OBSERVATIONS ON THE EMBRYONIC AND LARVAL DEVELOPMENT OF SOME ESTUARINE PALAEMONID PRAWNS

by K. RAJYALAKSHMI, *Central Inland Fisheries Research Station, Barrackpore*

(Communicated by B. S. Bhimachar, F.N.I.)

(*Received May 31*; *read August 5, 1960*)

ABSTRACT

An account of the embryonic development, hatching and the structure of the early larvae of *P. malcomsonii*, *P. rudis*, *P. scabriculus*, and *P. mirabilis* is given. A comparison between the different species described, shows certain differences in size, time taken for development and hatching and the time of appearance or functioning of various embryonic structures. Differences in the nature of chromatophores and their arrangement in the 1st stage larvae of all the species studied, have been described and the salient points of variation in the morphometric characters that distinguish the larvae of different species are discussed. The 2nd stage larva of *P. mirabilis* is described in detail.

Prawns belonging to the genera Palaemon and Leandər form an important fishery in the Hooghly estuary, accounting for about 70 per cent of the total catches of prawns in this region. During the course of studies on the populations of estuarine prawns, it was found necessary to assess the fluctuations in the abundance of juveniles during the various seasons in the year, hence this study on early embryonic and larval history was started with a view to establishing the identifying characters of eggs and larvae of different species. Nataraj (1947) has described in some detail the early development of *Palaemon idae* Heller, and Aiyer (1949), its embryology. Das (1935) and John (1947) reported having studied the development stages in *Palaemon lamarrei* H.M. Edw., and *Palaemon carcinus* Fabr., respectively, but the detailed descriptions have not yet been published. Menon (1938) has given the first detailed descriptions of the first two larval stages in *Palaemon carcinus* and *Palaemon rudis*. But for these, there are no published reports on the developmental features of any other species of the genus Palaemon of Indian waters.

This paper deals with four of the more important species of prawns, namely, *Palaemon malcomsonii* H.M. Edw., *P. rudis* Heller., *P. mirabilis* Kemp., and *P. scabriculus* Heller.

P. malcomsonii was recorded as occuring in the various parts of South India (Henderson and Matthai, 1910); as common in "peninsular rivers that drain into the Bay of Bengal; Malabar and east coast of India upto the Mahanadi delta; West coast of India from Indus delta to the northern limit of Malabar coast." (Tiwari, 1955). The species occurs in the Middle and upper zones of the river Hooghly and closely resembles a new variety described by Schenkel (1902) under the name *Palaemon spinipes* Var. *birmanicus*. However, in identifying this species as *P. malcomsonii*, the author has followed Holthuis (1950) who has observed, "The specimens of this new variety show all characters mentioned and figured by Henderson and Matthai for *M. malcomsonii*, so that I see no reason whatever to separate the two forms."

P. rudis was recorded as occurring in "Madras and Kakinada" in South India (Henderson and Matthai, 1910) from "Malabar and east coast of India upto Mahanadi area and the deltaic Bengals" (Tiwari 1955). In Hooghly, the species occurs mainly in the middle and upper zones.

P. scabriculus has been recorded as occuring in various parts of South India (Henderson and Matthai, 1910) ; from "Malabar and the east coast of India upto the Mahanadi delta ; the deltaic Bengals." (Tiwari 1955). In Hooghly, it is found mainly in the middle and upper zones.

P. mirabilis occurs in various localities of gangetic delta (Kemp 1917 ; Tiwari 1955). This species is distributed throughout the estuary though is landed in the catches mainly from the upper and middle zones.

Material and Methods

For studying the embryonic and larval development, live berried females obtained from the commercial catches were transported to the laboratory and reared in aquaria in fresh water. In a few instances where mature males and females were released in the aquaria, it was observed that extrusion of eggs in females had taken place subsequent to their introduction into the aquarium. To study the early embryonic development, microscopic examination of a sample of few eggs separated from the parent, at regular interval of 24 hours, was made. Thus, the development was traced upto hatching. Temperature readings of water in the aquaria were taken at regular intervals. Faxon (1879) working on *Palaemonetes vulgaris*, observed that "eggs if detached from the mother die invariably, unless the enclosed embryo has nearly reached the point of hatching". A similar conclusion was arrived at by Nataraj (1947) working on *Palaemon idae* Heller. However, in the course of the present studies, it has been possible to successfully rear to hatching, at least 50% of the eggs separated from the parent, in small glass bowls (capacity 350 c.c.) where changing of water and cleaning of eggs were done at periodic intervals.

The different stages assigned to the developing eggs in the descriptions given in the text, are based on the progressive changes in the colour of the egg-mass and the characteristics of the live embryo as observed with the aid of a research microscope.

The larvae of *P. rudis*, *P. mirabilis* and *P. scabriculus* survived for two to three days after the first moulting ; in *P. malcomsonii* the larva did not moult to second stage. Various measurements of the larvae were taken from dorsal side after rendering them inactive by the addition of a few drops of 30% alcohol. (Fig. 11).

Embryonic development

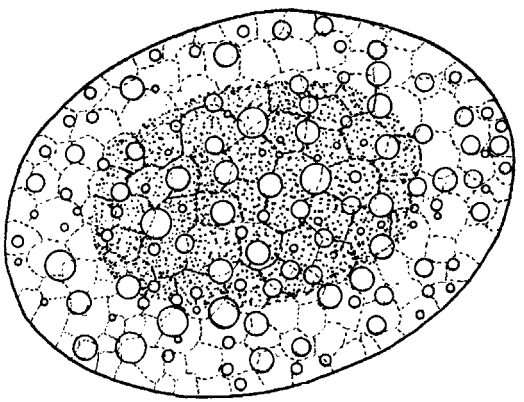
P. malcomsonii. Berried specimens of the species were available in the middle and upper zones of the river Hooghly in the months of May to September.

