PRAWN FARMING - CANDIDATE SPECIES

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CIBA
BULLETIN
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CENTRAL INSTITUTE OF BRACKISHWATER AQUACULTURE
(Indian Council of Agricultural Research)
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PREFACE

Prawn farming has gained momentum in India in the last few years, thanks to the efforts of the governments at the Centre, States and Union Territories and the enterprise of the private sector. From a traditional system of prawn filtration, we are moving to extensive, semi-intensive and intensive culture and all these systems co-exist. In all, about 65,000 ha area is under brackishwater aquaculture and the target is to reach a total 1,00,000 ha by 2000 AD under various systems.

The prime species under prawn farming in India is the tiger prawn, *Penaeus monodon*. Only when environmental factors are unfavourable for this species, the farmers resort to stocking of their ponds with the Indian white prawn *P.Indicus*. In spite of the fact that the natural occurrence of *P. mondon*, in abundance, is very much restricted to a narrow region from north Andhra to West Bengal coast, every prawn farmer in India desires to culture the tiger prawn, even by getting seed from distances of over a 1000 km. There is practically no interest in culturing the other species of prawns. The trend is to copy from the South-East Asian countries.

Little have we realised the potential for culture of other species of penaeid prawns. Nor are we learning lessons from the experience of some countries which, when faced with a situation of glut of tiger prawn production or when they suffered serious disease outbreaks, have realised the importance of diversification. The trend of species diversification in prawn culture has already started in Taiwan, China, the Philippines and Thailand. It was felt necessary to inform our farmers of the rich prawn species resource we have in the country which they should consider for farming. Rotation of crops and multiple cropping patterns are common principles in the management of our agriculture. Such practice is good for production and healthy for the soil. Similar approach is necessary in brackishwater aquaculture too. India has several distinct agro-ecological zones based on soil characters, rainfall and temperature regime. The coastlines along the east and west coasts and the fishery resources have a lot of differences. The prawn resources exploited by the coastal fishery as well as in the estuaries and brackishwater lakes, creeks etc. show distinct dominance or absence of some species. The quality of brackishwater is distinct from place to place and also undergoes seasonal fluctuation. These natural

factors should be clearly understood while planning strategies for developmer of prawn culture. It is prudent and necessary to plan for sustainable developmer, rather than for short-term benefit.

The present publication is an attempt to focus on the range of cultiv prawn species available in India. For the benefit of farmers, a brief accou.. on the biology of prawns has been given as basic information. There is some confusion in identifying the different species of prawns. Primarily, the object of this publication is to inform the farmers and industry the characteristic featu.. of the dozen penaeid prawns to help in correct identification of the spec.es. The morphological characters of a typical prawn have been illustrated in Fig. 1. Other figures are to illustrate typical characters in adults and seed. Use of technical terms could not be totally avoided, but these could be understood by referring to the illustrations. The common English names of the species are as adopted by the FAO. Notes on salinity tolerance, growth and culture characteristics have been included for each species.

The Central Institute of Brackishwater Aquaculture, which is the nodal agency for providing R & D support to this new production activity, intends to bring out a series of such Bulletins on technologies developed at the Institute. It is hoped that the farmers, industry and the planners will find the present publication useful.

Madras – 28
25th April 1992.

Dr. K. Alagarswami
Director

BIOLOGY OF PRAWNS - A GENERAL ACCOUNT

Prawns and shrimps are related to the lobsters and crabs and belong to a group of aquatic invertebrates called decapod crustaceans. The crustaceans form part of the major phylum Arthropoda (animals with jointed legs), which also includes the insects, spiders, millipedes and centipedes that are predominantly terrestrial. Crustacea consists of a number of freshwater and marine animal groups such as water fleas, brine shrimp, fairy shrimp, copepods, amphipods, isopods and the decapods. Among the decapods, the cultivable species of marine prawns belong to the family Penaeidae while the freshwater prawns of commercial importance belong to the family Palaemonidae. The names "shrimp" and "prawn" refer to the same animal.

Life cycle of prawns

All the cultivable species of penaeid prawns considered in this publication have a common life cycle. The adults live and breed in the sea. The larval development takes place in the sea. But the postlarvae drift towards the coast and enter the brackishwater creeks and estuaries which provide shelter and food to them. They grow into juveniles and after spending 4-6 months in the estuarine environment, the sub-adults migrate back to the sea where they grow, attain sexual maturity and spawn completing the life cycle. The natural ability of the postlarvae and juvenile prawns to live and grow in the fluctuating salinity conditions of estuaries has been made use of to culture them in brackishwater ponds.

Reproduction

The females of penaeid prawns are larger than the males. Externally, the males can be distinguished by the presence of the male sexual organ called the "petasma" borne on the first pair of swimming legs, while the females have a sperm storage organ called the "thelycum" between the 4th and 5th pair of walking legs. The shape of petasma and thelycum is specific to each species and is a very important character for identification of the species.

The sperms have no mobility because they do not possess a flagellum like the motile sperms of other animals. They are packed in sperm bags called

spermatophores which are transferred by the male with the help of the petasma to the thelycum of the female at the time of mating. Mating takes place as soon as the female moults and the spermatophore is stored in seminal receptacles under the thelycum. The female is able to release the stored sperms at the time of shedding the eggs during spawning. Because of this ability the males need not be present at the time of spawning. So mating and spawning are two different events separated by a span of time, usually 10 -15 days. At the time of mating the eggs are very small; they increase in size after mating by deposition of yolk material and when they are ripe they are shed into the seawater during spawning along with the sperms released from the thelycum. Fertilisation is external to the body, and takes place in seawater immediately after spawning.

When the female moults the sperms stored in the thelycum are lost along with the cast off shell (moult) of the prawn. But the prawn can spawn 2-3 times in the interval between two moultings (usually 3-4 weeks) using the same batch of stored sperms.

The eggs are small, about 0.3 mm in diameter, opaque white in colour, and sink to the bottom of the sea and lie loose on the substratum. Eight to twelve hours after spawning the eggs hatch and a free swimming larva called the "nauplius" emerges. The nauplius swims upwards attracted by the light on the surface of the sea. It has no mouth or alimentary canal and hence cannot feed. It grows utilising the yolk stored in its body and moults 5 times before transforming into the next larval stage called the "protozoea" after 36-48 hours. The protozoeae are filter feeders feeding on the unicellular plants called diatoms found floating in the seawater. There are three protozoeal stages which last for 3-4 days before metamorphosing into the next larval stage called the "mysis". There are 3 mysis stages which are also filter feeders. The mysis stage metamorphoses into the postlarval stage after 3 moultings in 3-4 days. The postlarvae lose the filter feeding habit and become carnivorous feeding on the small planktonic animals. The postlarvae look like miniature prawns and settle on the sea bottom after 4-5 days of planktonic life. The transition from postlarvae to juveniles is gradual after many moults and days, usually 20-30 days.

Food and feeding habits

The juvenile and adult prawns are omnivorous feeding on the small bottom-living animals and plants and the detritus that settles on the bottom. They are able to capture and pick up the prey organisms and detritus with the help of the small claws on the first 3 pairs of walking legs. The prawn holds the prey between the walking legs and slowly nibbles at it with the mandibles.

Growth

Since the body of the prawn is covered with a chitinous shell, it can grow only after shedding the shell. The process of shedding the shell is called moulting and the prawn grows by moulting frequently. The young prawns moult more frequently than the larger prawns; hence the younger prawns grow at a faster rate than the larger ones. The prawn grows in size immediately after moulting when the new shell is still soft. The shell hardens one or two days after moulting (Moulting usually takes place during the new moon and full moon phases). The prawns do not feed just before and immediately after moulting. Hence in pond culture of prawns, it is advisable to reduce the feeding frequency and ration during the new moon and full moon times to avoid wastage of feed.

The biological factors outlined above have a direct bearing on the culture practices followed in hatcheries and grow-out ponds and should be carefully understood.

1. INDIAN WHITE PRAWN *PENAEUS INDICUS* H.MILNE EDWARDS (Plate 1 A)

1.1. Characters for Identification

1.1.1. Adult

Body is light cream to yellowish with minute dots of red, yellow or black colour more or less evenly spread over the body. No bands on carapace and abdomen. Setae of swimming legs reddish. Antennal flagella reddish brown in the proximal half but yellow or white in the distal half.

Rostrum is long and sigmoid in shape. Number of teeth on the rostrum ranges 6-8 on dorsal side and 5-7 on ventral side; distal 1/3 of rostrum is without teeth on the dorsal side. Base of rostrum is not elevated into a triangular crest. Hepatic ridge is absent (Fig.2).

The structure of the thelycum of female and petasma of male is shown in Fig.4. In the 3rd maxillipede of adult males the distal segment is almost as long as the penultimate segment (Fig.6 A).

Note : Three species of genus *Penaeus,* namely *P. indicus, P. merguiensis* and *P. penicillatus* which are all white prawns, have many similarities and their identity could be mistaken if the distinguishing characters are not carefully checked. The descriptions of *P. merguiensis* and *P. penicillatus* may be seen in the text as well as in the figures.

1.1.2. Seed (20-25 mm in total length)

The seed of *P. indicus* shows some differences from the characters of adults in the following respects: Body translucent. Minute dots are present as in adults, but fewer in number. Setae of swimming legs colourless. Antennal flagella yellowish proximally, but whitish distally. Rostrum is longer in proportion to carapace and more sigmoid as compared to the adult.

The following characters will help in distinguishing the seed of *P. indicus* from that of other related species of white prawns:

Antennal flagella yellowish but white distally; no blue spot on the base of swimming legs. Rostrum sigmoid; distal 1/3 of dorsal margin without teeth; 6 dorsal teeth behind level of anterior margin of eye (Fig. 6 B). Mid-ventral prominence between the first pair of swimming legs blunt (Fig.6 C).

The morphological characters and pigmentation which are characteristic of the smaller postlarvae (10-15 mm) of *P. Indicus* are illustrated in Fig.7.

Note : All measurements of length of prawns in the text refer to total length measured from the tip of the rostrum to the tip of the telson.

1.2. Habits

P. indicus juveniles as well as adults are active both during day and night. They do not normally bury in the substratum. They prefer a sandy-mud bottom. The species is known to migrate long distances parallel to the coastline.

1.3. Salinity range

Postlarvae and juveniles occur in the salinity range of 15-30 ppt. Adults are normally found in the range of 30-35 ppt. However, juveniles tolerate a much wider range of salinity between 5-50 ppt. Optimum salinity range for culture is 20-30 ppt; outside this limit, growth slows down.

