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DECAPOD LARVAE FROM THE MADRAS PLANKTON—II

BY

M. KRISHNA MENON, M.A., M.SC.

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(*Published—November 1940*)

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DECAPOD LARVAE FROM THE MADRAS PLANKTON—II

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Two previous papers on this subject have been published by the author (1933 and 1937) and only those species that were represented by more or less complete series of larvae were dealt with in them. A large part of the material that had been collected was thus left out. A preliminary examination of it revealed the existence of larvae of a variety of species belonging to most of the important families of the order, and despite their incompleteness, a systematic study of them seemed well worth undertaking, especially in view of the fact that our knowledge of the larvae of Indian decapods is extremely unsatisfactory.

The total number of species is remarkably large and out of these, only those belonging to the Macrura are taken up in this paper, the Brachyura being reserved for a subsequent one. Full descriptions of all available stages are given in respect of every species dealt with. This plan has been adhered to even in the case of such species as *Lucifer hanseni* which has been previously described, not because such descriptions are incomplete, but because they are in foreign publications which may not always be available to future workers in this country. Lack of some of the earliest papers on the subject would have caused considerable difficulty in the course of the work, had it not been for the copious references to them contained in most of the recent publications.

I wish to express my deep indebtedness to Professor R. Gopala Ayyar, Director of the University Zoological Laboratory, Madras, for his help while working under him as a Research Scholar and for the loan of the material for completing this study. I should also thank Mr. K. H. Alikunhi, Research Scholar, for kindly procuring me some of the references.

Suborder NATANTIA.

Tribe PENAEIDEA.

Family PENAEIDAE.

Larvae of a large number of species of Penaeids have been already described ; but in most cases the determination of their parentage has been more or less guesswork, being based on evidence furnished by very young specimens or the larvae themselves. The usual method of keeping berried females under observation, in order to get the larvae hatched out is impracticable, since the female prawns in this family set their eggs free before hatching.

Consequently, though the general course of development is fully known, and the great variety of larval forms existing within the family has been amply demonstrated, it may yet be premature to attempt to define the larval characteristics of the various sub-families and genera, as has been done for several other families.

The larva hatches out as a Nauplius, but the number of moults it undergoes before passing into the next stage, namely, the Protozoea and whether this number is constant for the whole family are points remaining to be settled. Gurney (1927) has described 3 stages for *Penaeopsis stebbingi* and has remarked that there may be 4 stages as in *Solenocera*.

The number of Protozoea stages is 3 and seems to be constant not only in this family, but also in the closely related Sergestidae, a fact that has been indicated by Gurney (1927) and the present writer (1937).

The Protozoea is succeeded by the Mysis stage and it passes through at least 2 moults. Three stages have been described for *Gennadus* (Gurney, 1924) and *Penaeopsis stebbingi* (Gurney, 1927) and it is quite likely that other species may have more.

Of the four sub-families of the Penaeidae, larvae of only 2, Aristaeinae and Penaeinae, are known more or less satisfactorily. Gurney has attempted to point out the distinguishing characters of their Mysis stage (1924). A similar attempt with regard to their Protozoea may be rather premature, since, so far as I am aware of, we know fully only those of *Gennadus* in the sub-family Aristaeinae. Comparing its Protozoea with those of the Penaeinae it becomes at once apparent that the first Protozoea of both is more or less indistinguishable. In the second and third stages the rostrum shows some difference. In the Penaeinae (*Penaeus*, *Parapenaeus* and *Penaeopsis*) the base of the rostrum is considerably expanded horizontally, covering the proximal portions of the ocular peduncles, and the supra-ocular spines arise from the margins of this portion. Beyond this part it narrows abruptly and terminates slightly beyond the eyes. In *Gennadus* on the other hand the rostrum is long and gradually narrows to a point distally and the supra-ocular spines may or may not be present.

Again in the Penaeinae the last Protozoea possesses rudiments of all thoracic appendages while there is no trace of the last peraeopod in *Gennadus*.

Finally the dorso-median spine of the second abdominal somite is much longer than those of the others in the last Protozoea of *Gennadus*, a character which persists in the Mysis also.

In the present collection only one species, namely, *Solenocera crassicornis* belonging to the sub-family Penaeinae is represented.

Subfamily PENAEINAE.

Solenocera crassicornis, Milne Edward.

Larvae of 2 species of *Solenocera* are described by Gurney from the "Terra Nova" collection. In his account of the previous work on this genus he refers to the description of the larvae of another species, *S. siphonocera*, by Monticelli and Lo Bianco and also to the works of F. Muller (1863), Bate (1888), Ortmann (1893) and Stephensen (1923). Bate's *Platysacus crenatus* and Ortmann's *Opisthocaris mulleri* are larvae of this genus. Of the 2 species described by Gurney, one is from the Atlantic and the other, which he assigns to the species *S. novae-zealandiae*, from the Pacific. Of the 3 stages of the Atlantic species, the third is said to resemble closely the Mysis of *S. siphonocera* figured by Lo Bianco. The larvae described below obviously belong to the Mysis stage, the first being quite similar to stage 3 of the Atlantic species.

Stage 1—*Fig.* 1—*Total length* 5.5 *mm.*—This larva has a less spiny carapace than the Atlantic species ; but the spines seem to be comparatively larger.

Carapace is produced forwards into a long and pointed rostrum, reaching far beyond the tips of the antennules. There is a prominent spine at its base and behind it along the median line there are 2 more spines and 2 papillae. On either side of the rostrum there are large supra-ocular and sub-ocular spines and along the lateral margins are arranged a number (11—12) of teeth. The posterior margin carries 2 very large spines, one on either side of the median line, which are absent in the "Therra Nova" species. There are 3 more pairs of spines on the carapace, the most anterior of which corresponds to the hepatic spine of other forms, and is larger than the other two. The base of each spine of the posterior margin is continued forwards as a prominent ridge on either side of the middle line and at its extremity are placed the other 2 spines.

Each abdominal somite has a large median dorsal spine, a pair of lateral spines, another pair of ventro-laterals and a median ventral. The last mentioned is much smaller than the dorso-median, and the ventro-laterals are in the form of blunt teeth. The dorsal spine of the second somite is larger than the others but not as large as that of the Aristaeinae and in front of it, in all somites, there is a pair of small spines. The ventro-median and ventro-lateral spines are absent in the "Terra Nova" specimen.

Eyes.—Each ocular peduncle has a small tubercle on its dorsal side.

Antennule—Fig. 2.—Peduncle is two jointed, though the first joint of the adult appendage is faintly marked out. Along its inner margin and at the tip it carries a number of plumose setae. At the base the rudiment of the stylocerite is present and just above it there are 4 short setae in a row which have dilated bases. A little beyond this on the ventral side there is a large spine. Rudiments of both flagella are present ; the inner is shorter and is tipped with a long seta ; the outer carries 8 aesthetes and a short seta.

Antenna—Fig. 3.—A peduncle of two segments, an unsegmented flagellum, which is a direct continuation of the distal segment of the peduncle and a scale are present. Flagellum bears 3 setae on its outer margin and 3 more at the tip. Scale is fringed with 11 plumose setae, one of which is on the outer margin.

The mouth parts retain in a large measure the characteristics of the Protozoea stages.

Mandible—Fig. 4.—It has a short, apparently unjointed palp.

Maxilla I—Fig. 5.—Proximal endite is narrow while the distal is broad; both are armed with several setae. Endopodite has 3 segments, of which the first has 3 setae, the second 2 and the last 5. Exopodite is knoblike, bearing 4 plumose setae.

Maxilla II—Fig. 6.—Four endites are present, all of which are densely setose; the proximal being the largest. Endopodite of 5 segments; the first and the last having 3 setae each and the others 2. Scale is bordered with about 20 plumose setae, the hindermost of which is much larger than the rest.

Maxilliped I—Fig. 7.—Both coxopodite and basipodite are armed with numerous setae on their inner margin. Endopodite of 4 segments of which first and second have each a plumose seta on their outer margin. Exopodite has 9 plumose setae, 4 of which are on the outer margin, 2 at the tip and the remaining on the inner margin. A rudimentary epipodite springs from the coxopodite.

Maxilliped II—Fig. 8.—Coxopodite and basipodite have fewer setae on their inner margin. Endopodite is quite similar to that of maxilliped I. At the angle between endopodite and exopodite there is a plumose seta, absent in the preceding appendage. Exopodite has about 12 plumose setae. Besides an epipod rudiment, a gill rudiment is also present.