Stage I : (1–4 days)

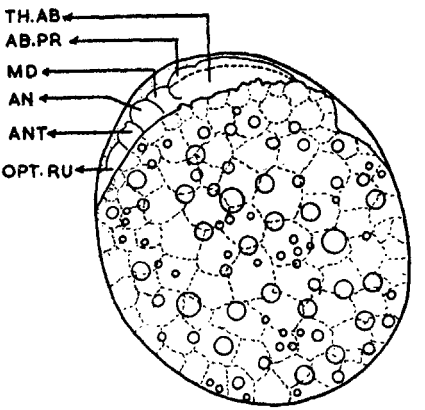
The fertilised eggs (Fig. 1) are found to be more or less elliptical in shape 12–14 hours after extrusion. They are deep yellow in colour and the individual eggs on an average measure 0.82 mm. × 0.52 mm. The centre of the egg is darker than its periphery, and has a thin transparent membrane completely covering it. Distinct hexagonal markings are seen on the surface showing an advanced stage of cleavage.

The ventral plate becomes noticeable as a well demarcated cellular transparent region at one end of the egg approximately 48 hours after extrusion. By the next day this structure increases in size, and the rudiments of the embryonic region namely, a stout cephalic lobe in front and a narrow and elongated thoracico-abdominal lobe behind with prominences of appendage buds, are well differentiated.

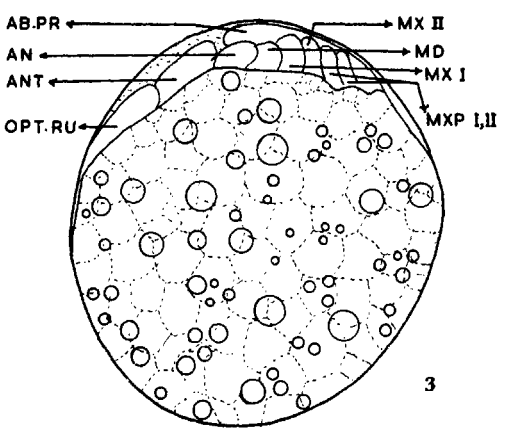
On the 4th day (Fig. 2) the cephalic lobe has increased in size and is divided into a larger anterior optic rudiment, and a smaller posterior rudiment of the antennule. Two knob like prominences *viz.*, the antennal and mandible rudiments, are differentiated towards the posterior region. The thoracico-abdominal lobe gets further differentiated into a forwardly flexed, abdominal process or telson rudiment.



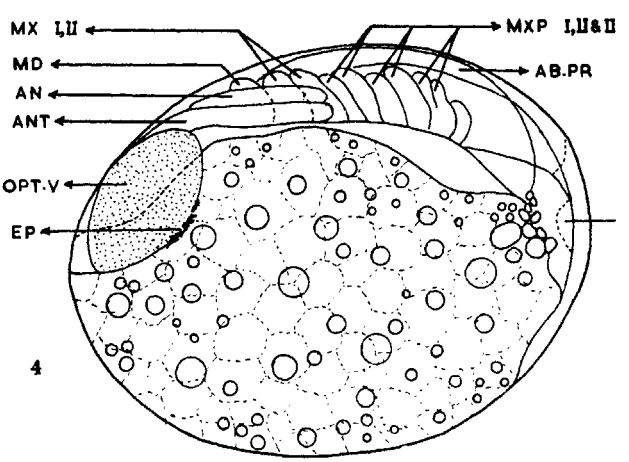
1



2



3



4

Fig. 1. Egg on the first day of development
Fig. 2. Egg on the 3rd day of development.
AB.PR : Abdominal process ; AN : Antenna ; ANT : Antennule ; MD : Mandible ; TH.AB : Thoracico-abdominal lobe ; OPT.RU : Optic rudiment.
Fig. 3. Egg on the 5th day of development
MX I and II : Maxilla I and II ; MXP : I, II : Maxillepeds I and II ; rest as in Fig. 2.
Fig. 4. Egg on the 7th day of development
EP : Eye-pigment ; H : Heart ; MXP I, II and III : Maxillepeds I, II and III ; OPT.V Optic Vesicle. Rest as in Fig. 2.

Stage II : (5–6 days)

By the beginning of 5th day (Fig. 3) the rudiments of four more cephalic appendages, namely, the first and second maxillae and 1st and 2nd maxillepeds are also formed. Thus, a total of eight prominences are clearly visible on the embryonic region. The abdominal process is more pronounced and extends upto the antennal region, as a well-defined forwardly-directed process. This process is the only part of the embryo projecting away from the yolk, while the rest of the embryonic rudiments namely, the optic lobe and cephalic appendages, lie flat over the under-lying yolk mass.

On the 6th day the optic rudiments are very conspicuous, lying flat over the yolk mass. The antennule and antenna are posteriorly directed. The mandible, the first and second maxillae, are still short and blunt, but directed downwards. The three maxillepeds are well defined by now. The abdominal process shows a cleft in its middle at posterior end. In the cephalo-thoracic region a tiny heart vesicle has made its appearance. At this region, a slightly elevated part of yolk mass of light yellow colour consisting of few large and small vacuoles is visible.