1.4. Growth

The maximum size of *P. Indicus* recorded in the sea is 230 mm (100 g) for females and 189 mm (55 g) for males. In semi-intensive culture it reaches a size of about 140-150 mm (20-24 g) in about 100 days.

1.5. Spawner availability

P. Indicus is exploited commercially along the coastline from Karwar (Karnataka) on the west coast to Puri (Orissa) on the east coast. The species spawns in the offshore grounds at depth of 20-30 m. Spawners are caught by shrimp trawlers and also in the gillnet operated from the country crafts. In peak seasons, the spawners form as high as 20% of the total prawn catch. Along the Kerala and Karnataka coasts, spawners are available from December through June, with peak seasons during January-February and again during May-June. On the east coast, its spawning activity is at a peak during July-September in the Gulf of Mannar, while on the Madras coast the peak spawning is during May-October and in some years during January-March also. On the Andhra Coast, peak spawning is during January-April but in some years even in May, July or October. It is seen that spawner availability is highly variable from place to place and year to year. *P. Indicus* broodstock can

also be raised in ponds in salinity range of 30-35 ppt. Females of size 140 mm (20 g) and above readily respond to unilateral eyestalk ablation and mature in captivity. Males mature even under pond conditions.

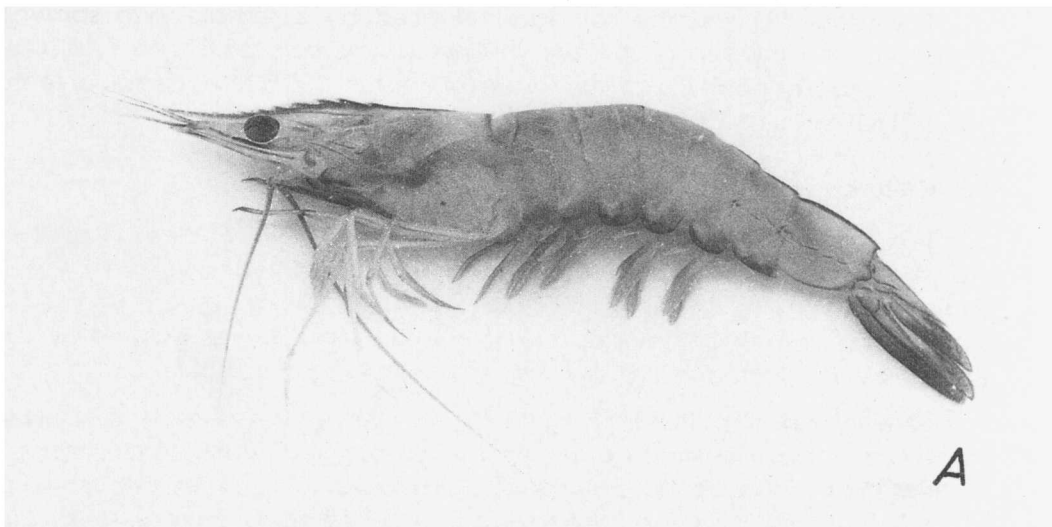
Normally, the minimum size at maturity is 130 mm (15 g) for females and 125 mm (13 g) for males.

The fecundity (number of eggs released by a female in a spawning) is dependent on the size of the prawn and ranges from 68,000 to 7,30,000 eggs. The average fecundity is of the order of about 1,00,000 eggs for a female of about 150 mm (25 g) size.

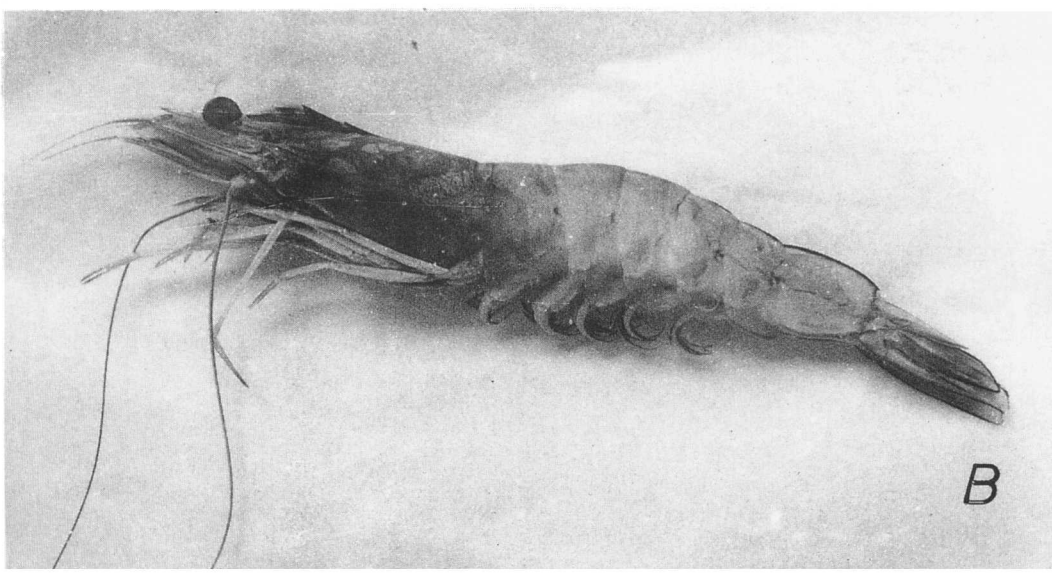
1.6. Culture

The white prawn *P. indicus* is the second major species, after the tiger prawn *P. monodon*, for culture especially in the southern region of the Indian peninsula. *P. indicus* is an important species in the traditional culture system in Kerala, as also in Karnataka. In the export market *P. indicus* fetches a higher price than *P. monodon* for the same size (count) category.

Semi-intensive culture of *P. indicus* is being done very successfully in pump-fed ponds constructed in the coastal areas of Tamil Nadu and Andhra Pradesh. Farmers take up culture of this species at centres where salinity of the water source is in the higher range or when the culture system is based entirely on pumped seawater. As compared to *P. monodon*, *P. indicus* is a hardier species and the stocking density can be higher for similar management practices. In intensive culture at a stocking density of 70 postlarvae/m^2, with imported feed, aeration and good water exchange, a production level of 8 t/ha/5 1/2 months with individual average weight of 20 g has been reported in India.



A. Indian white prawn, *Penaeus indicus*



B. Banana prawn *Penaeus merguiensis*

2. BANANA PRAWN *PENAEUS MERGUIENSIS* DE MAN (Plate 1 B)

2.1. Characters for Identification

2.1.1. Adult

Body light cream to yellowish, minutely speckled with brown, greenish or reddish spots spread more or less uniformly over the body. No bands on carapace or abdomen. Walking and swimming legs yellowish, the latter fringed with reddish brown setae. Antennal flagella reddish brown without bands (bands are found in very early juveniles).

Rostrum almost straight with a broadly triangular prominent crest at the base. Number of teeth on the rostrum ranges 6-9 on the dorsal side and 4-6 on the ventral side. Hepatic ridge absent (Fig.2).

Structure of thelycum and petasma as shown in Fig.4. In adult males the distal segment of the 3rd maxillipede is very short, hardly 1/3 length of penultimate segment (Fig.6 A).

2.1.2. Seed (20-25 mm)

The seed of *P. merguiensis* can be distinguished from that of *P. indicus* of the same size by the following characteristics :

General body colour whitish, sparsely speckled with reddish brown on lateral aspect of abdominal segments. Antennal flagella with reddish brown bands. A distinct blue spot present on the base of swimming legs. Rostrum (Fig.6 B) almost straight without triangular crest, the distal 1/3 with teeth, the dorsal teeth distributed evenly all along the dorsal margin. Five dorsal teeth behind level of anterior margin of eye. Mid-ventral prominence between the swimming legs on the first abdominal segment curved with pointed apex (Fig.6 C). The morphological characters and pigmentation of the smaller postlarvae (10-15 mm) of *P. merguiensis* are illustrated in Fig.7.

2.2. Habits

The banana prawns are gregarious forming large shoals. They do not normally bury in the substratum. They prefer muddy sand bottom. All stages are active swimmers like *P. indicus.*

2.3. Salinity tolerance

The seed (20-25 mm) and juveniles are found in salinities ranging from 15-30 ppt in estuaries and backwaters. Adults are found in the sea in 30-35 ppt salinity. This species seems to have a narrower range of salinity tolerance as compared to *P. indicus.*

2.4. Growth

This species grows to a larger size as compared to *P. Indicus.* The maximum size recorded is 240 mm (120 g) for females and 195 mm (60 g) for males. The species attains a size of 148-167 mm (33-37 g) under extensive culture in the salt pan reservoirs in the Gulf of Kutch region.

2.5. Spawner availability

In India, the occurrence of *P. mergulensis* in commercial quantities is restricted to the north-west coast north of Karwar and to the Orissa coast north of Chilka Lake. In the Andaman and Nicobar Islands this species entirely replaces *P. Indicus.*

The banana prawn breeds in the sea in 20-40 m depth zone. Large males and females can mature and mate in brackishwater areas where the salinity is 25-30 ppt.

The minimum size at maturity is 130 mm for females and 125 mm for males. The fecundity varies from 62,000 to 7,42,000 eggs depending on the size of the female.

The peak breeding season is February-April and August-December in Gujarat, December-May in Karwar region and July-August and November-December on the Orissa coast. Spawners can be obtained by trawling from the above mentioned areas during the peak breeding periods.

This species has been induced to mature in captivity by unilateral eyestalk ablation and the seed produced in hatcheries on a large scale.

2.6. Culture

It is a potential species for culture in the north-west and north-eastern coastal regions of India. Since seed can be easily produced in hatcheries and its growth potential is similar to that of *P. indicus*, it is a very good candidate species for culture in the above-mentioned regions.

3. RED TAIL PRAWN *PENAEUS PENICILLATUS* ALCOCK

3.1. Characters for Identification

3.1.1. Adult

Body light cream with minute red, brown and green dots spread over the body. The sides of the carapace, walking legs, swimming legs and tail fan appear bright red (yellowish in juveniles). No bands on the carapace or abdomen. Antennal flagella reddish brown without bands. Adult *P. penicillatus* from the sea appears more reddish than *P. merguiensis* from the marine environment.

Shape of rostrum and number of teeth similar to those of *P. merguiensis,* with triangular basal crest slightly less prominent. Hepatic ridge absent (Fig.2).

Thelycum and petasma similar to those of *P. merguiensis* (Fig.4). The distal segment of 3rd maxillipede in adult males 2 1/2 times length of penultimate segment (Fig.6 A).