Maxilliped III—Fig. 9.—Only basipodite bears setae. Endopodite is much longer than those of the others, with correspondingly longer setae. It has 4 joints; first 3 have each 2 inner setae and 2 outer (first has only one) and last has 5 terminally. Exopodite has 18 plumose setae. Two gill rudiments besides epipodite are present.

Pereiopod I—Fig. 10.—Protopodite and endopodite are similar to those of maxilliped III, except in the fact that the tip of the latter shows a rudimentary chela. Exopodite has 18—20 plumose setae. Epipod and 2 gill rudiments are present in this and the succeeding 3 pairs of legs.

Pereiopods II and III are also chelate and quite similar to the first. Pereiopods IV and V are not chelate. Last leg has neither epipodite nor gill rudiments.

Abdomen.—Abdominal somites are without pleopods.

Uropods—Fig. 11.—They are well developed, having short protopodite and narrow elogated rami. A short spine is borne by the protopodite on its ventral side and a slender spine by the outer margin of the exopodite. Plumose setae are borne on both margins of endopodite and on inner margin of exopodite.

Telson is quite similar to the " Terra Nova " species. It is forked, the forks being long and slightly diverging at their extremities. A pair of small lateral spines are present in front of the forks and 2 pairs at the middle of their outer margins. Four pairs of setae are borne on their inner margin.

Last stage—Total length 7.25 *mm.*—The animal in this stage is in possession of well developed biramous pleopods on all abdominal somites. They are, however, without setae and are therefore not functional. The appendages of the cephalothorax are larger, but otherwise do not show much alteration, and hence there is no necessity to describe them individually.

Flagella of both antennules and antennae have grown considerably, the latter showing segmentation beneath the cuticle. Antennal scale has a short spine at the distal end of its outer margin and carries 22 plumose setae along its inner margin and tip (Fig 12). The fingers of the chelae of the legs are now approximately equal in length. Maxillipeds II and III and the first 4 pereiopods have each an epipodite and 2 gill rudiments at their base. The spines on the outer margin of the forks of the telson have disappeared, but otherwise it is unaltered.

It has already been remarked that the first stage described above is similar to stage III of the " Terra Nova " Atlantic species and corresponds in all essential respects to the first Mysis stage of *Penaeus indicus* (Menon, 1937), *Penaeopsis stebbingi* (Gurney, 1927) and other genera of the sub-family. There is therefore no doubt that it represents the first Mysis of the present species also. It is also equally certain that the other stage described above is the last Mysis stage. Whether there is an intermediate stage between the two is a question difficult to answer at present. The increase in size of the last stage over the first may indicate the presence of such a stage ; but it would then be very strange that no specimen of this stage was secured from the plankton although several belonging to the other stages were obtained. It may therefore be not improbable that there are only two stages after all.

In the character of the telson and in the presence of a terminal spine on the outer margin of the exopodite of the uropod, these larvae resemble the Atlantic specimens of the " Terra Nova " collection. At the same time there are important differences also, namely, the possession of large spines on the posterior margin of the carapace which, as has been already pointed out, is less spinous, and the presence of ventro-lateral and ventro-median spines on the abdominal somites. Gurney has pointed out that the telson and uropods of his specimen differed from those of *S. siphonocera*, but the uropods resembled those of Muller's

larva. The latter, however, has a much longer rostrum and shows a different arrangement of the spines on the carapace. The rostrum of the present form also is larger than that of the "Terra Nova" species, but whether there are any other resemblances, particularly in the arrangement of the spines, is a matter which could not be determined, since I could not get Muller's work. Henderson (1893) has recorded the occurrence of *S. crassicornis* in Madras; but it is apparently rare, since he obtained only one specimen. It may not be unreasonable therefore to refer these larvae to it.

Family Sergestidae.

Larvae of four out of the five genera belonging to this family are known. The larva hatches out as a Protozoea except in the case of *Lucifer* in which it is hatched out as a Nauplius (Brooks, 1882). These Protozoeae can be easily distinguished from the same stage of the allied family Penaeidae by means of the characteristic armature of the carapace, which bears in addition to the rostrum, a median posterior and a pair of postero-lateral spines. There may also be a pair of anterior processes; and all of them are branched in *Sergestes*. The number of moults through which the Protozoea passes does not seem to be uniform for all genera. In *Lucifer* Brooks has recorded 4 Protozoea stages for *L. faxoni*, while Gurney (1927) was able to obtain only 3 stages for *L. hanseni*. In *Sergestes* and *Acetes* (1933) there are only three stages, while in *Petalidium* (Gurney, 1924) there are apparently 4.

The moult by which the last Protozoea passes into the Mysis stage effects a profound modification in the appearance of the animal. The spines of the carapace may disappear or persist in a reduced condition and when compared with that of the Penaeidae the thorax and abdomen are comparatively quite slender, a character which may be of use to distinguish them from those of the former family. The number of Mysis stages also, like the Protozoea, seems to be variable. *L. faxoni* passes through 3 Mysis stages, while *L. hanseni* and *Sergestes* pass through only 2. *Acetes* and *Petalidium* are remarkable, since both of them have only a single Mysis stage.

In the first post-larval or Mastigopus stage following the Mysis, the animal assumes the typical Sergestid appearance with slender body and appendages. One interesting change which takes place during this moult is the reduction in the number of thoracic appendages. The Mysis of *Lucifer* and *Acetes* have only the 4 anterior pairs of pereiopods while that of *Sergestes* and *Petalidium* have all the 5 pairs. During the moult the fourth pair in the former and the fourth and fifth pairs in the latter disappear completely although both of these limbs are absent only in the adult of *Lucifer*. This has been already pointed out by me (1933) and is a quite interesting characteristic of the whole family.

A somewhat detailed comparison of the larvae of the 4 genera mentioned above has already been attempted (1933) so that it need not be repeated now.

In the present collection larvae of 2 species of *Lucifer* and one species of *Sergestes* are present.

Subfamily LUCIFERINAE.

Lucifer hanseni, Nobili.

As has been remarked above the first stage in the development of *Lucifer* is a Nauplius, which seems to pass through a moult before reaching the Protozoea stage. Brooks' species passes through 4 Protozoeal stages whereas *L. Hanseni* passes through only 3. In this collection only 2 stages are present, the earlier of which corresponds to stage II of the Suez canal form.

Protozoea Stage II—Fig. 13.—*Length* 8 *mm.*—There is a carapace covering only the first 2 segments of the thorax. It has a pointed rostrum in front and a median and a pair of lateral spines behind, the median being shorter than the others. On the ventral side the labrum has a small spine.

Paired eyes are seen as 2 large dark masses on either side of the base of the rostrum.

Antennule.—It is a long, slender rod, divided into 2 segments, the anterior of which is shorter. Proximal joint has a seta on the inner margin. There is another at the junction of the two and 4 at the tip and 1 on the outer margin of the distal segment.

Antenna—Fig. 14.—Protopodite is two-jointed. Endopodite is a simple rod bearing 2 setae on its inner side and 3 longer ones terminally. Exopod consists of 8 segments, of which the first 2 are shorter than the others. Segments 3—7 have each a seta on the inner edge and segment 8 has 4 terminal setae. A seta on the outer margin is present on segment 3.

Mandible—Fig. 15.—Palp is absent.

Maxilla I—Fig. 16.—Proximal endite is narrower than the distal. Palp is three-jointed ; joints 1 and 2 have a single seta each, and joint 3 has 2 terminally. Exopodite is knoblike and bears 4 plumose setae.

Maxilla II—Fig. 17.—Protopodite has the usual 4 endites. Endopodite has 4 indistinctly marked out segments of which 1 has 3 setae and 2 and 3 have 2 each and segment 4 four terminally. Exopodite similar to that of maxilla I.

Maxilliped I—Fig. 18.—Both coxopodite and basipodite have setose inner margins, the setae being arranged in groups of 2 or 3. Endopodite consists of 4 segments, the first of which has 2 setae ; the second and third have 1 each and the fourth has 4. Exopodite is an unsegmented process, shorter than the endopodite, and tipped with 4 plumose setae below which, on its outer edge, there is a row of fine hairs.

Maxilliped II—Fig. 19.—Coxopodite is unarmed ; basipodite has but 2 setae. Endopodite short and two jointed. Exopodite similar to that of Maxilliped I.

Maxilliped III.—It is a small oval rudiment.