Stage III : (7–11 days)

From the 7th day to the time of hatching on the 14th day, the development appears mainly to consist of growth and further differentiation of the various regions and appendages already formed.

On the seventh day (Fig. 4) the heart vesicle begins to pulsate at irregular intervals in the beginning later on becoming more regular and rhythmic. The optic vesicle appears as a very thick and prominent structure and along its inner border, a short narrow and discontinuous dark streak of pigment becomes visible. The carapace has developed and covers the cephalo-thoracic region of the embryo. The appendages are elongated and tubular and the three maxillepeds appear distinctly bifid.

During the 8th and 9th days, the optic vesicles which are hitherto lying flat over the yolk begin to increase in size extending upwards on each side of the embryo. The eye-pigment has become continuous, oval shaped, and larger. The antennule and antenna have become more tubular, elongated backwards parallel to each other from the cephalic region to the region of the 1st maxilleped. The mandible and first and second maxillae remain short, but with slightly pointed ends, directed downward inclining slightly forwards. The three maxillepeds are more elongated. The yolk has diminished to more than half its original volume. Faint lines of segmentation are visible on the abdominal process which is seen at the level of maxillepeds ; the gut is visible as a very narrow tube along its centre. The liberated fluid yolk which appeared on the 6th day consisting of number of vacuoles, has increased in volume and shows regular but slow movements.

By the 10th day (Fig. 5) the eye pigment becomes larger. The distal end of antennule is very finely pointed, and that of antennal exopodite is faintly annulated, and from the lower edge of the latter are seen very fine setae. The lateral edge of carapace is more distinct, curved upward posteriorly. Peristaltic movements of the liquid yolk are found to be more frequent and occasionally are seen movements of a few droplets of yolk inside the gut. Viewed from the lower surface of the egg, on the enlarged bifid posterior end of the telson are seen setae, as small protuberances.

Stage IV : (12th day to 14th day)

On the 12th day (Fig. 6) the embryo appears quite advanced. The yolk is highly reduced, appearing as 4 blocks, two anterior and two posterior. The embryo occupies the major portion of the egg. The eye pigment is almost spherical.

Telson has extended beyond the anterior end of the embryo curving upwards; viewed from the lower surface of egg, on its concave posterior end, the setae are well defined. The biramous maxillepeds have elongated, their distal ends becoming setose. The 1st and 2nd pereiopods formed earlier, are visible as small tubular structures. The abdomen has six segments, the last one continuous with the telson. The embryo shows occasional jerky movements which became more frequent near the time of hatching.

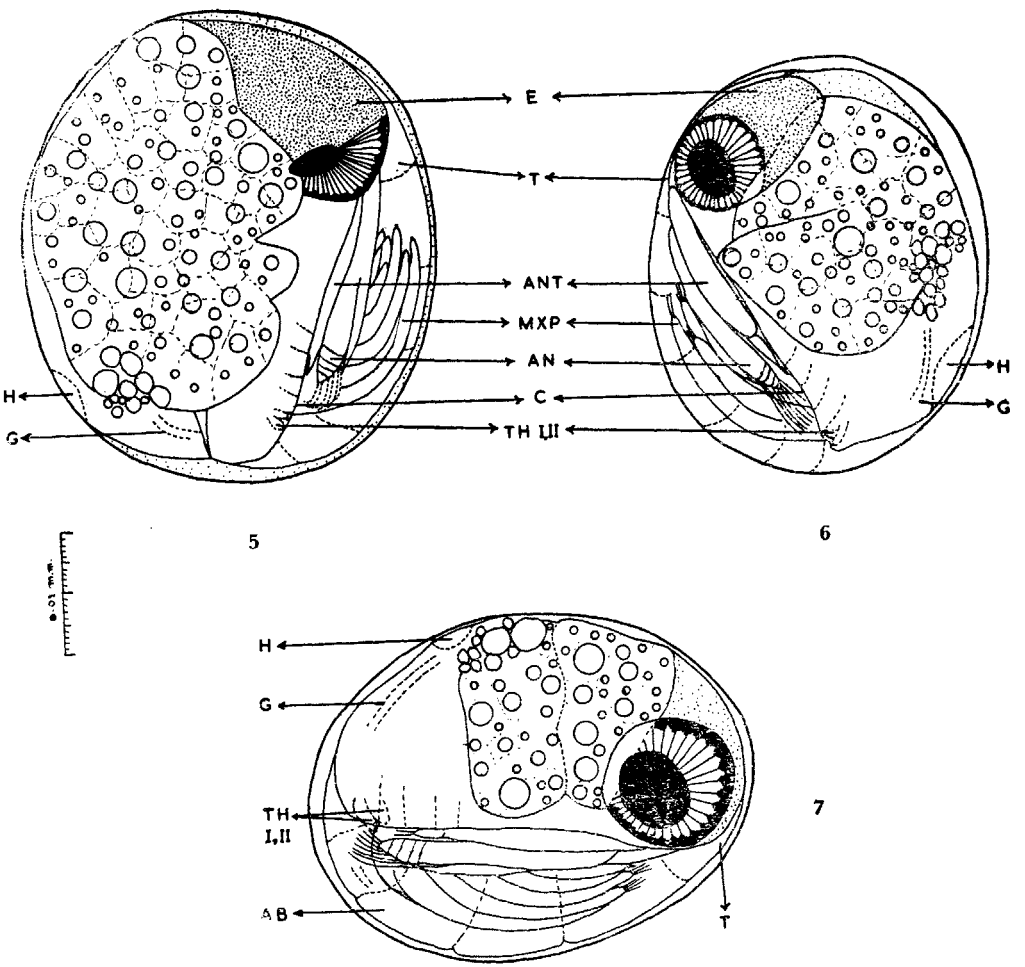


Fig. 5. Egg on the 10th day of development
C: Carapace; E: Eye; G: Gut; T: Telson; TH. I, II: Thoracic appendages (Pereiopods) I and II. Rest as in Fig. 2 and 4.
Fig. 6. Egg on the 12th day of Development
Abbreviations as in Fig. 5.
Fig. 7. Egg on the 14th day of development.
AB: Abdomen. Rest as in Fig. 5.