3.1.2. Seed (20-25 mm)

Colouration exactly similar in all respects to that of *P. merguiensis* seed, including the blue spot on the base of swimming legs. Rostrum also similar to that of *P. merguiensis* except that there is a minute tooth immediately behind the tip of rostrum on the dorsal side (Fig.6 B). The morphological characters and pigmentation of the smaller postlarvae (10-15 mm) of *P. penicillatus* are illustrated in Fig. 7.

3.2. Habits

The adults are gregarious forming shoals; do not normally bury in the substratum; prefer muddy sand bottom. All stages are active swimmers.

3.3. Salinity tolerance

Similar to that of *P. merguiensis.*

3.4. Growth

Maximum recorded size in the sea is 215 mm (80 g) for females and 165 mm (32 g) for males. Under culture conditions this species can attain a harvest size of 21 g in 4 months time.

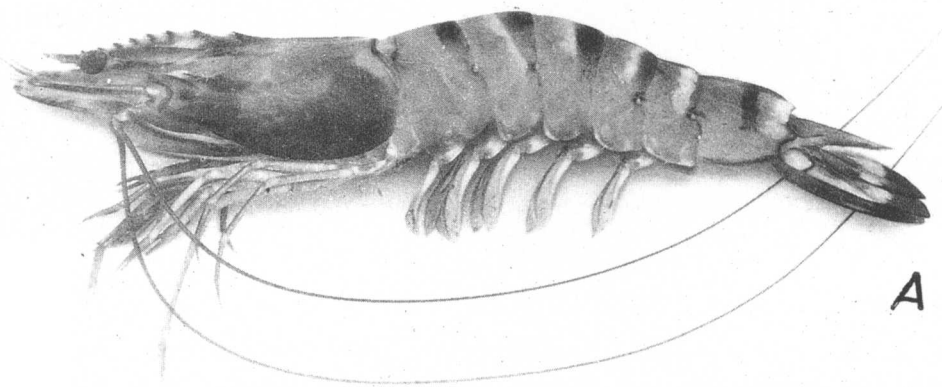
3.5 Spawner availability

In India, this species is found in commercial quantities only in the seas off the coast of Gujarat, Orissa and West Bengal; it is rare in the southern States. The species breeds in the sea in 20-50 m depth zone. Peak spawning is observed during October - December along the north-west coast and during December-March along the north-east coast. Spawners could be obtained by trawling from the offshore regions of Gujarat coast, Sandheads region at the head of the Bay of Bengal and off Mahanadi during the peak breeding season.

This species has been induced to breed in captivity by unilateral eyestalk ablation and the seed produced in hatcheries in Taiwan. But this has not been done so far in India.

3.6. Culture

P. penicillatus is cultured commercially only in Taiwan at present. It is a potential candidate species for culture in the north-western and north-eastern coastal regions of India, as it seems to tolerate the low winter temperatures in these regions.



A. Tiger prawn *Penaeus monodon*

B. Green tiger prawn, *Penaeus semisulcatus*

4. GIANT TIGER PRAWN *PENAEUS MONODON* FABRICIUS (Plate 2 A)

4.1. Characters for Identification

4.1.1. Adult

General body colour reddish brown (grey in brackishwaters) with whitish and dark reddish brown (black in brackishwaters) transverse bands on the dorsal side of the abdominal segments and tail-fan; whitish band absent on 1st abdominal segment. Carapace with 3 whitish transverse bands on dorsal side. Antennal flagella uniformly reddish brown without bands. Swimming legs fringed with bright red setae (dull red in brackishwaters) and have white patches (yellow and blue in brackishwater) on the basal segment.

Rostrum sigmoid in shape with 7-8 dorsal and 3 ventral teeth (Fig.2). No groove on dorsal ridge of carapace. Hepatic ridge present, straight and horizontal.

The structure of the thelycum of female and petasma of male is shown in Fig.4.

Note : *Penaeus monodon* and *P. semisulcatus* have many similarities and the distinguishing characters given here should be carefully observed.

4.1.2. Seed (10-15 mm)

The following characters help in distinguishing the seed of *P. monodon.* Brownish red or crimson streak extending without a break from tip of antennular flagella to tip of telson, the pigments appearing on the ventral side of the carapace and abdomen. Rest of the body colourless and transparent. The seed appear like brownish red colour threads. The number of pigment spots on the ventral side of 6th abdominal segment more than 13 (Fig.7). No pigment spot on anterolateral margin of 6th abdominal segment. The telson and inner margin of the endopods of the uropods pigmented from the proximal to the distal end. In later stage postlarvae more pigment spots develop and obscure the primary colour pattern described here.

Rostrum reaching anterior end of eye with 4-5 dorsal teeth; no ventral teeth. Lower antennular flagellum twice as long as upper flagellum. Sixth abdominal segment longer than carapace and lacks spinules on dorsal carina.

4.2. Habits

The adult tiger prawns are generally non-gregarious and do not form shoals; they do not normally bury in the substratum; prefer muddy bottom. The postlarvae and early juveniles cling to submerged weeds and grass in the shallow estuaries, and are not active swimmers like those of *P. indicus*.

4.3. Salinity tolerance

The postlarvae and early juveniles (12-25 mm) of *P. monodon* are found in a wide range of salinities in the estuaries (2-30 ppt). The juveniles and immature adults can be found in a much wider range of salinity (1-50 ppt). However, they grow fast in 15-25 ppt salinity. The mature adults are found in the sea in 30-35 ppt salinity.

4.4. Growth

Tiger prawn is the largest species of prawn in the world, the female growing to a length of 363 mm (440 g); the maximum size attained by males is 270 mm (180 g). In prawn culture farms they are usually harvested when they are about 160-165 mm (30-35 g) in size. The stocked seed (15-20 mm) attain this harvest-size in about 4 months in 15-25 ppt salinity. *P. monodon* is also known to tolerate hypersaline conditions (45-47 ppt) in culture ponds, reaching an average size of 24 g and yielding a production rate of 4 t/ha in 130 days duration, under semi-intensive culture.

4.5. Spawner availability

P. monodon is found to be commercially important mainly on the east coast of India, its abundance increasing northwards from Andhra Pradesh to West Bengal. It is rare on the west coast of India. The tiger prawn breeds in the sea in 20-50 m depth.

The minimum size at maturity is 170 mm (40 g) for males and 180 mm (50 g) for females. The fecundity varies from 2 to 19 lakh eggs depending on the size of the female. This prawn breeds throughout the year but peak spawning is observed from February-May and July-August on the east coast (mainly Andhra Pradesh, Orissa and West Bengal region). The spawners are rare on the west coast. Spawners can be obtained by trawling from the fishing

grounds during the peak spawning periods. Females 200 mm (65 g) and above have been induced to breed in captivity by unilateral eyestalk ablation.

4.6. Culture

In recent years it has become the species of choice for brackishwater aquaculture as it grows to a larger size. In semi-intensive culture of tiger prawn (stocking density 1.5 - 2.0 lakhs/ha) at Nellore in Andhra Pradesh and near Sirgazhi in Tamil Nadu in pump-fed farms with paddle wheel aeration, production of 4 to 5 tonnes per ha per crop have been achieved in 120 days of culture with imported feeds.

This species is widely cultivated in S.E. Asian countries, especially Taiwan, Thailand, Philippines and Indonesia. Taiwan has achieved the highest production rate of about 20 tonnes/ha under very intensive management and very high stocking densities in concrete walled earthern ponds.

5. GREEN TIGER PRAWN *PENAEUS SEMISULCATUS* DE HAAN (Plate 2 B)

5.1. Characters for Identification

5.1.1. Adult

Colour of body light reddish brown (light grey in juveniles) with creamish transverse bands on carapace (3 bands) and abdominal segments (one band each on first 5 segments and two on 6th segment) and tail fan. Antennal flagella banded. Walking legs red with yellow claws. Swimming legs with white patch on basal segment and red fringing setae.

Rostrum more or less straight with 6-8 dorsal teeth and 3 ventral teeth (Fig.2). A groove in the dorsal ridge of carapace behind the rostrum. Hepatic ridge oblique, pointing downwards. Structure of thelycum and petasma as shown in Fig.4.

5.1.2. Seed (10-15 mm)

Chromatophores brown in colour. Sixth abdominal segment with 8-10 chromatophores on ventral side and one lateral chromatophore on either side (Fig.7). Only distal half of tail fan pigmented. In larger postlarvae, more pigment spots appear and swamp the colour pattern described here. Larger seed found amongst seagrasses have a greenish colour for camouflage.

Rostrum reaching anterior end of eye, with 5-6 dorsal teeth; no ventral teeth. Lower antennal flagellum equal to or slightly longer than upper flagellum. Sixth abdominal segment less than or as long as carapace and lacks spinules on dorsal carina.

5.2. Habits

The adults are generally non-gregarious and do not form shoals; they bury themselves in the substratum during daytime and emerge for feeding during night; prefer sandy bottom.

The early juveniles prefer seagrass beds in shallow inshore waters. They cling to seaweeds and seagrasses. This clinging habit is so pronounced that when kept in a container without seaweeds they cling to each other. The juveniles are rarely found in estuaries. But in estuaries with seagrass beds they may occur under high saline conditions.

5.3. Salinity tolerance

This species does not tolerate low salinities. The adults live in the sea salinity of 30-35 ppt. However, in the Persian Gulf and Red Sea where the salinity is usually in the range of 40-45 ppt this is the dominant species of penaeid prawn.

The juveniles may be found in the salinity range 20-25 ppt but not in lower salinities.

5.4. Growth

The maximum size recorded from the sea is about 250 mm (140 g) for females and 190 mm (65 g) for males.

It has not so far been cultured on a commercial scale. In experimental culture in Taiwan, the species grew to an average size of 33.7 g in 315 days with a survival rate of 83.0%.

5.5. Spawner availability

Widely distributed in the Indo-Pacific region, this species contributes to commercial fisheries only in areas where seaweeds and seagrasses are found in abundance, as the postlarvae and juveniles seem to be dependent on the marine vegetation for survival.

In India, they are found in commercial quantities in the Gulf of Mannar and Palk Bay on the south-east coast and the Gulf of Kutch in the north-west coast which have seaweed and seagrass resources. This species breeds in the 20-50 m depth zone.

The minimum size at maturity is 120 mm for males and 125 mm for females. The fecundity varies from 52,000 to 6,60,000 eggs depending on the size of the female.

In the Gulf of Mannar and Palk Bay the peak breeding season is January-February and June-September and spawners can be obtained by trawling during night.