Behind this the next 4 thoracic segments and the first 4 abdominal somites are marked out, of which the last of the thorax shows a ventral groove as in the Suez canal form, indicating that it represents the undifferentiated seventh and eighth somites. Small rudiments of the 4 anterior peraeopods and uropods are visible below the cuticle of the ventral side.

Telson is slightly indented at the middle of its posterior margin and bears on each side of this notch 5 setae, the outermost of which is on the outer margin. A pair of small spines are present on either side of the anus which are regarded by Gurney as belonging to the telson, but which have been moved ventrally.

Stage III—Fig. 20—*Length* 1—1.2 *mm.*—Carapace is unaltered. Lateral eyes are quite prominent and pigmented, but not yet free from the carapace. The spine of the labrum is still present.

The appendages of the preceding stage persist in much the same condition so that detailed description of them is unnecessary. Maxilliped III is a large biramous rudiment, but without setae. Behind it there are 4 pairs of biramous rudiments, representing the first 4 pairs of legs, the last of which arise from the front half of the last thoracic somite in front of the groove : All the abdominal somites are well differentiated, but only the uropods have developed, and they are, however, not functional. The spines on either side of the anus have disappeared ; but a pair of large setiform spines have appeared in front of the uropods.

It may be seen from the account given above that these larvae are identical with those of *L. hanseni* from the Suez Canal. According to Hansen (1919) this species is widely distributed in the Indian ocean and has been recorded from several places in the Bay of Bengal. Though adult specimens are absent in this collection about half a dozen half-grown ones are available for study. They measure 5 mm. in length and seem to belong to one species. Their most important characters are given below.

Eye-stalks are short and both eye and stalk together form roughly an inverted cone (Fig. 21). The distance from their base to the insertion of the labrum is $2\frac{1}{6}$ times the length of the eye and stalk. First joint of the antennular peduncle is slightly longer than the other two together. Exopod of uropods is a little more than 3 times as long as broad (Fig. 22) and the spine on its outer margin stops considerably behind the tip. These characters, particularly the broad exopodite of the uropods, seem to indicate that the specimens under consideration may belong to *L. hanseni.* For the reason of the adult being found in the same locality and of the extreme similarity of the larvae I have identified the Madras forms as belonging to the same species.

Lucifer sp.

Among the larvae described above were a few specimens differing from them in a striking manner, namely, in the absence of the median posterior spine of the carapace. In this respect they differ from the Protozoea of *L. faxoni* also (Fig. 23). Further, they have a more robust body than that of *L. hanseni*. The appendages, however, show no difference worth recording. The differences noted are, however, of sufficient importance to justify them being regarded as belonging to a different species. Besides *L. hanseni*, two more species, namely, *L. reynaudi* and *L. acestra* are found in the Bay of Bengal. Kemp records that the first 2 of these were frequently found in the same haul and it is therefore likely that this larva may belong to *L. reynaudi*.

A number of larvae belonging to the Mysis and Mastigopus stages are also present in the collection. But they are all so much alike that it is impossible to determine whether all of them belong to the same species or to more than one. There is, however, very little doubt that many of them belong to *L. hanseni*. Since they cannot be isolated a general account of the successive stages is given below without referring them to any species.

The earliest stage corresponds to the first Mysis of *L. hanseni* and therefore may be taken to belong to the same stage.

Mysis—Stage I—Fig. 24—*Length* 2 *mm.*—The body has assumed the characteristic slender appearance of the Sergestidae. The rostrum is slender and pointed and projects slightly beyond the extremity of the eyes. Sub-orbital spines are large and prominent, but there are no supra-oculars and the labral spine of the Protozoea persists with little change.

Eyes are now free.

Antennules.—They consist of a peduncle of 2 segments and a single flagellum carrying 4 aesthetes and 1 or 2 setae.

Antenna—Fig. 25.—Scale is narrow, not much longer than the flagellum, and has few setae.

Mandible is similar to that of the Protozoea.

Maxilla I—Fig. 26.—Segmentation of the palp is not so clear as in the Protozoea. Exopodite has the same number of plumose setae, though they are reduced in size. (In *L. hanseni* there are only 2.)

Maxilla II—Fig. 27.—Endites and endopodite are hardly changed. Exopodite persists as a reduced vestige with no setae.

Maxilliped I.—It is also not much altered.

Maxilliped II—Fig. 28.—Endopodite is now much longer and three jointed ; segments 1 and 2 have each 1 seta and segment 3 has 4 terminally. Exopodite carries 10 plumose setae.

Maxilliped III and the following 4 pairs of legs (Fig. 29) are now fully developed with functional exopodites and endopodites. The latter consist of 4 segments, except that of leg 4, which has only 3. The first, second and last joints carry setae. Exopodites have 10-12 swimming setae. Leg 5 is absent.

Abdomen is elongated, almost 3 times as long as cephalothorax, and in this respect the larva is quite similar to that of *L. hanseni*. The first 5 somites are about equal in length, while the sixth is twice as long as these. All have a pair of small lateral spines and the sixth has a median spine also dorsally. Somite 1 has a small lateral process at its front end, which overlaps the hinder end of the carapace.

Pleopods are absent ; but uropods are functional with clearly developed protopodite and setose exopodites and endopodites. The former has a small spine at the extremity of its outer margin.

Telson—Fig. 30.—It is long and narrow with parallel sides, thus resembling that of Penaeids. The posterior margin has practically no median notch and is armed with 8 spines. A pair of small lateral spines are present at about the middle of the telson.

Mysis Stage II—Length 2.5 *mm.*—This is the only other Mysis represented in the collection, and its size and the general development of its appendages show that it is very likely the next, in which case there are only 2 Mysis stages for these forms.

The body, especially the abdomen, is very much compressed laterally, thus approximating to the condition of the adult. Carapace (Fig. 31) has a hepatic spine also on each side, in addition to the spines of the previous stage, and presents a well-marked cervical groove at the middle.

So far as the cephalic and thoracic appendages are concerned the only development worth noting is that of the antenna, the flagellum of which is now more than twice the scale in length, and is distinctly jointed, while the latter has a spine at the extremity of its outer margin.

In the abdomen somite 6 is slightly longer (about 2½ times as long as somite 5) and the preceding 5 segments are now provided with uniramous pleopod rudiments.

Mastigopus (Post-larval)—Stage I—Length 3.2 *mm.*—The animal has now attained the characteristic appearance of the adult. Carapace (*Fig.* 32) has a supraocular spine also. The portion of the cephalothorax between the antenna and the labrum has elongated to form the " neck " of the adult and is approximately as long as the hinder part.

Only the first 3 pairs of peraeopods are now present, the fourth pair having disappeared during the moult from the last stage. But minute vestiges of these legs and of the exopodites of the preceding 3 pairs are still to be seen.

Pleopods are now functional, having several plumose setae at the extremities of their exopodites. Endopodites are present as small papillae and in this respect these larvae differ from the same stage of *L. hanseni*, in which the pleopods are still uniramous and remain so even in the next stage.

Subfamily SERGESTINAE.

As remarked on a previous page larvae of 3 genera, namely, *Sergestes*, *Acetes* and *Petalidium* belonging to this sub-family are fully known and since they exhibit such marked variation from one another it is not necessary here to attempt to set forth the characters of each. Of these *Sergestes* and *Acetes* are represented in this collection. A species of the latter (*A. erythraeus*, 1933) has been already studied in detail by me in a previous paper, so that only the former need be taken up here.

Sergestes orientalis, Hansen.

Larvae of a large number of species of this genus have been described by various authors. The first stage is a Protozoea which has been described under the name of *Elaphocaris* by earlier workers and this passes through 2 moults. There are 2 Mysis stages (the *Acanthosoma* of older writers), the last passing into the Mastigopus. There is only a single specimen in this collection and it belongs to the second Mysis stage. A figure of the entire specimen with a brief description of those characters that could be made out from the entire animal is given below, not because it presents anything strikingly new, but because even such a fragmentary account may not be without interest, since our knowledge of the larvae of Indian and Pacific forms is so imperfect.

Mysis—Stage II—Fig. 33—*Length about* 2.5 *mm.*—Carapace has a forwardly directed rostrum which is, however, broken. From its base a prominent spine projects upwards. Some distance behind it there is a median papilla. Large supra-ocular and hepatic spines bearing a number of small spinules arise from the anterior portion, the former being slightly longer than the stalked eyes. Laterally there are prominent anterior and posterior processes, both of which are branched and posteriorly there is a median process bearing spinules.