The embryo continues to grow absorbing the remaining yolk, and by the 14th day (Fig. 7) the development is complete. The embryo is transparent, with a small amount of yolk beneath the carapace. Eye-pigment, completely spherical by now, is visible clearly to the naked eye. The heart-beat, peristaltic movements of the liquid yolk and the jerky motions of the embryo are more rapid.

Hatching

The larvae reared in aquaria hatched out late on the 14th day between 2–5 a.m. when the temperature was 25.5°C. At the time of hatching, the parent was found to swim constantly. The rapid movement of its pleopods along with the jerky movements of the embryo inside the egg membrane presumably help the process of hatching. The movements of the pleopods disperse the larvae. The larvae were hatched out in batches and after each batch is released, the parent rested for a while at the bottom of the aquarium slowing down its movements and after 2 or 3 minutes it swam up again to release and disperse a fresh batch of hatched larvae. The entire hatching took 2–3 hours in the aquarium.

By the next morning all the larvae were seen concentrated at one corner of the aquarium, some attached to the glass sides, all hanging head downwards.

Embryonic development in P. rudis, P. mirabilis and P. scabriculus

The general pattern of development in these three species bears a very close resemblance to that of *P. malcomsonii* which is described above. So, only the main points of differences noticed in the embryonic history of these species are indicated here.

P. rudis breeds in the middle and upper zones of the estuary from February to October with the peak period from June to October. The eggs take 19 days for development and hatching in temperature ranging from 25 to 32°C. The eggs are light green at the time of extrusion and measure 0.61–0.71 mm. (long axis) and 0.49–0.56 mm. (short axis). The ventral plate and embryonic rudiments appear on the third and fourth day respectively. The peristaltic movements of the liberated yolk are seen on the 9th day ; and the pulsation of the heart vesicle on the 10th day ; the streak of eye-pigment also appears on the same day.

P. mirabilis appears to breed all the year round in all the zones of the estuary. The eggs take 17–19 days in different broods to develop and hatch. The entire development and hatching took place when the water temperature in the aquarium ranged between 25 and 26°C in January 1958 and 28 and 29°C. in August 1958. The eggs which are deep orange in colour at the time of hatching, become lighter as the development advances, till finally they become almost transparent at the time of hatching. The measurements of the extruded eggs range from 0.54–0.61 mm. (long axis) and 0.41–0.46 mm. (short axis). The ventral plate and the embryonic structures make their appearance by the 4th and 5th day respectively. The streak of eye-pigment becomes visible on the inner border of the optic vesicle on the 9th day and the pulsation of the heart vesicle and the peristaltic movements of the liberated yolk become noticeable by the 10th day.

P. scabriculus appears to breed in the middle and upper zones from late July to January with a peak breeding period from August to November. The eggs take 20 days to develop and hatch into larvae at the temperature ranging from 22°–23.5°C. They are brownish-yellow when extruded, becoming lighter as development advances and measure 0.46–0.59 mm. (long axis) and 0.37–0.41 mm. (short axis). The ventral plate and embryonic structures appear on the 3rd and 4th day of development, respectively. The pulsation of the heart and the peristaltic movements of the liberated yolk are noticeable on the 11th day. On the inner border of the optic vesicle, the streak of eye-pigment appears on the 10th day.

Larval Development

Palaemon malcomsonii Stage I : (Fig. 8A and B). The larvae measure 2.06–2.28 mm. from the tip of the rostrum to the tip of telson. The rostrum is long and slender, bent towards the tip reaching more than half of the antennular peduncle. It measures 0.17–0.20 mm. from its base to the tip. Antero-lateral angles of the carapace are drawn out into small spines.