Females weighing 40 g in size have been induced to breed in captivity by unilateral eyestalk ablation and the seed produced in hatcheries on a large scale.

5.6. Culture

It has not been successfully cultured under pond conditions on a commercial scale. Experimental scale culture has been attempted in India, Kuwait, Bahrain, Taiwan and Malaysia.

Being a species which does not tolerate wide fluctuations in salinity, its culture requirements seem to be more stringent. It may be suitable for cultivation in culture system using seawater of 30-35 ppt salinity. It should also be remembered that it is a burrowing species which prefers sandy bottom.

This is an ideal species for sea ranching in bays and creeks with seaweeds and seagrasses which serve as nurseries. In India this species is ranched in the Palk Bay along Tamil Nadu coast.

6. KURUMA PRAWN *PENAEUS JAPONICUS* BATE (Plate 3 A)

6.1. Characters for Identification

6.1.1. Adults

Body light yellowish brown with characteristic pattern of dark reddish brown bands on the carapace, abdomen and tail fan. Tip of the tail fan yellow and peacock blue in colour. Swimming legs yellowish with white patch on basal segment. Walking legs yellow and blue. Antennal flagellum brownish red without bands. (The bands on the body are indistinct in juveniles and in very early juveniles the body is speckled with blue chromatophores).

Rostrum almost straight with 8-10 dorsal teeth and one ventral tooth. Prominent grooves on either side of dorsal ridge (which itself is grooved) extending upto posterior margin of carapace. Hepatic ridge slanting downwards (Fig.2). Telson with 3 pairs of short movable lateral spines.

Structure of thelycum and petasma as shown in Fig.4.

6.1.2. Seed (10-15 mm)

Crimson coloured chromatophores all along the ventral side of the body forming a streak as in *P. monodon,* but 6th abdominal segment has only 10-11 ventral chromatophores; no lateral chromatophores. The endopod of uropod with one chromatophore near the base on median aspect; exopod of uropod without chromatophores (Fig.7).

Rostrum very short, reaching only half length of eye; with 4-5 dorsal teeth; no ventral tooth. Sixth abdominal segment slightly shorter than carapace, with minute spinules on dorsal carina. These characters are shared by the postlarvae of *P. latisulcatus* also.

6.2. Habits

The adults are generally non-gregarious and do not form shoals. It is a typical burrowing species which prefers a sandy bottom. It lies buried during day time and comes out for feeding during night.

All the life history stages are found only in the sea. The juveniles may be found in the lower reaches of estuaries where the salinity is equal to that of seawater.

6.3. Salinity tolerance

Adults, juveniles and postlarvae do not tolerate wide fluctuations in salinity. They prefer to live in 30-35 ppt. Lower salinities are avoided even by juveniles. They can tolerate higher salinities upto 40 ppt if the change is gradual.

6.4. Growth

Adults in the sea grow upto 285 mm (205 g) in Japan. In India the maximum size recorded is 235 mm (100 g) for females and 200 mm (70 g) for males.

Under culture conditions in Japan the prawn is harvested at a size of 20 g which it attains in 6 months. Under the warmer Indian conditions this size is attained in 4 1/2 months.

6.5. Spawner availability

In Indian waters, the species is found in stray numbers, except on the Maharashtra coast where it forms a seasonal fishery during June-September. The kuruma prawn breeds in the sea in 20-25 m depth zone. The minimum size at maturity is 132 mm (15 g) for males and 145 mm (20 g) for females. Fecundity varies from 75,000 to 7,00,000 eggs depending on the size of the female.

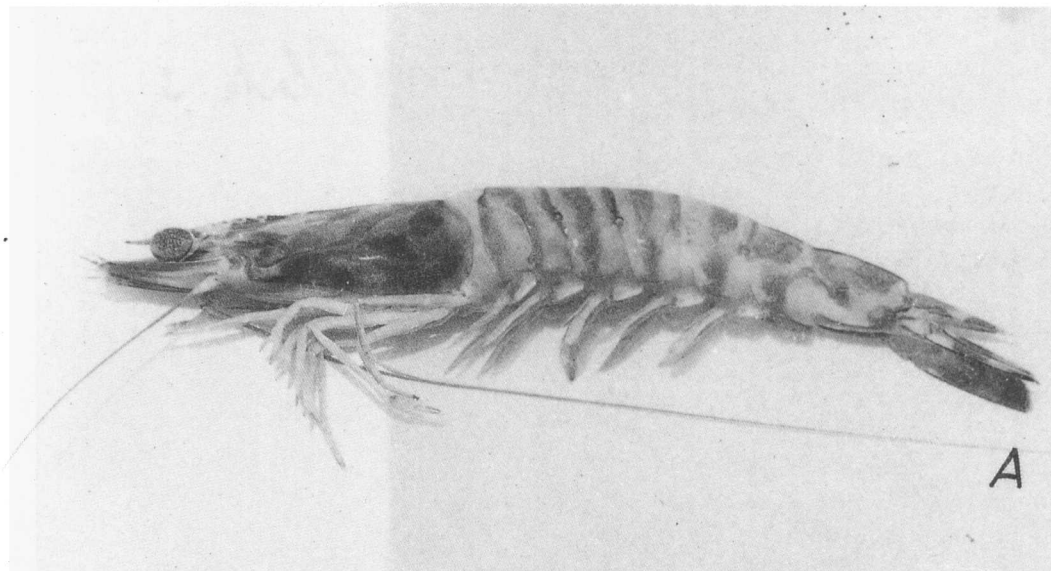
The peak spawning season is July-September on the Maharashtra coast and December-May on the Madras coast.

This species has been bred in captivity and seed have been produced under hatchery conditions.

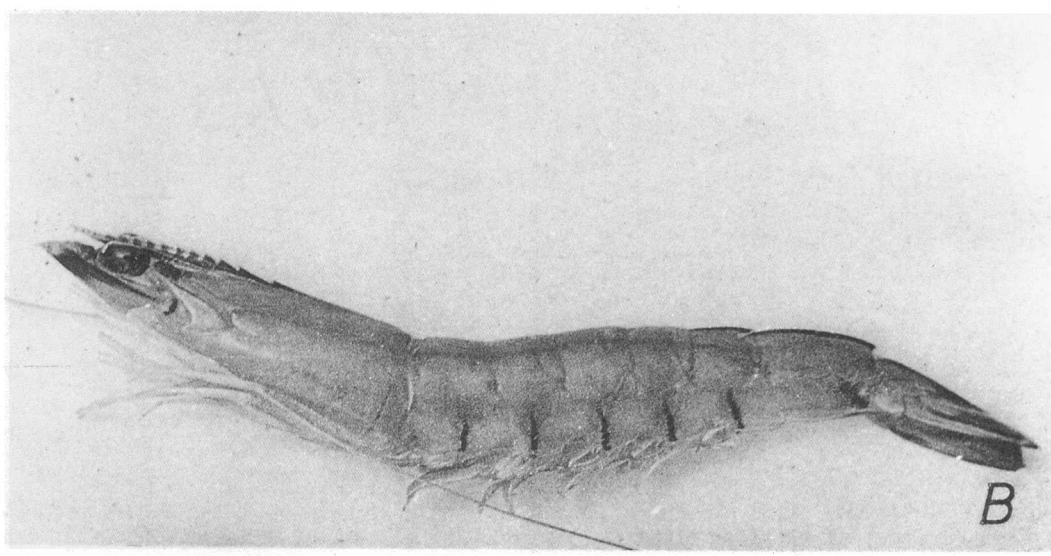
6.6. Culture

Intensive culture of *P. japonicus* is practised in Japan and Taiwan in large concrete tanks with high stocking densities, high rate of water exchange, continuous aeration and high energy artificial feeds. Although the cost of production is very high, culture is profitable as the prawns are sold alive to luxury hotels at very high prices. In India culture of the species has been taken up on an experimental scale.

There is good scope for culturing this prawn in India on a commercial scale in semi-intensive systems to cater to the increasing demands for live kuruma prawn in Japan. Although natural seed is not available in large quantities in Indian waters, it can be produced in hatcheries. The broodstock will have to be maintained in captivity as the species is not abundant in the commercial catches. *P. japonicus* is also a good species for ranching in suitable areas as it burrows in the sand and does not move far away from the point of release.



A Kuruma prawn, *Penaeus japonicus*



B. King prawn, *Penaeus latisulcatus*

7. KING PRAWN *PENAEUS LATISULCATUS* KISHINOUYE (Plate 3 B)

7.1. Characters for Identification

7.1.1. Adults

Body light yellowish brown with dark brown vertical markings on lateral side of abdominal segments. Vertical lateral bands indistinct in juveniles. This species is closely related to the kuruma prawn, but can be easily distinguished by the colour pattern described above.

Rostrum almost straight with 8-11 dorsal teeth and 1-2 ventral teeth (Fig.2). Grooves on either side of the dorsal carina extending almost upto posterior margin of carapace. Hepatic ridge slanting downwards. Telson with 3 pairs of short movable lateral spines.

Thelycum and petasma as shown in Fig.4.

7.1.2. Seed (10-15 mm)

The seed of *P. latisulcatus* share the morphological characters with *P. japonicus* seed. However, the chromatophore pattern of *P. latisulcatus* seed is slightly different (Fig.7).

7.2. Habits

A non-gregarious species which does not form shoals. Lies buried in the substratum during day time and comes out for feeding at night. Prefers sandy bottom. Like *P. japonicus* all life history stages are found in the sea. Juveniles may enter estuaries and coastal lagoons when the salinity is equal to that of sea water.

7.3. Salinity tolerance

Can tolerate only a limited range of salinity (28-35 ppt). Lower salinities are avoided even by the juveniles. Can live in salinities upto 40 ppt if the change is gradual.

7.4. Growth

The females of this species attain a maximum of 220 mm (70 g) in Indian waters. The maximum size for males is 165 mm (35 g).

7.5. Spawner availability

P. latisulcatus occurs in stray numbers all along the east and west coast of India. The females attain maturity at 115 mm (14 g) while males mature at 105 mm (10 g). This prawn breeds in the sea in 20-30 m depth zone. Fecundity varies from 40,000 to 6,50,000 eggs depending on the size of the female. The spawning season is March-May along the Tamil Nadu coast.

The species has been induced to breed in captivity by unilateral eyestalk ablation and seed has been produced on an experimental basis. Since the species is not abundant in the commercial catches, broodstock will have to be maintained in captivity for use in the hatchery.

7.6. Culture

This species has been cultured on an experimental basis in Australia. It seems to be a potential species for pen culture or ranching in the lagoons of Lakshadweep Islands and in coastal areas with sandy bottom on the mainland. The seed can be easily produced in hatcheries.

