17:229 p.

Holthuis, L.B. and H. Rosa, Jr., 1965 List of species of shrimps and prawns of economic value. FAO Fish.tech.Pap., (52):21 p.

Kemp, S., 1915 Fauna of the Chilka Lake. Crustacea Decapoda. Mem.Indian Mus., 5(3):201-325

Kesteven, G.L. and T.J. Job, 1957 Shrimp culture in Asia and the Far East; a preliminary review. Proc.Gulf Caribb.Fish.Inst., 10:49-68

Menon, M.K., The life history and bionomics of an Indian penaeid prawn Metapenaeus
1952 dobsoni (Miers). Proc.Indo-Pacif.Fish.Coun., 3(2):80-93

Menon, M.K., Notes on the bionomics and fishery of the prawn Metapenaeus dobsoni
1955 (Miers) on the south west coast of India. Indian J.Fish., 2(1):41-56

_____, On the paddy field prawn fishery of Travanoore-Cochin and an experiment
1955a in prawn culture. Proc.Indo-Pacif.Fish.Coun., 5(2):131-5

_____, Identification of marine and inshore prawns of commercial value in
1956 India. Proc.Indo-Pacif.Fish.Coun., 6(3):345-6

_____, Contributions to the biology of penaeid prawns of the South west coast
1957 of India. I. Sex ratio and movements. Indian J.Fish., 4(1):62-74

_____, Life history of prawns - A review of recent studies with special refer-
1965 ence to Indian species. Fishery Technol.Ernakulam, 2(1):12-8

Menon, M.K. and K. Raman, Observations on the prawn fishery of the Cochin backwaters
1961 with special reference to the stake net catches. Indian J.Fish., 8(1):1-23

Miers, E.J., Notes on the Penaeidae in the collection of the British Museum with
1878 descriptions of some new species. Proc.zool.Soc.London., 1878:298-310

Milne Edwards, H., Histoire Naturelle des Crustacés, comprenant l'anatomie, la physio-
1837 logie et la classification de ces animaux. Paris, vol.2, 532 p.

Mohamed, K.H., P. V. Rao and M. J. George, Postlarvae of penaeid prawns of southwest
1968 coast of India with a key to their identification. FAO Fish.Rep., (57) Vol.2:487-503

Nataraj, S., A note on the prawn fauna of Travancore. Curr.Sci., 11(12):468-9
1942

Nayar, S.G., A preliminary account of the fisheries of Vizhingam. Indian J.Fish.,
1958 5(1):32-55

Nobili, G., Contributo alla fauna carcinologica di Borneo. Boll.Mus.Zool.Anat.Comp.
1903 Torino, 18(447):1-32

Panikkar, N.K., The prawn industry of the Malabar coast. J.Bombay nat.hist.Soc.,
1937 39(2):343-53

Panikkar, N.K. and M.K. Menon, Prawn fisheries of India. Proc.Indo-Pacif.Fish.Coun.,
1956 6(3):328-44

Racek, A.A. and W. Dall, Littoral Penaeinae (Crustacea Decapoda) from northern Aus-
1965 tralia, New Guinea and adjacent waters. Verh.K.ned.Akad.Wet.(B), 56(3): 1-119

Rao, P.V., Maturation and spawning of the penaeid prawns of the southwest coast of
1968 India. FAO Fish.Rep., (57)Vol.2:285-302

Subramanyam, M., Lunar, diurnal and tidal periodicity in relation to the prawn abundance
1965 and migration in the Godavari estuarine systems. Fishery Technol., Ernakulam, 2(1):26-33

Wood-Mason, J. and A. Alcock, Natural history notes from H.M. Indian marine survey
1891 steamer INVESTIGATOR. Ann.Mag.nat.Hist., 8(6):268-86

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