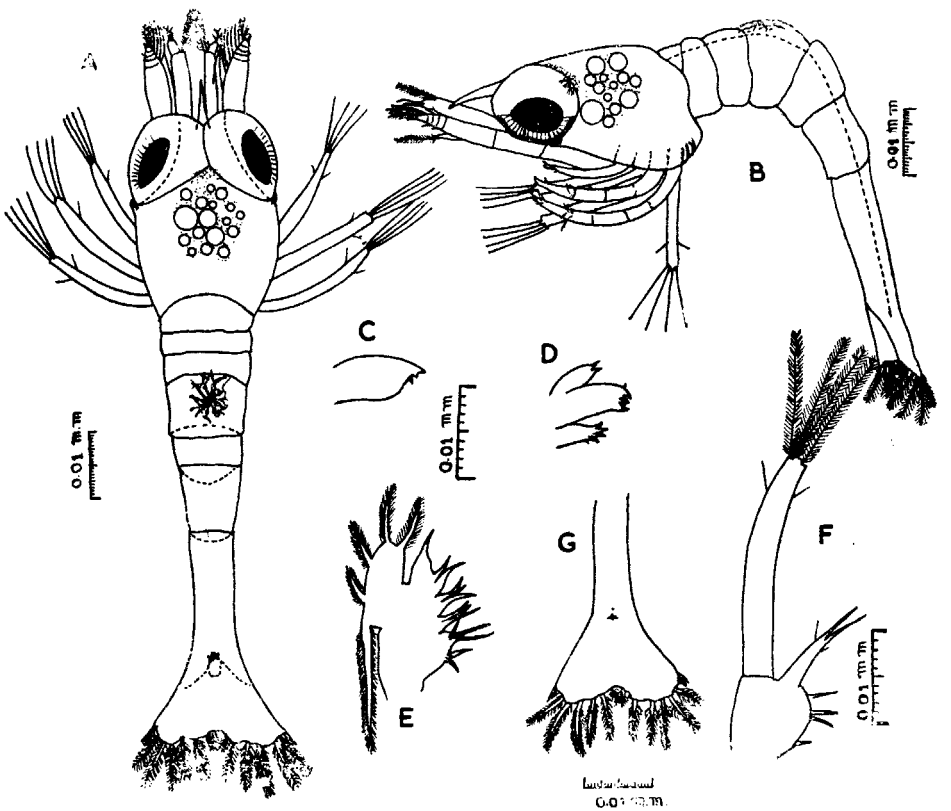


Fig. 8. A. 1st stage larva of *P. malcomsonii* : Dorsal view ; B. Lateral view ; C. Mandible ; D. Maxilla I ; E. Maxilla II ; F. Maxilleped I ; G. Telson.

Colouration : Under transmitted light, the larva appears transparent with light bluish pigment at the base of optic vesicles. A pigment spot of orange-red colour is seen at the base of each antenna and pink pigment on the oral region. There is a prominent orange-red dendritic chromatophore on the third abdominal segment, the branches of which extend on to the 2nd segment. A small chromatophore of the same colour at the base of telson. The eyes are large and sessile.

Antennule : The peduncle is long and unsegmented, with an outer unsegmented flagellum having 4 aesthetes and one short plumose seta. The inner flagellum is a long plumose seta.

Antenna : The peduncle has a small slender spine at the base. The flagellum starting from this region is elongated, unsegmented and about 2/3 as long as the antennal exopodite, terminally bearing a long plumose seta and a small spine. There are 4 annulations terminally on the exopodite and 10 setae along its inner margin and apex the most distal one of which is small and spine-like. On the outer margin are two very small setae and there is a small papilla at the base of the 1st seta on inner margin.

Mandibles : (Fig. 8C) are small and short. The upper incisor part has 2 teeth and a slender and long tooth below them. The molar part is smooth, free of any teeth. The mandibles of both sides are similar in shape and size.

Maxilla I : (Fig. 8D). The endopod (palp) is small carrying two terminal spine-like setae ; of the two lacinia (masticatory processes), the proximal one is narrow, less than half the size of the distal one. It carries 4 setae at its tip and one on its proximal margin, anteriorly. The distal process carries terminally 4 teeth, 2 of which are slightly larger, and a short seta.

Maxilla II : (Fig. 8E). The endopod has a terminal seta and a well-marked basal lobe carrying two setae. The protopodite with three masticatory processes each with three setae except the proximal large one, which carries 4 or 5 setae ; the exopod (scale) carries 5 plumose setae along its outer margin and apex, the most proximal one of which is the largest, and is directed backwards.

Maxilleped I : (Fig. 8F) has a slightly protuberant basis carrying 4 small setae on its outer margin. An unsegmented small and narrow endopodite carrying 3 terminal setae and a small one on its lateral margin. The exopodite has 4 plumose setae terminally and two setae, one on either side, a little lower down.

Maxilleped II : has a single seta on its slightly protuberant basis. The endopodite has four segments the last three of which are well demarcated. The third segment carries one seta on its margin and the last segment has 3 terminal setae and a basal one. Exopodite is as in the first maxilleped.

Maxilleped III : is similar to maxilleped II, except for the presence of 3 terminal and 2 basal setae on the last segment of endopodite. No setae are visible on the basis.

Pereiopods I and II : are large folded biramous rudiments behind the 3rd maxilleped.

Telson : (Fig. 8G). is broad with concave posterior edge. It carries 7 spines on each lobe, the third and the fourth being the longest and the 7th the smallest.

The 1st stage larvae of P. rudis, P. scabriculus and P. mirabilis

The I stage larvae in all the species, bear a very close resemblance to the corresponding stage described above and the stage described by Menon (1938) in *P. carcinus* and *P. rudis*. So, only the salient differences between I stage larvae of the various species including *P. rudis* (described by Menon 1938) are mentioned below :

P. rudis : The total length of the larva ranges from 1.92–2.06 mm. and that of the rostrum from 0.20–0.24 mm. The latter reaches to a little more than half of the antennular peduncle. The larva is transparent with light green yolk under the carapace. A tiny red spot at the base of the peduncle of antenna ; blue and pink pigment at oral region ; orange-red chromatophore on the mid-dorsal side of the third abdominal segment and pink and blue pigment around it.

P. scabriculus : The total length of the larvae ranges from 1.76–2.01 mm. and that of the rostrum from 0.19–0.20 mm.; the latter reaches to little more than half of the antennular peduncle. The larva is transparent with light brownish-yellow yolk under the carapace. The larvae that hatched from different broods

in the aquaria, as well as those from tow-net collections do not show the presence of any chromatophores. The only colour visible is the red and blue pigment in the oral region.