Abdominal somites have conspicuous median spines dorsally, those of 3 and 4 being the largest. From the lower margins of the pleura of each segment arise a pair of equally prominent spines, which project obliquely forwards, except those of the fifth and sixth. The latter are small and project downwards. Besides these, the first 5 somites have short median spines on the ventral side between each pair of pleopods.

Eyes have long stalks and reach almost up to the end of the antennular peduncle.

Antennule.—It is long and slender. The third joint of the peduncle is shorter than either of the other 2, although the first is only indistinctly marked out.

Antenna.—Flagellum is long and jointed. Scale also is long and narrow and its outer margin is drawn out distally into a prominent spine bordered with small spinules.

All thoracic appendages are well developed with functional exopodites and jointed endopodites, among the latter, that of the third maxilliped being much longer than those of the rest ; its tip reaches to the base of the rostrum. None of the legs are chelate in this stage.

Pleopods are uniramous and functionless. In the uropods both exopods and endopods are long and narrow, the former bearing setae on both margins except at the proximal part of the outer, the length of this being less than a fifth of its total length.

Telson is short and forked, the 2 forks being drawn out as spines.

Gurney (1924) has classified the numerous larvae described under the name *Elaphocaris* into 3 types, namely, *Elaphocaris dohrni*, *E. ortmanni* and *E. hispida*. They differ from one another, especially in the armature of the carapace. When the last *Elaphocaris* changes into the *Acanthosoma* the differences between the 3 types are not quite so pronounced, so that it is difficult to connect one type of *Elaphocaris* with its corresponding *Acanthosoma* from plankton material. Nevertheless he has described 2 types of *Acanthosoma* which he believes to belong to the 2 *Elaphocaris* types *E. hispida* and *E. dohrni*. The *Acanthosoma* described above resembles his *A. dohrni* (1924) and seems to belong to that type, since the lateral processes of the carapace (much larger in this form) are branched in the same way as those of the *Elaphocaris* of this type. It cannot, however, belong to the same species on account of the following differences :—

1. It is considerably smaller than the 'Terra Nova' specimen.
2. The ventro-lateral spines of abdominal somite 5 are not in the form of points.
3. The median ventral spines of the first 5 abdominal somites do not seem to be present in the latter, since no mention of them is made in the description.
4. The smooth basal part of the outer margin of the exopod of the uropod in this form is less than a fifth of its total length, while it is about a third in the other.

It has been remarked that the *Acanthosoma* also of those species, which have long third maxillipeds in the adult, has this appendage proportionately longer than the rest. The present specimen therefore seems to belong to such a species. Hansen (1919) has figured and described the *Acanthosoma* of *Sergestes orientalis*, with both of which my specimen agrees remarkably closely, the only difference worth noting, being the absence of the pair of lateral protuberances on the first abdominal segment of this form, and its comparatively larger carapace spines. The latter may, after all, be only a difference of age, since his larva seems to be older than this. It would seem therefore that the two differ only in the presence or absence of the abdominal process mentioned above. This *Acanthosoma* should thus belong either to the same species or a closely allied one. The same author has remarked

that *S. orientalis* is so closely similar to *S. edwardsi* that only a study of the petasma could reveal features sufficiently important to separate the two species. But the latter has not yet been recorded from the Indian ocean and hence I venture to refer this larva also to *S. orientalis*.

The Mysis stage of the Penaeidea.—When studying the larval history of the members of this tribe one is struck with the profound change that comes over the larva during the transition from the Protozoea to the Mysis stage. As the literature on the subject includes accounts of several genera, it may not be without interest if a comparative study of this stage is undertaken with a view to discover its distinguishing characters.

The following are the species, the Mysis of which is known to the present writer :—

Penaeidae—

Aristaeinae—*Gennadus sp. ; Hepomadus sp. ; Benthesicymus sp.*

Penaeinae—*Penaeus indicus ; Penaeopsis stebbingi ; Penaeopsis sp. ; Parapenaeus sp. ; Solenocera* (2 species).

Sergestidae—

Luciferinae—*Lucifer* (3 species).

Sergestinae—*Sergestes* (numerous species) ; *Acetes erythraeus ; Petalidium.*

Besides the striking change of body form, some of the appendages also show noticeable differences from those of the Protozoea. The antennules and antennae which served as locomotor organs in the Protozoea have no longer to perform that function and have accordingly assumed, though imperfectly, the adult type of structure. The mouth parts also are changed ; but this change is not uniform and hence the information available regarding them is summarised below.

Gennadus.—Mandible with or without palp ; maxilla I with no exopodite and reduced endopodite ; maxilla II similar to adult appendage ; maxilliped I with endites on the protopodite as in the adult.

Hepomadus and *Benthesicymus.*—Nothing is known.

Parapenaeus.—Nothing is known.

Penaeopsis.—Mandible with rudimentary palp ; maxillae and maxillipeds differ but little from those of the Protozoea.

Penaeus.—Mandible without palp in the first stage ; maxilla I identical with that of the Protozoea ; maxilla II and maxilliped I very similar to those of *Penaeopsis.*

Solenocera.—Mandible with palp ; maxillae and maxilliped I like those of the two preceding forms.

Lucifer.—Mandible, maxillae and maxilliped I are scarcely altered from those of the Protozoea, except for the absence of setae from the exopodite of maxilla II.

Sergestes.—Mandible with small palp ; maxillae as in Protozoea with the exception of exopod of maxilla II which has only 1 seta.

Acetes.—Mandible without palp ; maxillae and maxilliped I are degenerated, but have the same parts as those of the adult appendages.

Petalidium.—Mandible with palp ; maxillae and maxilliped like those of Acetes.

It is evident from this summary that in the Penaeidae only *Gennadus* shows change in mouth parts, while in all the other genera they, particularly the maxillae and the first maxilliped, retain their Protozoeal character. With reference to this peculiarity in *Penaeopsis stebbingi* Gurney has remarked that the " development is remarkable for the absence of an abrupt transition from the Protozoea to the Mysis stage, such as is found in *Gennadus*, and development must be regarded as to this extent more primitive than in *Gennadus*." Similarly in the Sergestidae the genera *Lucifer* and *Sergestes* conform to the type illustrated by *Penaeopsis* while *Acetes* and *Petalidium* show a sharp transition from Protozoea to Mysis as shown by *Gennadus*. It would therefore seem that the evidence so far available does not permit of a precise definition of this stage as is possible for the Protozoea, a fact that has been emphasized by Gurney in his report on the " Terra Nova " collection. At the same time the statement that the metamorphosis of the Penaeidae involves a double transformation of the appendages (between the Ptotozoea and Mysis and between the latter and the first post-larval stage) seems to have only a limited application since, as already pointed out, it is true only for *Gennadus*.

Regarding the rest of the appendages there is no such divergence. The posterior thoracic appendages attain their maximum larval development, with functional exopodites carrying swimming setae and jointed endopodites. The abdominal appendages also are well developed, at least in the later stages, though they become functional, except uropods, only in the post-larval stage.

The Mysis of the Penaeidea thus seems to be characterised by the following features :—

1. An elongated, somewhat laterally compressed body, more or less similar to that of the adult Natantia.
2. Antennules and antennae have essentially the same form as the adult appendages.
3. All or the anterior 4 pairs of thoracic legs are biramous with functional exopodites.
4. Pleopods absent in the early stage ; in later stages present but functionless ; uropods functional throughout.

All these characters are shared by the Caridea and other groups which pass through such a stage. But the second and fourth are possessed by groups of Reptantia which do not pass through a Mysis stage and the first is possessed even by the early stages of the

Caridea and other tribes. It thus appears that the only character which belongs exclusively to this stage is the possession of exopodites on all or some of the ambulatory legs (the statement applies only to larvae). But Gurney has remarked (1924) that if the term Mysis is to be retained in larval nomenclature "it must certainly not be founded on the presence or number of exopodites." It is, however, the only character peculiar to it, and the name, when used, could only refer to the stage in possession of one or more biramous walking legs. As to the question of the advisability of retaining the term the writer does not feel competent to pronounce a definite opinion on it, since the significance of the character on which the name is based is questioned by so competent an authority. It may, however, be pertinent to invite attention to the following facts :—

1. In the Sergestidae exopodites are developed even on legs which disappear during the moult to the Mastigopus stage.
2. Among the Reptantia a stage possessing one or more biramous legs is passed through by members of the higher groups, such as Thalassinidea (of the Anomura) and Dromiacea (in the Brachyura).
3. It is admitted by all that the presence of these biramous legs during the development of these forms is clearly an indication of their primitive nature.