8. SPECKLED PRAWN *METAPENAEUS MONOCEROS* (FABRICIUS)

8.1. Characters for Identification

8.1.1. Adults

Body uniformly light brown or pinkish brown without any bands. Walking and swimming legs light orange with white patches at the base. Body covered with short setae.

Rostrum more or less straight, upturned with 8-10 teeth on dorsal side alone (Fig.3); no ventral teeth. Post-rostral ridge reaching posterior margin of carapace. Dorsal ridge present on all abdominal segments. Fifth walking leg does not exceed antennal scale in length.

Thelycum and petasma as shown in Fig.5. In the male, the second segment of the 5th walking leg has a well-developed hook-like projection on the ventral aspect (Fig. 8A).

8.1.2. Seed (15-30 mm)

Rostrum slightly curved downwards with 6-7 dorsal teeth, reaching just beyond the eye (Fig.6 D). The mid-dorsal carina of the abdomen starts from 3rd segment. Body with bluish or brownish chromatophores, those on the carapace larger and highly branched and form patches on the postero-dorsal and lateral aspects. A distinct dark bluish band on the mid-lateral region of carapace is characteristic of the species. In dorsal view, the 4th abdominal segment has bluish black chromatophores in the form of the letter 'M' (Fig.6 E).

8.2. Habits

The species is gregarious and found in dense concentrations, buried in the substratum. Prefers muddy bottom. More active during night. Adults live in the sea in 50-100 m depth zone. Late postlarvae and juveniles are found in estuaries and backwaters.

8.3. Salinity tolerance

Although the adults live in deeper waters of the sea in 34-35 ppt salinity, the juveniles are highly tolerant to low salinities. They are found even in very low salinity of 1 ppt in the upper reaches of creeks and estuaries.

8.4. Growth

In sea the females attain a maximum size of 200 mm (80 g) and the males 150 mm (35 g). But in the brackishwater estuaries and traditional prawn filtration fields specimens larger than 100 mm are rare.

8.5. Spawner availability

In India *M. monoceros* is commercially more important on the east coast than on the west coast. It breeds in the sea in relatively deeper waters (50-100 m) compared to the other species of penaeid prawns. The minimum size at maturity is 95 mm (5 g) for males and 116 mm (12 g) for females. Fecundity varies from 54,000 to 4,16,000 eggs depending on the size of the female. This species breeds throughout the year but peak spawning is observed during October-April on the west coast (North Kerala, Karnataka and South Maharashtra coasts) and during March- September on the east coast (North Tamil Nadu, Andhra Pradesh and Orissa coasts). Spawners can be obtained by trawling in the deeper (60-80 m) areas during the peak spawning periods.

It has also been induced to mature in captivity by unilateral eye-stalk ablation.

8.6. Culture

At present *M. monoceros* is not grown in monoculture in India. By virtue of its hardiness and wide salinity tolerance, it is a potential species for culture on the east coast of India in extensive culture systems or along with milkfish or mullets. Seed of this species is available in abundance in the estuaries of the east coast and could be easily collected with drag nets. This species can be considered for semi-intensive culture in low saline areas where the larger species of *Penaeus* cannot be grown.

9. GREASY BACK PRAWN *METAPENAEUS ENSIS* (DE HAAN)

9.1 Characters for Identification

9.1.1. Adult

Very similar to *M. monoceros* in colouration and other morphological features except for the differences in the shape of the thelycum and petasma (Fig.5) and the tooth-like (not hook-like) projection on the 5th walking leg of the adult male (Fig.8 B).

9.1.2. Seed

It is very difficult to distinguish between the seed (15-30 mm) of *M. monoceros* and *M. ensis*. However, the pigment pattern on the 4th abdominal segment is characteristic of *M. ensis* seed and is illustrated in Fig.6 E.

9.2. Habits

Like *M. monoceros* this species is also gregarious and is found in dense concentrations; buries in muddy bottom and is more active during night time.

Adults are found in 50-80 m depth zone of the sea while juveniles and late postlarvae extend far into the upper reaches of the estuaries.

9.3. Salinity tolerance

The juveniles and late postlarvae are highly tolerant to wide fluctuations in salinity and are found even in very low salinities (1 ppt). But adults live in 32-35 ppt salinity.

9.4. Growth

The maximum size recorded in the sea for females is 190 mm (52 g) and for males 155 mm (28 g). In estuaries the average size is about 115 mm (10 g).

9.5. Spawner availability

In India, *M. ensis* is found in commercial quantities only off the coasts of Orissa, West Bengal and the Andaman Islands although it is found in stray

numbers along the Tamil Nadu and Andhra coasts. It is absent on the west coast of India. This species replaces *M. monoceros* in the Andaman Islands.

M. ensis breeds in the sea in 50-80 m depth zone. The minimum size at first maturity is 120 mm (13 g) for females and 100 mm (6 g) for males.

The species breeds throughout the year with peak spawning during March-September along the Orissa and West Bengal coasts. Spawners can be collected by trawling during the peak breeding season from these regions.

9.6. Culture

It is a potential species for culture in West Bengal. The seed are readily available in abundance in the estuaries and can be collected easily in large quantities. They attain a size of 100-120 mm in the bheries. Its hardiness and wide salinity tolerance make it a suitable species for culture especially in low saline areas where the large species of *Penaeus* cannot be cultured. *M. ensis* is one of the major species under extensive culture in China and S.E.Asian countries.

10. GINGER PRAWN *METAPENAEUS KUTCHENSIS* GEORGE, GEORGE AND RAO

10.1. Characters for Identification

10.1.1. Adult

The colouration of *M. kutchensis* is very similar to that of *M. monoceros* during the juvenile stage. However, the walking and swimming legs of *M. kutchensis* in adult stage are reddish orange in colour.

Rostrum slightly sigmoid with 7-9 dorsal teeth; no ventral teeth (Fig.3). Mid-dorsal ridge well defined on 4th, 5th and 6th abdominal segments. Fairly extensive non-setose patches on the carapace and abdomen. Fifth walking leg does not exceed antennal scale in length.

Thelycum and petasma as shown in Fig.5.

10.1.2. Seed

Some characteristics of the seed of *M. kutchensis* are illustrated in Fig.6 D.

The species has been confused with *M. monoceros* and *M. affinis* till very recently.

10.2. Habits

A gregarious, burrowing species, like *M. monoceros* and *M. ensis*. The adults are marine, found in 20-40 m depth zone while the juveniles are found in the coastal saline creeks.

10.3. Salinity tolerance

The adults and larger juveniles seem to tolerate salinities upto 45 ppt, while the juveniles can be found in creeks in lower salinities (10-20 ppt).

10.4. Growth

In sea, the females attain a maximum size of 175 mm (40 g) and the males 145 mm (20 g). In the creeks, the average size is 70-95 mm (3-5 g). In the salt pan reservoirs they grow to a size of 135 mm (17 g).

10.5. Spawner availability

In India, the species is restricted to the Gujarat coast. It breeds in the sea in 20-40 m depth zone on the Saurashtra and South Gujarat coast. Has been found to mature in the salt pan reservoirs also. The minimum size at maturity for females is 110 mm (8 g). The peak spawning period is February-September. The fecundity varies from 1.2 to 4.0 lakh eggs.

10.6. Culture

It has been cultured on an experimental basis in the salt pan reservoirs bordering the Gulf of Kutch. This seems to be a potential species for extensive and semi-intensive culture in the high saline salt pan reservoirs. Large quantities of seed are available in the Gulf of Kutch region in the creeks. It has also been bred in captivity and the seed raised in hatcheries on an experimental scale.

11. FLOWER TAIL PRAWN *METAPENAEUS DOBSONI* (MIERS)

11.1. Characters for Identification

11.1.1. Adults

The body is uniformly yellowish cream in colour without any bands. Carapace and abdomen with extensive setose patches.

Rostrum slightly sigmoid; distal 1/3 without teeth; 5-7 dorsal teeth; no ventral teeth (Fig.3). Fifth walking leg in adult females vestigial. In adult males the basal spine on 3rd walking leg prominent with barbed tip.

Thelycum and petasma as shown in Fig.5. Mated females with a prominent white patch on thelycum.

11.1.2. Seed (15-30 mm)

Ground colour of body cream white with sparsely scattered small dark bluish and brownish chromatophores which do not form distinct bands either on the carapace or on the abdomen. Rostrum short extending to base of eye, with 5-8 dorsal teeth and conspicuous dorsal crest (Fig.6 D & E). In the abdomen the mid-dorsal carina commences from the 4th segment.

11.2. Habits

A gregarious species which sometimes forms large pelagic shoals during the monsoon season. It prefers muddy bottom and normally lies buried in the mud. The adults are found in inshore waters in 5-10 m depth zone. The juveniles and post-larvae are found in the backwaters and the upper reaches of estuaries.

11.3. Salinity tolerance

Highly tolerant to wide ranges in salinity (1-30 ppt) during the juvenile stage. Adults live in 30-35 ppt salinity.

11.4. Growth

M. dobsoni is a relatively small species, the maximum size of females in the marine environment is 135 mm (15 g) and that of males 120 mm (11 g). In the estuary the maximum size attained is 100 mm (6 g).

11.5. Spawner availability

In India, *M. dobsoni* is commercially important mainly on the west coast (Kerala and Karnataka) and less so on the east coast (Tamil Nadu and Andhra Pradesh). It is also common in the Andaman Islands.

M. dobsoni breeds in the inshore waters in 5-10 m depth zone. It has been found to mature even in brackishwater areas. The minimum size at first maturity is 74 mm for females and 55 mm for males. Fecundity varies from 35,000 to 1,60,000 eggs depending on the size of the female.

Breeds throughout the year with peak spawning during April-June and October-December along the Kerala and Karnataka coasts and during April-August and October-December along the Tamil Nadu coast.

11.6. Culture

M. dobsoni is not cultivated in monoculture due to its small size. But it is a potential species for extensive and semi-intensive culture in low saline areas, where the large species of the genus *Penaeus* cannot be cultured.

The seed of *M. dobsoni* are available in abundance in the backwaters of Kerala and Karnataka and can be collected easily by drag nets in large quantities for culture purposes.

This species has been induced to mature and spawn in captivity and the seed reared on a large scale in hatcheries with ease.

12. YELLOW PRAWN *METAPENAEUS BREVICORNIS* (H. MILNE EDWARDS)

12.1. Characters for identification

12.1.1. Adults

The female is cream coloured, uniformly speckled with bluish black spots; no bands on the body. The males are yellow in colour. The body is glabrous without setose patches.