P. mirabilis : The total length of the larvae ranges from 2.02 mm.–2.27 mm.; that of the rostrum from 0.20–0.22 mm. The rostrum reaches to a little more than half of antennular peduncle. The larva is transparent with light yellow yolk under the carapace. In transmitted light, the chromatophores and pigment are distributed as follows : At the base of each eye a thin streak of brown pigment and an orange-red chromatophore; orange-red pigment at the oral region ; a large finely-branched orange-brown chromatophore, one on each side of the third abdominal segment, the branches of which ramify all over the segment and extend on to the preceeding and succeeding segments ; pink and blue pigment in the mid-dorsal region of the same segment ; a very small orange-brown chromatophore on the telson, where it joins the 6th abdominal segment.

P. mirabilis : (Fig. 9A) Stage II larva

As mentioned earlier, the larvae survived to stage II in *P. rudis*, *P. scabriculus*, and *P. mirabilis*. Description of stage II larva of *P. mirabilis* is given below :

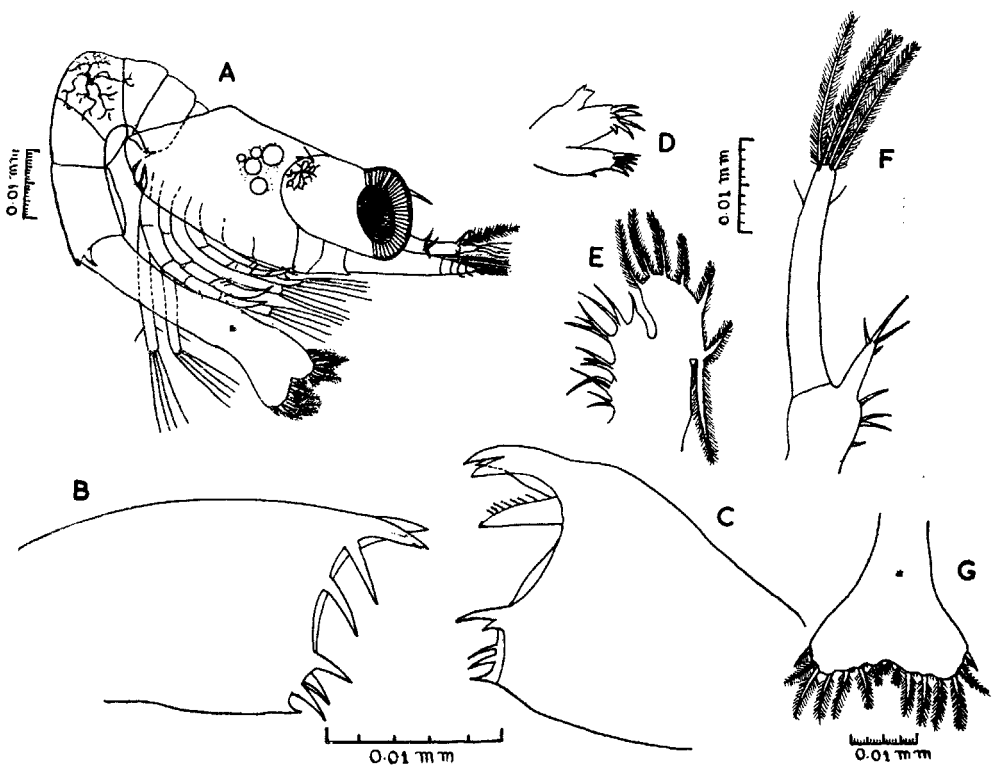


Fig. 9. A. 2nd stage larva of *P. mirabilis* : lateral view ; B. Mandible (right side) ; C. Mandible (left side) ; D. Maxilla I ; E. Maxilla II ; F. Maxilleped I ; G. Telson.

The 1st stage larva moulted at a temperature of 28°C. to the second stage, approximately 24 hours after hatching. The total length of the larva is 2.35 mm.

and that of the rostrum 0.31 mm. Rostrum reaches nearly to half the length of antennular peduncle. A pterygostomial spine is present at each antero-lateral angle of the carapace, and a supraorbital spine on either side at the base of rostrum. A pair of dorso-lateral spines are seen on the 5th abdominal segment. An additional pair of tiny setae appear on the telson between the innermost pair of stage I. Pereiopods I and II are functional and folded biramous rudiments of pereiopods III and IV are seen behind them. Eyes are stalked and freely movable.

Colouration : In addition to the chromatophores present in the stage I, orange-red pigment appears at the basal segments of all the maxillepeds as well as the first two pereiopods.

Antennule : The peduncle is segmented. The distal segment has two setae and the proximal one has a group of three setae terminally. Outer flagellum is unsegmented, bearing one plumose spine-like seta and 4 slender aesthetes. The inner flagellum is plumose and long.

Antenna : The scale (Exopodite) has 4 annulations distally and more than 10 setae on its inner margin and apex. Two small setae are present on its outer margin, and a papilla at the base of the first seta on its inner margin. The flagellum is long and slender with a spine opposite its base, and reaches to 2/3 the length of the scale. It has a long terminal plumose seta and a small spine.

Mandibles : The right and left mandibles differ slightly. The incisor part of the right mandible (Fig. 9C) bears 3 short blunt teeth and the molar part 4–5 slender teeth. Between the two, a large spine serrated on its margin is present. The left mandible (Fig. 9B), has 2 large teeth on the incisor part and a long slender spine. The molar part bears 4–5 small teeth; between the two is a long and slender, nonserrated spine.

Maxilla I : (Fig. 9D). The distal masticatory process carries 4 large and 2 small spines and the proximal one 4–5 very fine spines and a minute one on its margin anteriorly. The endopod has two spine-like setae terminally.