In the light of these facts it seems to me that the appearance of exopodites on the walking legs may not be without significance.

The summary of the characters of the Mysis of the Sergestidae brings to light the fact that in the metamorphosis of 2 genera, namely *Acetes* and *Petalidium*, the mouth parts undergo a considerable change during the moult from the Protozoea to the Mysis and to this extent therefore they resemble *Gennadus*. Since this type of development is considered to be more advanced, there may be some justification for their separation from the other genera so as to form a new sub-family, the original Sergestinae then containing, till something is known of the development of *Sicyonella*, only the genera *Sergestes* and *Sicyonella*.

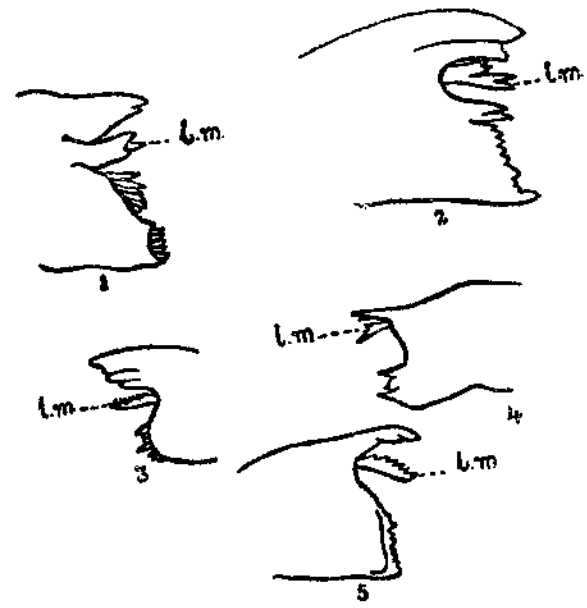
In the case of the Penaeidae, however, the evidence of the larval characters seems to be opposed to the evidence yielded by adult structure. Of the 4 sub-families nothing is known of the larvae of 2, namely, Sicyoninae and Cerataspinae. Of the other 2, in the Aristaeinae the Mysis is sharply different from the Protozoea and so the development should be taken to be more advanced than that of the Penaeinae in which the transition from the latter to the former is not abrupt. Adult structure, on the other hand, proves that in the Penaeidae, Aristaeinae is the most primitive. The choice between the 2 sets of conflicting evidences in the determination of the problem is difficult and the writer's purpose in referring to it is to focus attention on it.

Tribe CARIDEA.

In the Caridea generally the larva hatches out as a Zoea, characterized by the following peculiarities :—

1. Eyes are not stalked.
2. Carapace without spines.
3. All three pairs of maxillipeds well developed and biramous with functional exopodites.
4. Telson with 7 spines on each side.

The last character, of course, is not peculiar to Caridea ; but Gurney has pointed out that in the embryonic telson there are only 6 spines on each side, a character which is, with the exception of some Penaeidea, quite distinctive of the tribe. This is, however, an embryonic character and cannot therefore be made use of for identifying free-swimming larvae. A character which is of some interest and which is exhibited in all stages by all those forms that I have studied may be appropriately noted here. It concerns the mandibles. These appendages on the two sides are slightly asymmetrical. On one side, as shown in text fig. 1, between the incisor and molar processes, but close to the former, there is an additional blade (l.m.) or a group of 3 or 4 spines which are serrated on their lower sides



MANDIBLES OF CARIDEA.

1. Mysidacea.
2. Pasiphaeidae.
3. Palaemonidae.
4. Alphaeidae.
5. Hippolytidae.

and seem to be movable. Below them there may be a varying number of spines, the former very likely belonging to the same series but slightly modified. On the opposite side only the spines are present. This blade is inconspicuous and hence is easily overlooked in the first stage, except in larvae of comparatively larger size. But in the later stages it is quite easily made out. It has been noticed in the larvae of the following families ; Pasiphaeidae (*Leptochela*), Palaemonidae (*Palaemon*), Alphaeidae and Hippolytidae. Such a structure, so far as the author is aware of, has not been met with in any other group of decapods. It may, in all likelihood, be a character shared by all Caridean larvae, but until more larvae belonging to other families also are examined nothing can be definitely said on this point. The blade referred to above resembles very closely the " lacinia mobilis " of the Mysidacea, Isopoda and Amphipoda. In the first order it differs in form on the two sides, while in the two latter it is serrated and is present always on the left side (text fig. 1). It is absent in the adult Euphausiacea, but spines of the same kind are developed in some of the larvae. A comparison of the figures shows clearly that this accessory blade in the case of the Caridean mandible should also be considered as a lacinia mobilis, and if that is so the opinion of Boas and Hansen that it is characteristic of the divisions of the Malacostraca in which the development takes place in brood pouches cannot be true.

The presence of such a structure in these larvae is undoubtedly a primitive character, and is highly interesting since it is absent in the adult appendage and in the larvae and adults of the other tribes. It seems to strengthen the view put forward by Gurney (1924) that " the evidence to be drawn from a study of the larvae tends to emphasize the primitive nature of the Caridea, etc."

In stage II the eyes become free and spines when present appear on the carapace, while in the next the uropods appear. In all those forms where larval life is not abbreviated the developmental course traced above holds good for the first 3 stages. The subsequent course may be completed in one or several more stages during which some or all of the remaining thoracic appendages become biramous and the pleopods are also developed.

One peculiarity which has been noticed by previous workers is the striking general resemblance of these larvae and the consequent difficulty to discover characters which distinguish the various families. Except in a few cases, e.g., the Alphaeidae, it is extremely difficult to assign larvae to their respective families and genera even after careful study of the appendages and hence the works of Gurney, Miss Lebour and Miss Webb, who have tried to draw up family and generaic characters after careful comparative study, are of great help to workers on this group. Larvae of only 3 families are found in the present collection. They are the Hippolytidae, the Alphaeidae and the Palaemonidae comprising four, two and one species respectively.

Family HIPPOLYTIDAE.

In an excellent paper on the Hippolytidae (1937) Gurney has given a summary of the characters of the various genera studied so far and the identification of the following forms is based on it. Though only a few stages are available for each species they are described here with the object of elucidating how far they differ from the foreign forms.

So far as known, the larvae of 2 genera, *Lysmata* and *Hippolysmata* are quite distinct from the others of the family and are characterized by the possession of long ocular peduncles and enormously large fifth thoracic legs, the penultimate joint of which is expanded into a paddle-like structure. Further, in *Lysmata*, it is also known that this leg develops precociously, in as early a stage as the second, when legs 3 and 4 are completely absent and leg 2 rudimentary.

Numerous such larvae have been described by various authors under the name *Eretmocaris*, first used by Bate. Gurney has summarized in his recent paper on this family the early literature concerning this larval genus, and has described several new types obtained from the Red Sea, the Great Barrier Reef and the "Discovery" Expedition collection.

Hippolysmata sp.

Stage I—Fig. 34—*Length about 2 mm.—Eyes* are sessile. Carapace has a long slender rostrum, which reaches considerably beyond the extremity of the antennular peduncle. Its lateral margin carries in front a well developed pterygostomial spine and behind it 3 small teeth. Abdominal somite 5 has a pair of spines on its posterior margin.

Antennule—Fig. 35.—Peduncle unsegmented ; Outer flagellum with a short plumose seta and 4 aesthetes, one of which is expanded distally as in the species described by Gurney (1937). Inner flagellum represented by a short plumose seta.

Antenna—Fig. 36.—Flagellum is small and carries at its tip a long plumose seta. Scale has 4 distinct segments terminally and carries 10 setae on the inner margin and tip, the one at the extreme tip being little more than a spine. Two short setae are borne on the outer margin.

Maxilla I—Fig. 37.—Palp unsegmented, with 5 setae, two on the inner margin and three at the tip.

Maxilla II—Fig. 38.—Proximal endite very broad and roughly semi-circular in shape, from which the second is separated by only a small notch. Endopodite unsegmented with 6 setae on the inner margin and 3 at the tip. Scale has 5 large plumose setae.

Maxilliped I—Fig. 39.—Both coxopodite and basipodite are large and armed with several setae. Endopodite of 4 segments armed with 3, 1, 2 and 3 setae respectively. Exopodite has 3 terminal setae and 1 on the outer margin.