The rostrum of adult females straight with a prominent basal crest; distal 1/3 without teeth; 6-8 dorsal teeth present on the rostral crest; ventral teeth absent (Fig.3).

Thelycum and petasma as shown in Fig.5. Mated females with prominent white patch on thelycum. Some characteristics of the seed of *M. brevicornis* are illustrated in Fig.6 D.

1.2. Habits

A gregarious species found in shallow inshore waters (5-10 m); prefers muddy sand bottom. The juveniles and late postlarvae extend far into the upper reaches of estuaries.

12.3. Salinity tolerance

The adults live in 30-35 ppt salinity while the juveniles can tolerate a wide range of salinities (1-30 ppt).

12.4. Growth

In sea, the females attain a maximum size of 140 mm while males reach a maximum size of 98 mm. In the estuaries the average size of juveniles is 80-90 mm.

12.5. Spawner availability

In India, the distribution of *M. brevicornis* is patchy, being found in commercial abundance only on the coast of Saurashtra, south Gujarat and north Maharashtra on the west coast and at Kakinada (Andhra Pradesh) and West Bengal on the east coast.

M. brevicornis breeds in shallow inshore waters (5-10 m). In the bheries of West Bengal the males attain maturity and mate with the females. Maturing females have also been observed in the bheries during the summer months when the salinity is higher (20- 25 ppt).

The minimum size at maturity is 67 mm for males and 86 mm for females.

12.6. Culture

It has not been cultivated in monoculture due to its small size. But its tolerance to a wide range of salinity and its hardiness makes it a potential species for extensive and semi-intensive culture in the low saline areas where the larger sized species belonging to the genus *Penaeus* cannot be grown. The natural seed is available in plenty in the Hooghly estuary.

Key to the identification of cultivable species of prawns in India

1. (a) Rostrum with teeth on dorsal and ventral margins. Body smooth without short setae 2

   (b) Rostrum with teeth on dorsal margin alone. Body covered with short setae either throughout or in patches 8

2. (a) Rostrum with 4-7 teeth on ventral margin. No hepatic ridge on carapace. Body without transverse colour bands 3

   (b) Rostrum with 1-3 teeth on ventral margin. Hepatic ridge on carapace present. Body with transverse colour bands 5

3. (a) Rostrum sigmoid without elevated basal crest; distal 1/3 of rostrum without teeth on dorsal side. Antennal flagella yellow or white ..... *Penaeus indicus*

   (b) Rostrum more or less straight with triangular basal crest; distal 1/3 of rostrum with teeth. Antennal flagella reddish brown 4

4. (a) In the 3rd maxillipede of adult male distal segment is short, 1/3 as long as penultimate segment ..... *Penaeus merguiensis*

   (b) In the 3rd maxillipede of adult male distal segment is very long, 2 1/2 times as long as penultimate segment ..... *Penaeus penicillatus*

5. (a) Rostrum with 3 ventral teeth. No longitudinal grooves on either side of mid dorsal ridge on carapace 6

   (b) Rostrum with 1 ventral tooth. Prominent longitudinal grooves on either side of mid dorsal ridge on carapace extending to posterior margin of carapace 7

6. (a) Hepatic ridge on carapace horizontal. Dorsal ridge on carapace posterior to rostrum without groove. Antennal flagella uniformly reddish brown, not banded ..... *Penaeus monodon*

(b) Hepatic ridge oblique. Dorsal ridge on carapace posterior to rostrum with distinct groove. Antennal flagella with white and reddish brown bands ..... *Penaeus semisulcatus*

7. (a) Body with prominent reddish brown bands on carapace and all abdominal segments. Uropods tipped with yellow and peacock blue ..... *Penaeus japonicus*

(b) Body uniformly yellowish cream with vertical lateral band on each abdominal segment. Uropods peacock blue with a small patch of brown at the tip ..... *Penaeus latisulcatus*

8. (a) Distal 1/3 of rostrum without teeth 9

(b) Distal 1/3 of rostrum with teeth 10

9. (a) Rostrum with triangular basal crest in female; carapace smooth without short setae ..... *Metapenaeus brevicornis*

(b) Rostrum without basal crest in female; carapace with patches of short setae ..... *Metapenaeus dobsoni*

10. (a) Mid dorsal ridge on all six abdominal segments. Post rostral ridge on carapace extending to posterior margin. Entire body covered with short setae 11

(b) Mid dorsal ridge restricted to 4-6 abdominal segments. Short setae on body in patches ..... *Metapenaeus kutchensis*

11. (a) 5th leg of adult male with curved hook-like spine on the 2nd segment ..... *Metapenaeus monoceros*

(b) 5th leg of adult male with short tooth on 2nd segment ..... *Metapenaeus ensis*

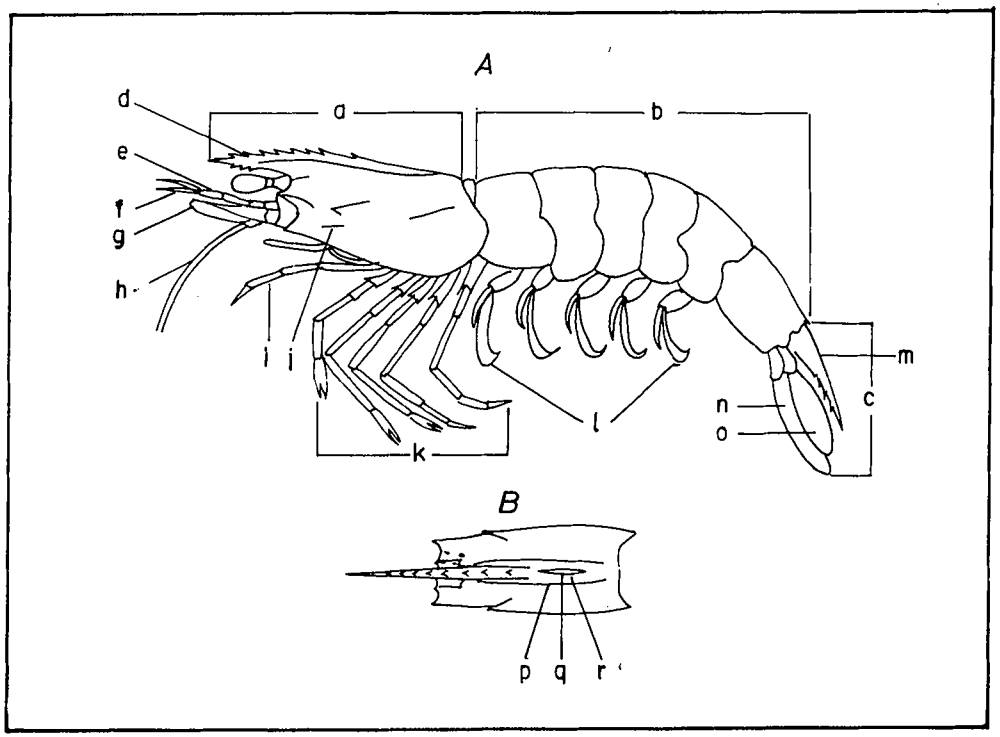


Fig.1. Diagrammatic sketch of a penaeid prawn to illustrate important taxonomic characters mentioned in the text. A- lateral view of prawn: a. carapace, b. abdomen, c. tail-fan, d. rostrum, e. antennular peduncle, f. antennular flagella, g. antennal scale, h. antennal flagellum, i. third maxillipede, j. hepatic ridge, k. walking legs, l. swimming legs, m. telson, n. exopod of uropod, o. endopod of uropod. B - dorsal view of carapace: p. adrostral carina, q. post-rostral median sulcus, r. adrostral sulcus.

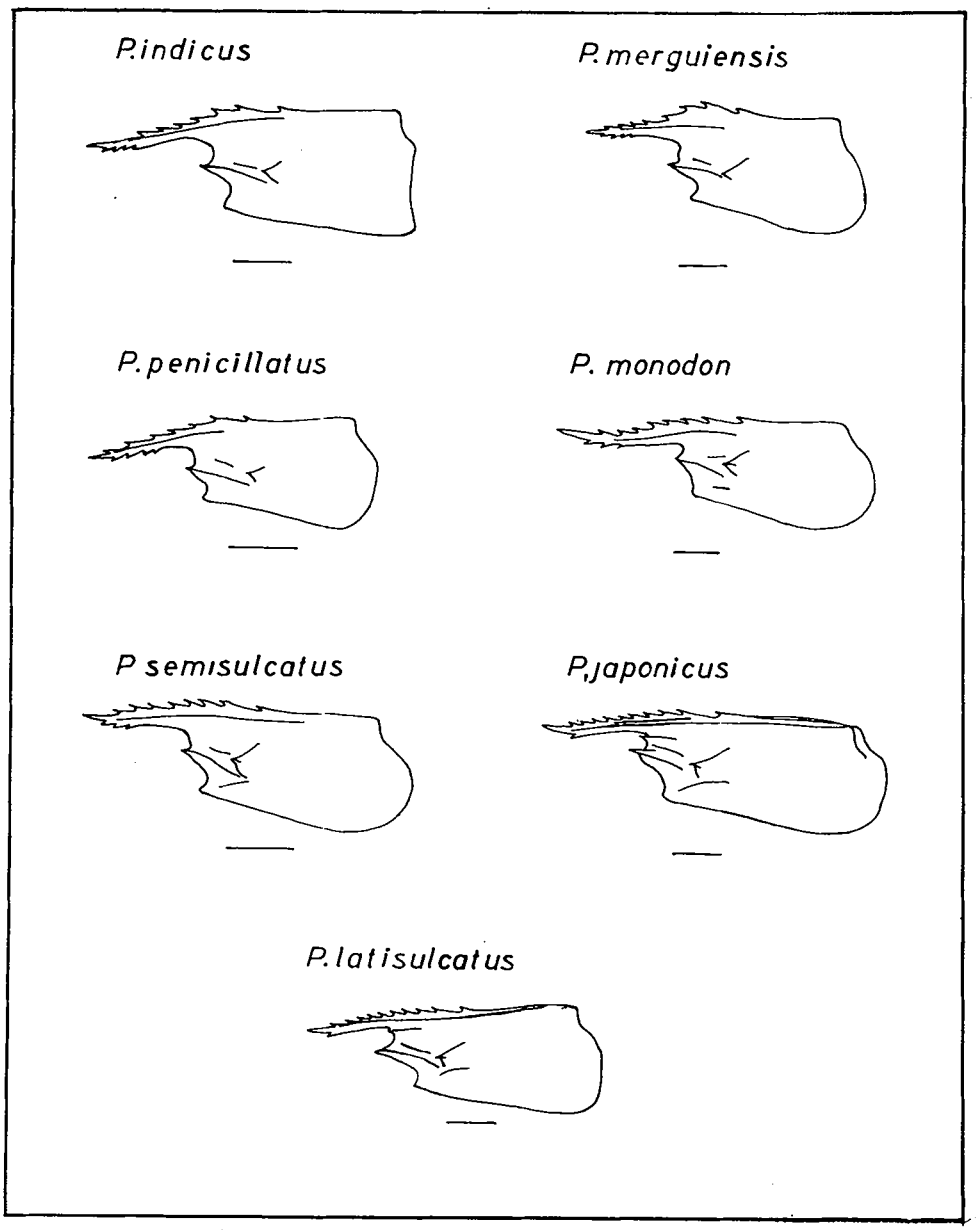


Fig.2. Carapace of *Penaeus* species. Scale represents 1 cm.