Maxilla II : (Fig. 9E). The scale (exopod) bears 7 plumose setae, of which the proximal-most one is the largest. Protopodite carries three masticatory processes, the first of which bears 4 to 5 setae and the rest 3 setae each. The endopod has a terminal seta and a basal lobe carrying two setae.

Maxilleped I : (Fig. 9F). Basis bears three to four setae on its margin. The endopodite is unsegmented with three terminal setae and one lateral one. The exopodite has 6 setae, four terminally and two lower down one on each side.

Maxilleped II : With five-segmented endopodite having 2 setae distally on its third segment and one laterally on the last segment. Exopodite is as in the Maxilleped I.

Maxilleped III : With two setae on the basis. The endopodite is five- segmented ; one seta is present on each of the first three segments, two setae on the fourth and 4 on the last segment terminally. Exopodite is as in the other maxillepeds.

Pereiopods I and II : With five-segmented endopodites ; one seta is present on each of the first three segments as above, and two on the fourth and last segments. Exopodites are as in the maxillepeds.

Pereiopods III and IV : Are folded biramous appendages.

Telson : (Fig. 9G). Is broad and on its concave posterior border are present 8 setae on each lobe, the innermost one being the smallest.

The larvae survived for one day without moulting.

Discussion

There are several points of similarity between the larvae of various species. However, some differences both in external features and morphometric characters do exist, by which it is possible to distinguish the larvae. Eight different morphometric characters as detailed in Table I and Fig. 11 are used in this study. *P. scabriculus* is different from all the other species in that it has no chromatophores on the third abdominal segment. *P. mirabilis* is characterized by the presence of one large dendritic chromatophore on each side, placed along the midlateral region of the third abdominal segment. The character that distinguishes both *P. malcomsonii* and *P. rudis* from the above two species is the presence of single large dendritic chromatophore placed middorsally on the third abdominal segment.

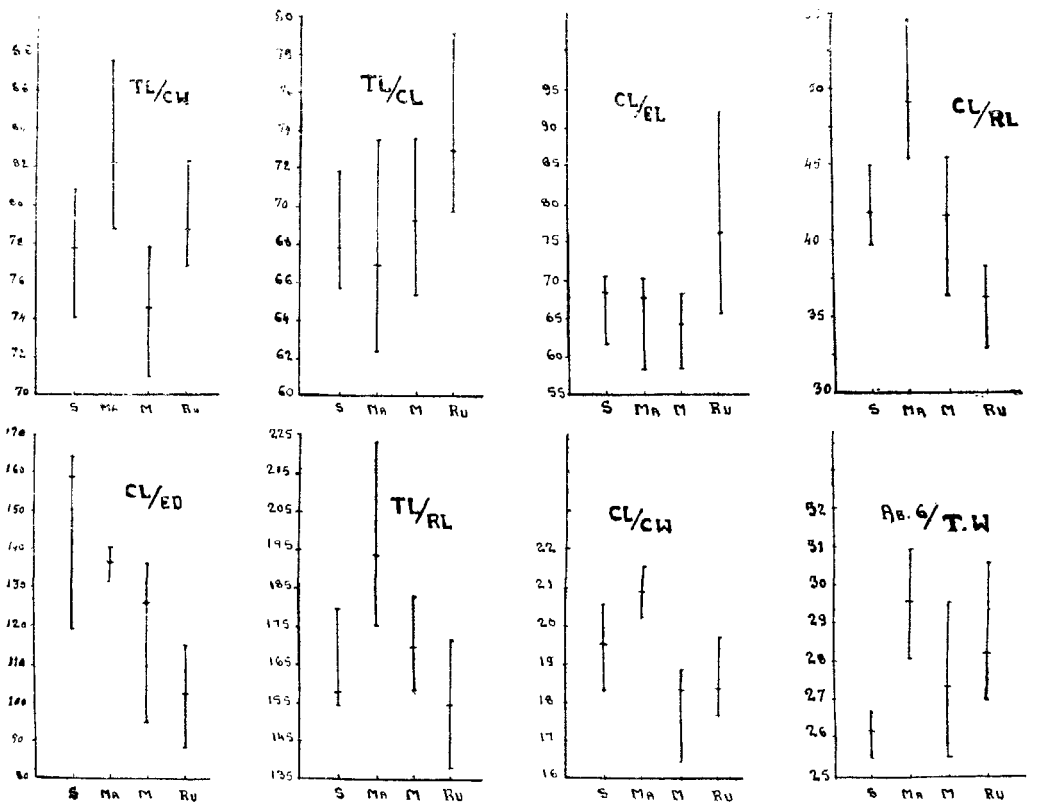


Fig. 10. Showing ranges and means of various morphometric characters—S : *P. scabriculus*; MA : *P. malcomsonii* ; M : *P. mirabilis* ; RU : *P. rudis*.