Maxilliped II—Fig. 40.—Coxopodite is reduced and unarmed ; basipodite has a few small setae. Endopodite has only 3 segments, the last of which has 5 terminal setae and 1 on the outer margin near the base. Exopodite is very long and bears 3 terminal and 4 lateral setae.

Maxilliped III—Fig. 41.—Endopod is much longer than those of the two anterior pairs ; but consists of only 3 joints. Exopod has 3 terminal and 6 lateral setae.

Behind this appendage there are small rudiments of the first or the first two legs.

Abdomen has 5 somites and the telson. The latter (*Fig.* 42) is broadly triangular with its posterior margin deeply indented in the middle and carries 7 spines on either side, one of which is on the lateral margin.

In the nature of the carapace, telson and the appendages this larva is identical with that of the Red Sea (R.S.I.) and hence I have referred them to the same genus.

Stage II—Fig. 43.—The material contained only a single specimen of this stage. Eyes have now rather long peduncles, the length of the latter being about half the whole appendage. Carapace is equal to the eyes in length and has a slender, long rostrum, reaching beyond the tips of the ocular peduncles. It is curved at its base and behind it there is a prominent papilla. The pterygostomial spine and the marginal teeth of stage I are still present and a small supra-orbital spine has also made its appearance.

Antennule.—Base of the peduncle is swollen on the outer side. Distally it bears the large plumose seta of the previous stage and 2 shorter setae arising from the opposite side and passing to the dorsal and ventral sides respectively (Fig. 44), a character noted by Gurney also. Flagellum lacks the plumose seta and has only 5 aesthetes, one of which is expanded distally.

Antenna.—Ten setae are borne by the scale now ; otherwise there is no change.

Exopods of maxillipeds with 4 terminal setae and 2, 6 and 8 lateral setae respectively.

Behind maxilliped 3 there are rudiments of the first two legs, that of the first being biramous.

Abdominal somites retain all characters of the last stage. Telson (Fig. 45) has 8 spines on each side ; but is otherwise unaltered.

The differences between the Madras form and the Red Sea species are the following :—

(*a*) The curvature of the rostrum.

(*b*) The prominent median papilla behind it.

(*c*) The presence of 2 leg rudiments.

Later stages of this species are absent.

Lysmata sp.

Stage IV—Fig. 46—*Length slightly over* 3 *mm.*—This stage also is represented by only a single specimen. The rostrum of the carapace is quite similar to that of stage 2 of the last species. In the place of its papilla there is a prominent hook-like, procurved spine as shown in the figure. Supra-orbital spine is absent; but small antennal and pterygostomial spines are present. Lateral margin of the carapace is devoid of teeth. Peduncle of the eye is less than half the total length. Antennule with only the distal joint of the stalk cut off. Two short flagella are present both of which are three-jointed. The outer has the expanded aesthetes possessed by the previous species also.

Flagellum of the antenna is considerably reduced (Fig. 47). Scale does not show any trace of segmentation and carries 17 plumose setae and a spine at the tip; no setae on the outer margin.

Endopodites of maxillipeds in much the same condition as they were in stage II of the previous species. All thoracic legs, except the fourth, are well developed; the first 3 with functional, setose exopodites and jointed endopodites. Leg 4 is still a small biramous rudiment (Fig. 47). Leg 5 is lost on both sides.

Abdominal somite 5 has no spines on the dorsal side. Uropods are well developed with distinct protopodite and setose rami.

Telson (Fig. 48) is long, with parallel sides, the length being 2½ times its width. Posterior margin is distinctly concave and carries seven spines on each side. A pair of small spines are borne on the lateral margins. Anal spine is absent.

Stage VI—Total length about 4 *mm.*—Of this stage also there was only one specimen. Carapace possesses all of the spines present in stage IV. A number of grooves are seen on its surface, but are too indistinct to be figured accurately.

Antennule.—Proximal joint of the peduncle is also cut off, and it has a broad blunt rudiment of the stylocerite.

Antenna.—Flagellum is about 2/5 of the scale in length. The latter is long and narrow and has 22 setae on its inner margin and tip besides the spine at the extremity of the outer margin.

Maxillipeds and legs are more or less as they were in stage IV. Leg 4 is now fully developed and biramous, but is distinctly smaller than the others, the exopodite being about half the size of the rest. Leg 5 is lost.

Abdominal somites have small uniramous pleopod rudiments.

Uropods.—Peduncle carries a spine on its outer margin distally.

Telson—Fig. 49.—Distal half of the telson is now distinctly narrower than the proximal half. Posterior margin is still slightly concave and has 5 spines on either side. Two pairs of small spines are present on the posterior half of the lateral margins.

Stage VII—Length about 5 *mm.*—Rostrum has 2 small teeth on its upper edge (Fig. 50). In other characters carapace quite similar to that of stage VI.

Peduncle of eye is shorter than rostrum.

Antenna.—Flagellum is longer than scale, but is unsegmented.

Maxilla I—Fig. 51.—Both endites are more or less equal in size ; palp is unsegmented and carries 5 setae and a spine.

Maxilla II—Fig. 52.—Second endite not deeply divided from first. Endopodite short and unsegmented and bears 9 setae. Scale is broad in front and is bordered with numerous setae.

Maxilliped I—Fig. 53.—Both coxopodite and basipodite have prominent inner lobes armed with numerous setae ; the former has a large bilobed epipodite. Exopodite has 4 plumose setae terminally and 1 on the outer margin close to the tip. It has also the basal lobe characteristic of the Caridea carrying 6 setae.

Maxilliped II.—Endopod is four-jointed as in maxilliped I. Exopod has 4 terminal and 8 lateral setae.

Maxilliped III and legs 1-4 are more or less as they were in the previous stage. Exopod of maxilliped III has 8 and those of the first 3 legs have 9 pairs of lateral setae. That of leg 4 is still much smaller and has only 5 pairs. Anterior legs are not chelate. Leg 5 is lost in both the specimens belonging to this stage.

Pleopods are now biramous, but without setae ; uropods and telson are practically unchanged.

Stage VIII—Fig. 54—*Length* 6-6·75 *mm.*—Rostrum carries 3 teeth dorsally.

Eyes.—Total length of the eye far exceeds that of the carapace.

Antennule.—Stylocerite more or less as in the two preceding stages. Flagella are about twice as long as peduncle ; the outer carries several aesthetes in the middle.

Antenna.—Flagellum is about 3/4 as long again as the scale, and is jointed.

Mandible and maxillae show little change.

Maxilliped I.—Basal lobe of exopod carries 8 setae.

Maxilliped II has a small epipodite.

Legs 1 and 2 have rudimentary chelae.

Leg 5 is without exopodite and is enormous in size in comparison with the others, the total length beyond the protopodite being about 6·75 mm. Propodus shows the characteristic expansion of the *Eretmocaris* larva. It gradually widens towards its extremity, the greatest width being roughly a third of its length, and is serrated on both margins except at their proximal portions. The distal extremity has a semicircular notch and just internal to it is the articulation with the dactylus which is small and tipped with a short seta. The three joints proximal to the propodite have each a spine terminally.

Rudiments of 5 gills are present at the base of the 5 legs.

Pleopods are still functionless.

In shape the telson is unchanged. The anterior pair of lateral spines have now disappeared and the posterior are much reduced. On the posterior margin the innermost pair are only visible when highly magnified.

Stage IX—Length about 8 *mm.*—Tip of rostrum reaches up to or just beyond the first segment of antennular peduncle. Of the 2 specimens in the collection one had 4 and the other 5 teeth on its dorsal side ; but none ventrally. Other characters of the carapace remain unmodified. In this stage and in the two preceding stages also the dorsal side of the ocular peduncle has a prominent hump at about the middle.

Flagella of both antennule and antenna are longer and consist of numerous joints.

The rest of the appendages of the cephalothorax do not show any noticeable change.

The rami of the pleopods are longer than those of the previous stage and are provided with spine-like rudiments of setae at their tips (Fig. 55).

In the telson (Fig. 56) the lateral spines have completely disappeared, but the rest persist.