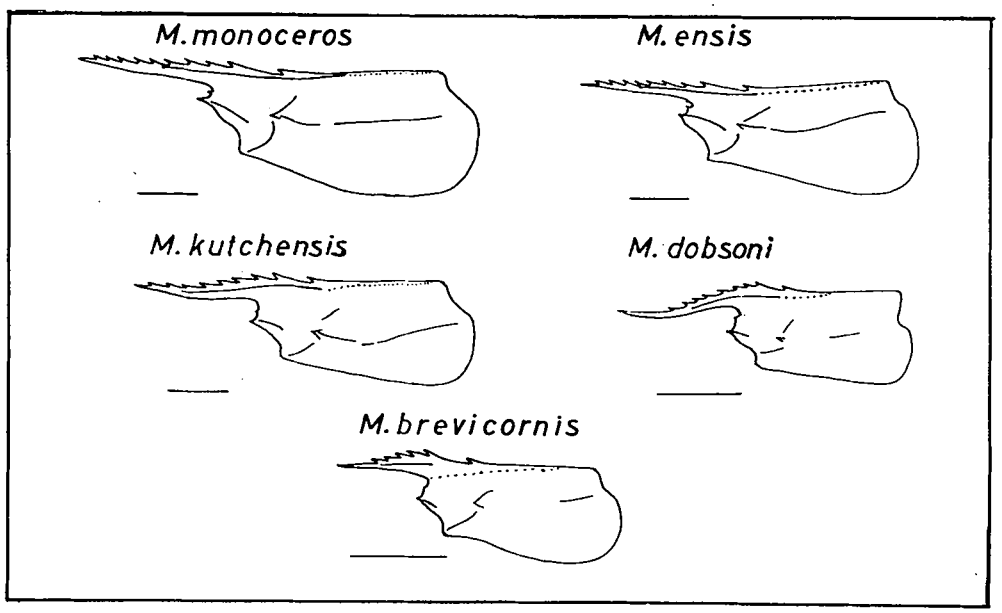


Fig.3. Carapace of *Metapenaeus* species. Scale represents 1 cm.

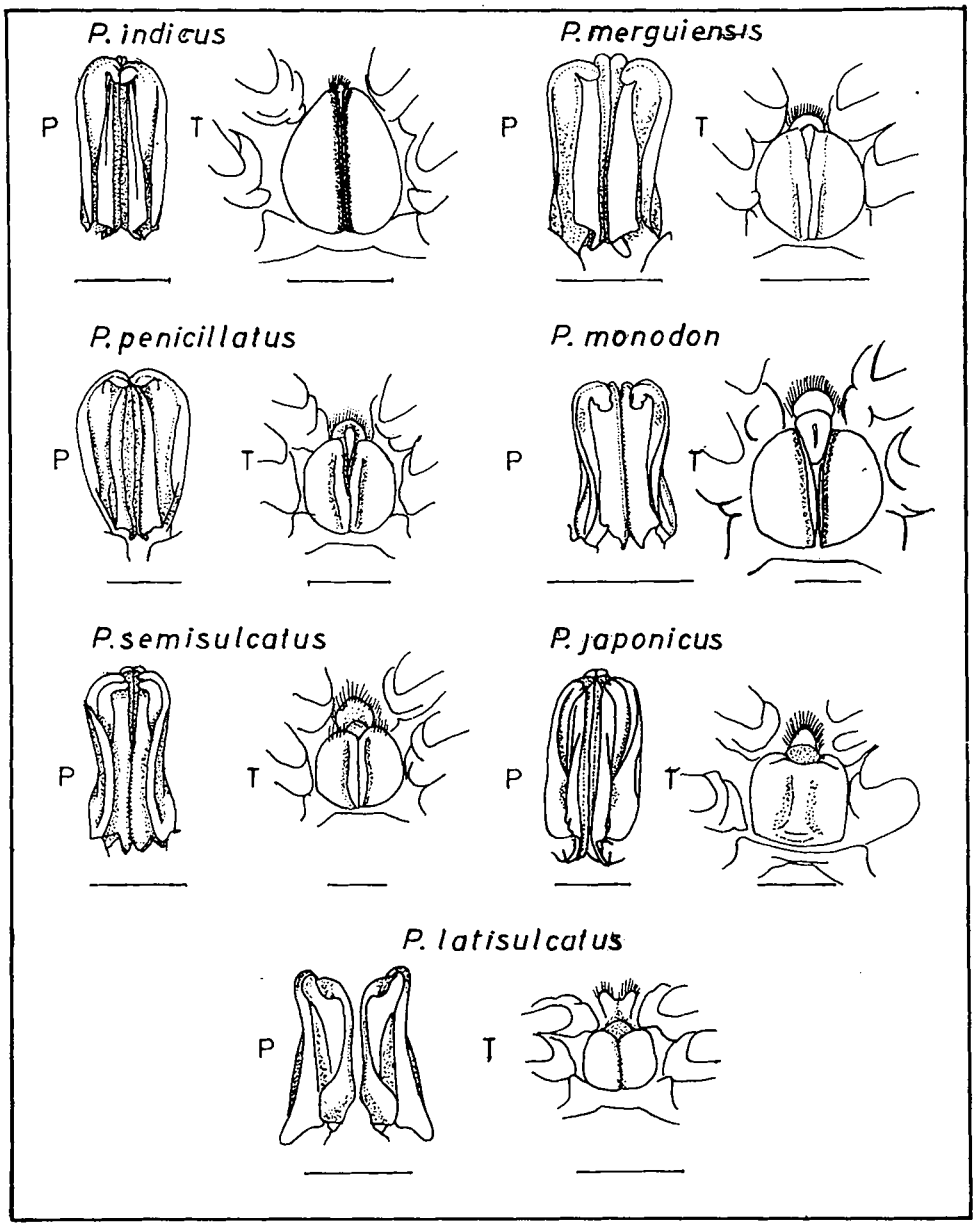


Fig.4. Male and female genital structures of *Penaeus* species.
P. petasma, T. thelycum. Scale represents 0.5 cm.

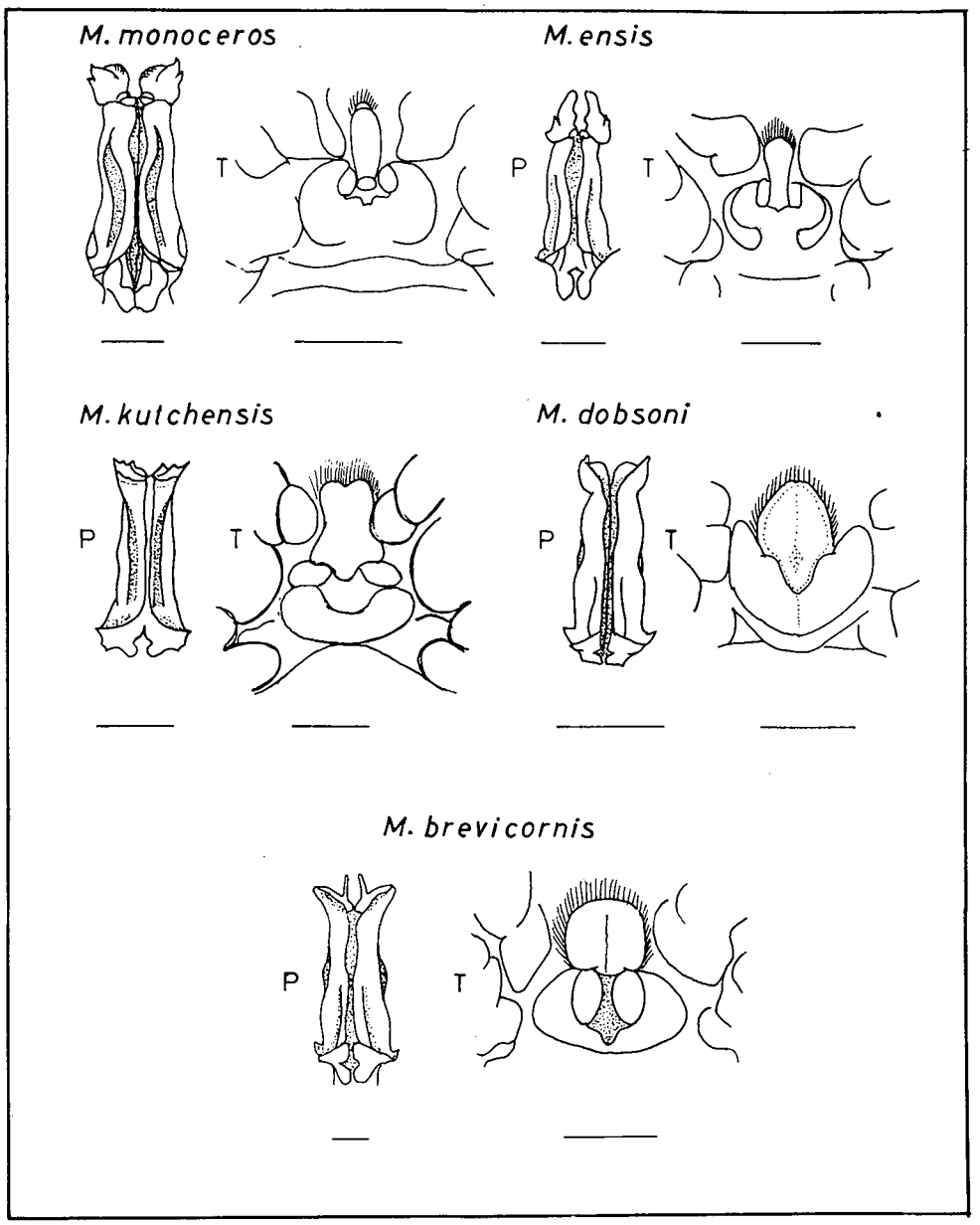


Fig.5. Male and female genital structures of *Metapenaeus* species. P. petasma, T. thelycum. Scale represents 0.5 cm.