These last two species can be distinguished from each other only by the differences in certain morphometric characters, important among which are the ratios of Total length/Rostral length, "Carapace" length/Rostral length, "Carapace" length/Diameter of the eye pigment and "Carapace" length/width of cephalothorax at the region of eyes (vide Table I and Fig. 10). There are no significant differences

TABLE I

Showing the ranges and means of various morphometric characters

		P. scabriculus	*P. malcomsonii*	*P. mirabilis*	*P. rudis*
Total length/width of Cephalothorax at the region of eyes	Range Mean	74.12— 80.75μ 77.69μ	78.71— 87.55μ 82.11μ	70.89— 77.69μ 74.46μ	76.84— 82.28μ 78.71μ
Total length/"carapace" length	Range Mean	65.62— 71.74μ 67.66μ	62.39— 73.44μ 66.98μ	65.28— 73.44μ 69.19μ	69.70— 79.05μ 72.93μ
"Carapace" length/length of eyepigment	Range Mean	61.71— 70.38μ 68.34μ	58.48— 70.21μ 67.83μ	58.48— 68.00μ 64.33μ	65.62— 91.80μ 76.16μ
"Carapace" length/Rostral length	Range Mean	39.61— 44.88μ 41.82μ	45.39— 54.40μ 49.13μ	36.55— 45.39μ 41.65μ	32.81— 38.25μ 36.04μ
"Carapace" length/width of eyepigment	Range Mean	119.00—164.39μ 158.95μ	131.75—140.25μ 136.51μ	95.20—136.00μ 126.14μ	88.40—114.75μ 102.17μ
Total length/Rostral length	Range Mean	154.36—179.35μ 157.76μ	175.61—222.70μ 193.12μ	158.27—182.75μ 169.66μ	131.19—171.36μ 154.46μ
"Carapace" length/width of Cephalothorax at the region of eyes	Range Mean	18.36— 20.57μ 19.55μ	20.23— 21.59μ 20.91μ	16.49— 18.87μ 18.36μ	17.68— 19.72μ 18.36μ
Length of 6th abdominal Segment and telson/width of telson	Range Mean	25.50— 26.69μ 26.18μ	28.05— 30.94μ 29.58μ	25.50— 29.58μ 27.37μ	27.03— 30.60μ 28.22μ

in morphometric characters between *P. scabriculus* and *P. mirabilis* ; and *P. mirabilis* and *P. rudis*. *P. mirabilis* differs from *P. malcomsonii* in respect of "Carapace" length/width of cephalothorax at the region of eyes, and Total length/width of

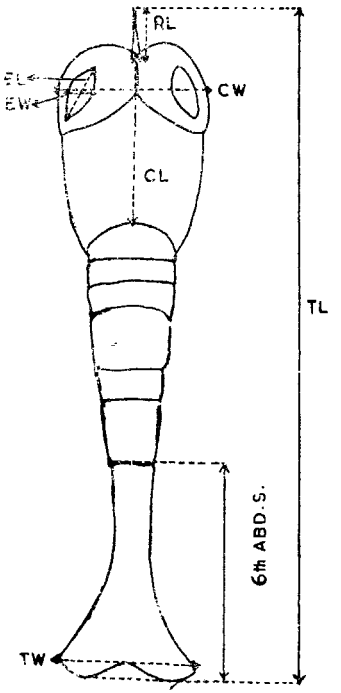


Fig. 11. Measurements used in this study.

cephalothorax at the region of eyes. *P. scabriculus* differs from *P. malcomsonii* in respect of "Carapace" length/Rostral length, and length of the 6th abdominal segment/width of telson ; and from *P. rudis* in "Carapace" length/Diameter of eye-pigment, and the length of the 6th abdominal segment/width of telson, and "Carapace" length/Rostral length. (vide Table I and Fig. 10).

Acknowledgements

The author is grateful to Dr. B. S. Bhimachar, F.N.I., for his keen interest in this work and to Dr. T. V. R. Pillay and Mr. V. R. Pantulu for going through the manuscript and giving helpful suggestions. Her thanks are also due to Mr. J. Ghosh for the help rendered in drawing the figures. She is thankful to the Government of India for having awarded the scholarship, during the tenure of which, this study was conducted.

References

Aiyer, R. P. (1949). On the embryology of *Palaemon idae* Heller. *Proc. zool. Soc. Bengal*, **2**, (2), 101–148.

Das, K. N. (1935). Developmental Stages of *Palaemon lamarrei*. H. M. Edw. *Proc. Indian Sci. Congr.*, 22nd (Abst.).

Faxon, W. (1879). On the development of *Palaemonetes vulgaris*. *Bull. Mus. comp. Zool. Harv.*, **5**, 303–330.

Henderson, J. R. and Matthai, G. (1910). On certain species of Palaemon from South India. *Rec. Indian Mus.*, **5**, 277–306.

Holthuis, L. B. (1950). The Decapoda of the Siboga Expedition. Part X. The Palaemonidae collected by the Siboga and Snellius Expeditions with remarks on other species. 1. Subfamily : Palaemoninae. Siboga-Exped. Leiden, 39a9 : 1–267.

John, M. C. (1947). Bionomics and life-history of *Palaemon carcinus*. *Proc. Indian Sci. Congr.* 34th. 177 (Abst.)

Kemp, S. (1917). Notes on Crustacea Decapoda in the Indian Museum. *Rec. Indian Mus.*, VIII, XIII (1–6), 43–58.

Menon, M. K. (1938). The Early larval stages of two species of Palaemon. *Proc. Indian Acad. Sci.*, B(4), VIII.

Nataraj, S. (1947). Preliminary observations on the Bionomics, Reproduction and Embryonic stages of *Palaemon idae* Heller. *Rec. Indian Mus.*, XLV(I), 89–96.

Tiwari, K. K. (1955). Distribution of the Indo Burmese Freshwater prawns of the genus Palaemon Fabr., and its bearing on the Satpura hypothesis. *Bull. nat. Inst. Sci. India.*, **7**, 230–239.

Von Schenkel, E. (1902). Beitrag zur Kenntnis der Deka poden fauna Von celebes. *Verh. naturf. Ges. Basel.*, **13**, 501–504.