There can be no doubt that all the stages described above belong to the same species. Their resemblance to the larvae of *Lysmata* is quite obvious. The following is the list of characters drawn up by Gurney for the genus :—

1. Rostrum short with few dorsal teeth.
2. Carapace with antennal and pterygostomial spines, and dorsal tooth (with or without supraorbital spine ?).
3. Abdominal somites without spines, and with rounded pleura.
4. Eyes carried on long but not excessively long stalks.
5. Endopod of antenna in stages I and II a slender rod, with a long seta ; reduced to a short stump in stages III and IV.
6. Leg 4 with exopod ; propod not dilated.
7. Leg 5 fully developed in stage II when legs 3 and 4 are rudimentary.
8. Leg 5 enormously large, with dilated propod.

All these characters, except the seventh, are shown by these larvae. The earliest available stage in the present series is IV and in it this leg seems to be fully developed though broken. But at what stage it first appears remains uncertain. It may also be interesting to mention here that the last two stages are strikingly similar to the species B.R. II from the Barrier Reef (compare Fig. 54 with Fig. 31 of the Discovery Reports). Indeed the resemblance is so close as to suggest the possibility of their belonging to the same species.

It should, however, be pointed out that the identification can only be provisional. Most of the characters in the above list are also shared by larvae of the closely allied genus *Hippolysmata*. Only two stages of a species (*H. ensirostris*) are definitely known to belong to this genus, one considered to be the last, described by Kemp (1916) and the other by Gurney (1937). The only peculiar character of this larva is the spine carried by the ocular peduncle ; but that is hardly a feature likely to be shared by all species. Assuming that the fifth leg is enlarged as in the other genus (leg 5 is lost in both the stages studied) the only other character that seems to constitute a constant difference is the supra-orbital spine. Save for these two differences the general resemblance of the two genera is extremely close. The truth of this can be realized by comparing stage II of the previous species with the earliest of the present one.

In the early stages, however, if Gurney's identification of the Red Sea species is correct, the two genera can be recognized a little more easily. The marginal spines of the carapace and the dorsal spines of abdominal somite 5 do not seem to be shared by all species, since the late stages of *H. ensirostris* do not have them. The appearance of the fifth leg only late in larval life (after stage III), as pointed out by this author, may be an important difference between the two. So far as our present knowledge goes this peculiarity and the possession of supra-orbital spines seem to be the only generic differences between the two.

Hippolytidae, species A.

Two specimens of a larva which were at first mistaken for Galatheids are present in the collection. Careful examination, however, revealed their Hippolytid affinities. Both belong to the same stage. In view of their peculiar characters, apparently unique in the family, a brief description is given below.

Fig. 57—Total length 5 mm.—The rostrum is very long with the tip probably broken off so that the total length may be more than what is given above. It is devoid of teeth or spines. At its base there is a small median papilla. The lateral margin of the carapace carries anteriorly a small pterygostomial spine and three small teeth and posteriorly a small tooth, in front of which there is a pronounced notch and in these characters the larva resembles those of *Latreutes* and *Saron*. Abdominal somite 3 is larger than the others ; somite 5 has a pair of large dorso-lateral processes and all have very large pleura. An anal spine is present.

Antennule—Fig. 58.—Peduncle is short and thick with only 2 segments, the proximal one being not yet marked out. A large rudiment of the stylocerite is present at its base. Inner flagellum is a short papilla with a single seta at its tip ; the outer carries a number of aesthetes.

Antenna—Fig. 59.—Peduncle bears a short spine at its outer angle. Scale is long and resembles that of the larva of *Munida* (Galatheidea) and bears numerous setae along its inner margin except at the tip, which very likely represents the spine of other larvae. Flagellum is about a third as long as the scale, unjointed and spiniform at the tip.

Maxilla I—Fig. 60.—Distal endite is broader than the proximal. Palp is unjointed and is armed with 5 setae, 2 of which are on the inner margin.

Maxilla II—Fig. 61.—There are 4 endites the second of which is the smallest. Palp has one segment incompletely marked out at the base and carries 8 setae, 5 on the inner margin and 3 at the tip. Scale is broad ; its rounded anterior end projecting far beyond the tip of the palp and is fringed with 18 setae of which the hindermost is the largest.

Maxilliped I—Fig. 62.—Both coxopodite and basipodite are well armed with setae. Endopodite of 4 segments, of which the first has an inner lobe armed with 6 or 7 setae. It carries a plumose seta on its outer margin. The other segments have 2, 2 and 4 setae, respectively, one of the last being on its outer margin. Exopodite has 4 plumose setae terminally and several laterally (exact number could not be determined). A large rudimentary epipodite is also present.

Maxilliped II—Fig. 63.—Coxopodite is reduced ; basipodite has fewer setae. Endopodite of 5 segments ; segment 1 has a smaller lobe like that of the same segment of maxilliped I, armed with 2 setae ; segment 2 has no setae ; 3 has 1 ; 4 has 2 inner and 1 outer setae and 5 has 5 terminal and 1 outer setae. Exopodite has 4 terminal and 6 lateral setae. A knoblike rudiment of the epipodite is present.

Maxilliped III—Fig. 64.—Both coxopodite and basipodite are reduced. Endopodite has only 4 segments though a pair of setae mark the limit of the first. All segments have setae on outer margin, the third having 3 or 4 . Exopodite and epipodite as in maxilliped II.

Leg 1—*Fig.* 65.—It is biramous with an exopodite quite similar to that of maxilliped III. Endopodite is short and not clearly segmented but the tip shows a rudimentary chela. A small epipodite is present.

Legs 2-5 are uniramous rudiments about equal in size to endopodite of leg 1. Leg 2 is chelate and has a minute epipodite.

Abdominal somites possess small biramous pleopods. Uropods are well developed with functional rami.

Telson—Fig. 66.—It is long and narrow with parallel sides in the hinder margin. Posterior margin shows a slight notch in the middle and on either side there are 5 spines, the innermost of which is minute.

So far as can be inferred from a study of the appendages the larvae seem to belong to the penultimate larval stage. They are extremely interesting inasmuch as they combine characters belonging to the genera *Tozeuma* and *Latreutes* (the later stages of the second genus are not fully known). The long rostrum and elongated antennal scale (not so long as in the present form), the lateral spines of abdominal somite 5 and the broad scaphognathite of the second maxilla which projects beyond the tip of the palp are common features of *Tozeuma* and the present form. But there are important differences also which exclude the possibility of these larvae belonging to this genus. The rostrum has no ventral teeth ; though elongated in some species, the scale of the antenna is never so long as it is in this species ; there is no supra-orbital spine ; lateral margin of carapace has teeth in front and behind ; and lastly the telson is entirely different in shape. With *Latreutes* the resemblance is much closer. The teeth on the lateral margin of the carapace and the spines of the fifth abdominal somite are possessed by *Latreutes*. Further, though shorter than that of *Tozeuma* the antennal scale is essentially of the same type as that of the present form. The telson is only slightly different and what is probably more important than all these, in *Latreutes* also legs 2-5 have no exopodites. (The characters of *Latreutes* given above are taken from the larva described by Gurney in his Discovery Reports.)

It will be seen from the discussion that the affinites of these larvae are such as to indicate their origin from a parent closely related to these two genera. The genus *Paralatreutes* (Kemp, 1925) occupies an intermediate position between them, though more nearly allied to *Latreutes* and it would not therefore be very unreasonable to assign these larvae to it. Only one species, *P. bicornis* has been recorded from Port Blair in the Andamans.

Hippolytidae, species B.

The fourth species in this family is represented by a number of larvae all of which except one belong to the first stage. Since only the early stages are available their identification is very difficult.

Stage I—Fig. 67—*Length* 1·6 *mm.*—There is no rostrum ; a small pterygostomial spine is present. Eyes are not stalked. No abdominal somite has spines.

Antennule—Fig. 68.—Peduncle is unsegmented. Outer flagellum with a short plumose seta and 4 aesthetes, of which one is setiform. Inner flagellum represented by a single seta.

Antenna—Fig. 69.—Peduncle carries a short spine opposite flagellum. Tip of scale jointed (only 2 segments marked out) and carries 9 setae along inner margin and tip and 2 small ones on outer margin. Flagellum is about half as long as scale and tipped with a large spine and a short seta.

Maxilla I—Fig. 70.—Proximal endite has several setae ; distal has 5 or 6, of which 2 are stouter. Palp is unjointed and has 4 setae, 2 of which are terminal and the rest subterminal.

Maxilla II—Fig. 71.—Four endites, of which the proximal is the largest. Endopodite is unjointed and bears 7 setae on the inner margin and 2 at the tip. Scale has 5 setae.