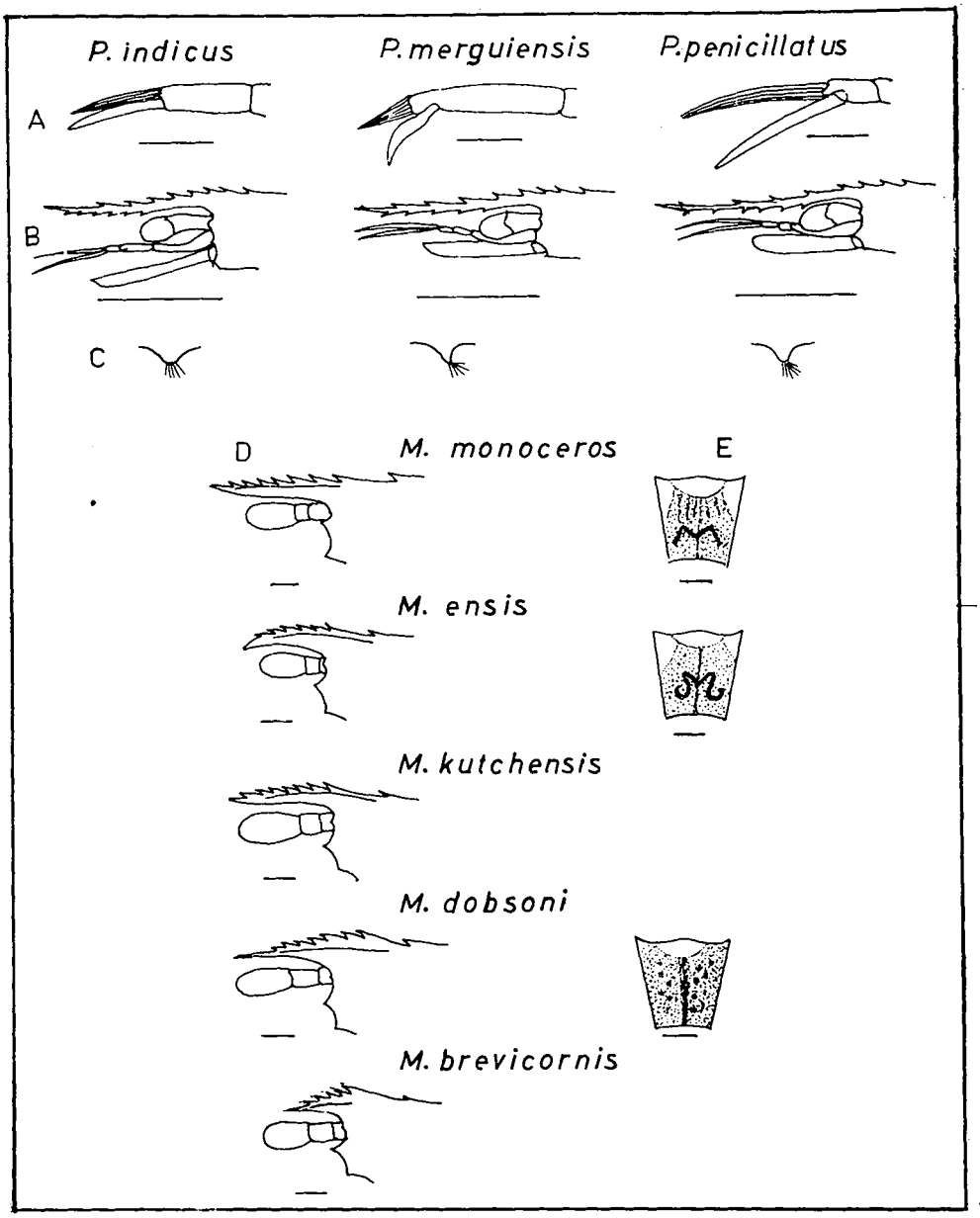


Fig.6. A. terminal segments of third maxillipede in adults, B. rostrum and C. midventral prominence between the first pair of swimming legs in early juveniles measuring 22 mm in TL, D. rostrum and E. chromotophore pattern on fourth abdominal segment in early juveniles measuring 27 mm in TL. Scale represents 1 cm.

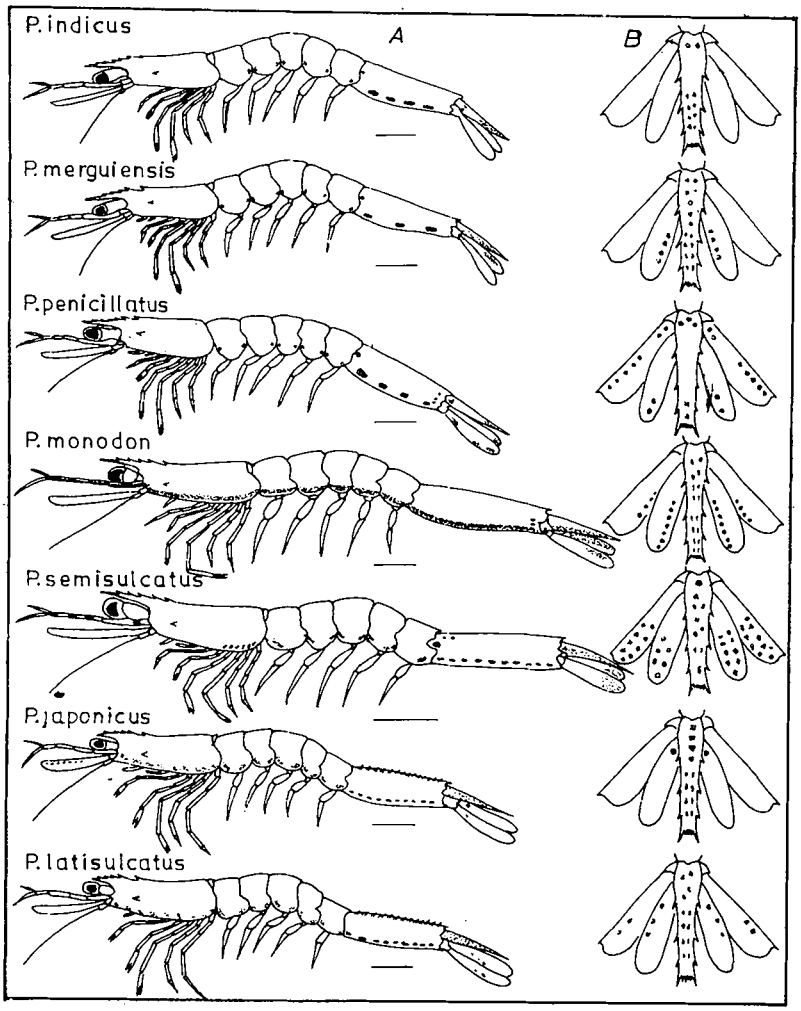


Fig.7. Chromotophore pattern in postlarvae of *Penaeus* species. A. whole animal, B. tail-fan. Scale represents 0.5 cm.

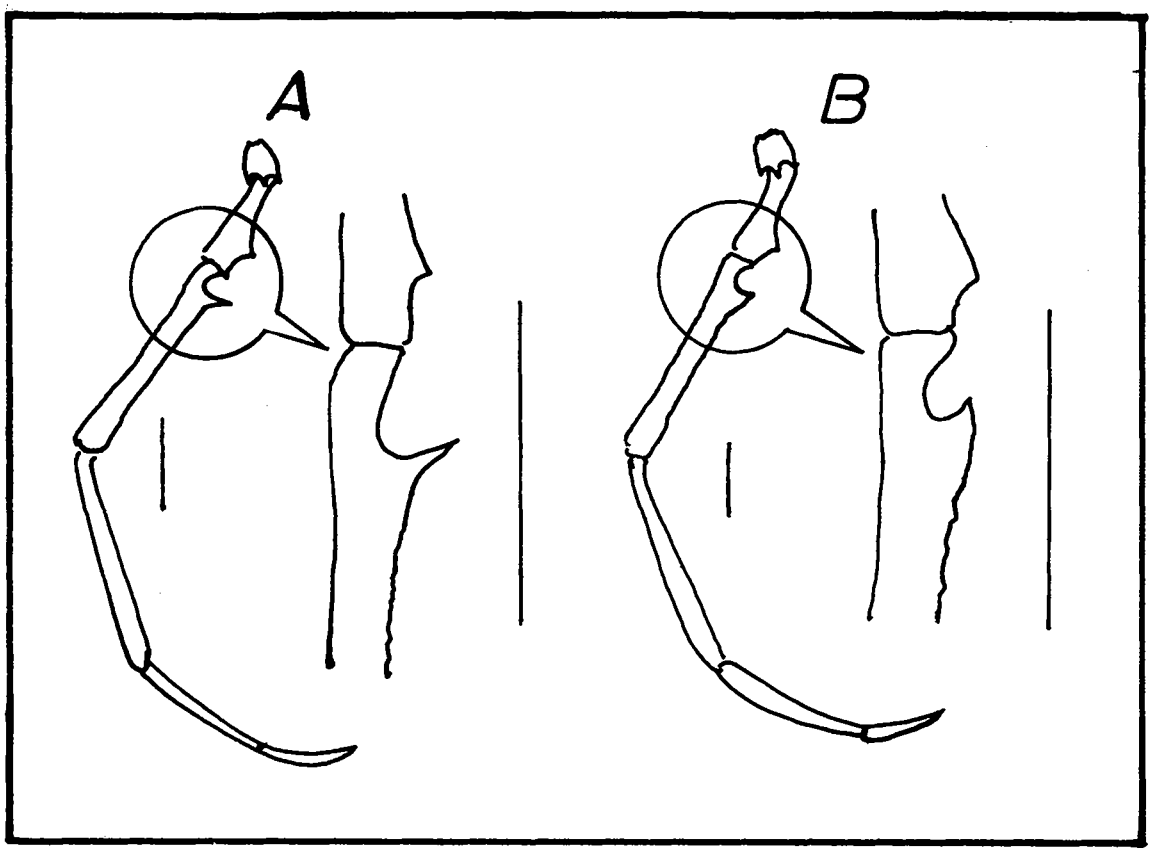


Fig.8. Fifth walking leg. A. *M. monoceros*, B. *M. ensis*. Scale represents 0.5 cm