Maxilliped I—Fig. 72.—Coxopodite has only 2 setae ; basipodite has about 10. Endopodite has 4 joints armed with 3, 1, 1 and 2 setae respectively. Exopodite has 4 terminal setae and one on the outer margin.

Maxilliped II—Fig. 73.—Coxopodite is reduced ; basipodite has only 3 setae. Endopod of 4 segments carrying 2, 1, 2 and 5 setae respectively. Exopod has 6 plumose setae, 4 terminal and 2 lateral.

Maxilliped III—Fig. 74.—Protopodite segments much narrower than those of the first two, but armed in the same way. Endopod more than twice as long as that of the second, but having the same number of segments bearing 2, 1, 2 and 4 setae respectively, one of the last joint being on the outer margin as in the second. Exopod has 8 setae, 4 terminal and 4 lateral.

Behind it a small rudiment of the first leg is present.

Abdomen has 5 segments and the telson. The latter (Fig. 75) is broadly triangular with a small notch at the middle of its posterior margin. On either side of it there are 7 ciliated spines the outermost of which is on the lateral margin.

Stage II—Fig. 76.—The only specimen of this stage is hardly larger than the previous. Eyes are now stalked. Carapace has a short pointed rostrum and behind it a papilla.

Antennule—Fig. 77.—The distal segment of the peduncle is now cut off and its base is slightly swollen.

Antenna and the following 3 pairs of appendages seem to be unaltered.

Maxillipeds also appear to be unchanged.

Rudiment of the first leg is now biramous, and behind it another has also made its appearance.

Abdominal segments are unchanged. Telson has 8 spines on either side of the notch.

The characters of the two stages given above approach more those of the Hippolytidae than of any other related family and so they should be placed here for the time being. Among the larvae of this family known so far there is none with which it agrees closely. The possession of four terminal setae by the exopods of the maxillipeds is a character shared by *Saron* and *Latreutes*; but with neither of these genera do they show any other important points of resemblance. The ventral margin of the carapace has no teeth and the telson also is broader. The flagellum of the antenna is slightly different from its usual spiniform character since it has at its tip a spine and a seta. But a flagellum of this type has been described in *Spirontocaris spinus*, var. *Lillejeborgi* (Lebour, 1937) and *Latreutes fucorum* (Gurney, 1936). The larvae, however, are peculiar and in the absence of later stages extended comparison with those of other genera may not be of much use.

Family Alpheidae.

Larvae of this family are generally characterised by the precocious development of the fifth thoracic legs, which are long and styliform in all but the first 2 stages. They could therefore be easily identified by means of this character. The close relationship of the family to the Palaemonidae has been proved by Gurney (1938) in his recent paper on the two families. Larvae of two species are contained in the collection one of which is fairly complete.

Alpheus.

The larval history of this genus has been fully traced. Except in the case of some species with abbreviated development the larva hatches out in the form of a normal Caridian Zoea and in some cases passes through as many as 9 stages before changing into post-larval condition, so that larval life is quite as long as that of many species of Hippolytidae. In the case of the species described below also there seem to be the same number of stages.

Alpheus sp.

Stage II—Fig. 78—*Length* 2.25 *mm.*—Carapace has a short and pointed rostrum and a small pterygostomial spine on either side; a small median papilla is present behind the rostrum Abdominal somites are without spines. Eyes are stalked.

Antennule—Fig. 79.—Distal joint of peduncle is already marked out. Inner flagellum is a small knob with a large seta at its tip; outer flagellum with 4—5 aesthetes.

Antenna—Fig. 80.—Peduncle bears a short spine at the base of the flagellum. The latter is small, less than a third of the scale in length and bears at its tip a small spine and a seta. Scale is narrow with 4 joints distally; along its inner margin and tip are 10 setae, the most distal of which is quite minute; on the outer margin there are 2 more.

Maxilla I.—Fig. 81.—Both endites have few setae. Palp is unjointed and tipped with a single seta.

Maxilla II—Fig. 82.—Only 3 endites are present and in this respect resembles that of the Palaemonidae. Endopod is broad and unjointed with apparently only one seta at the tip and another on the inner margin. Scale has 5 setae.

Maxilliped I—Fig. 83.—Coxopodite has a small seta ; basipodite has 5, 4 of which are spinelike. Endopod an unsegmented process having 1 seta at its base and 3 at the tip. Exopod has 4 terminal setae.

Maxilliped II—Fig. 84.—Coxopodite much reduced ; basipodite has 3 setae. Endopod has 4 segments ; segments 1 and 3 have 1 seta each and segment 4 has 3 terminal and 1 outer seta. Exopod has 6 setae.

Maxilliped III—Fig. 85.—Protopodite segments very small. Endopod elongated and indistinctly divided into 5 joints ; penultimate joint has 2 setae and last joint has 1 very long seta which seems to be a continuation of the joint itself and two smaller ones. Exopod similar to that of maxilliped II.

Leg 1.—*Fig.* 86.—Is a rudiment having an elongated but unarmed exopodite and a very small endopod.

Rudiments of legs 2 and 3 present, the former being biramous. Leg 4 is absent while leg 5 is an elongated unjointed rod.

Abdomen consists of the first 5 somites and the telson. The latter (Fig. 87) is broad and triangular with a more or less straight posterior margin having 8 teethlike spines on each side. There is no anal spine.

Stage III—Fig. 88.—*Length* 2.75—3 *mm.*—Carapace is unchanged.

Antennule—Fig. 89.—Basal joint of the peduncle is indicated by a cluster of short setae ; behind this on the inner margin there is a spine. Inner flagellum has grown and is practically equal to the outer in length.

Antenna—Fig. 90.—Scale is not segmented and has 14 setae and a small spine at the extremity of its outer margin. Flagellum slightly longer ; its apical spine has also grown into a setalike structure.

Maxilla II—Scale has 6 plumose setae and palp has one more terminal seta.

Maxilliped II—Endopod has 5 segments, joint 3 of the previous stage having been differentiated into 2 during the moult.

Leg 1.—Exopodite has swimming setae at its tip ; but the exact number could not be determined. (Only 2 specimens were available and in both the exopods were slightly damaged.)

Legs 2 and 3.—Remain in the same condition ; a small rudiment of leg 4 has also appeared. Leg 5 is well developed and has assumed its characteristic styliform appearance, the tip projecting far beyond the extremities of the eyes. It consists of 6 segments, the terminal one bearing 2 setae, one of which is enormous.

Abdominal somite 6 is now cut off from the telson and the uropods have developed. The latter has small endopod and large exopod carrying a few setae (Fig. 91). Telson is slightly narrower than in stage II.

There is only a single specimen belonging to each of the next two stages.

Stage IV.—Length about 3.25 mm.—Carapace same as in the previous stages.

Leg 2 also has now developed into a biramous appendage with exopods bearing swimming setae so that at this stage there are 5 pairs of functional exopodites, the first having 4 and the rest 6 plumose setae.

Abdominal somites are still without pleopods. Uropods and telson (Fig. 92) are slightly altered. The former have distinct protopodites and the endopodites are provided with setae ; outer margin of exopodite has a small terminal spine. Telson is roughly oblong in shape with parallel margins and 5 spines on the posterior edge.

Stage V.—Length 3.75 mm.—On either side of the base of the rostrum there is a minute papilla ; otherwise carapace is unaltered.

Antennal flagellum is now about the scale in length ; but is unsegmented.

Pereiopod III also has functional exopodite armed with plumose setae ; endopod of all the legs are short and unsegmented. Fourth leg is still a uniramous rudiment. Abdominal somites are without pleopods. Both rami of uropods have a few more setae.

Telson (Fig. 93) has altered greatly in shape, being much narrower posteriorly ; hinder edge has only 4 spines on each side.

Stage VIII—Fig. 94—Length 4.75 mm.—The difference in length between this and stage V is 1 mm. while the difference between any of the previous two consecutive stages is ·5 mm. or less. Further in both the fourth and fifth stages it was seen that before a leg is fully developed with a functional exopodite it existed in the immediately preceding stage as a biramous rudiment without setae. In stage V the fourth leg was uniramous, but in this stage it has developed a functional exopodite. The difference in size and the degree of development of the fourth peraeopod make it extremely probable that we are dealing with a stage between which and the last there may have been one stage, though unrepresented in the collection.

Rostrum extends approximately to the tips of the eyes and the lateral papilla noticed in stage V has now grown into a small tooth, representing possibly the supraorbital spine.

Peduncle of antennule is now clearly three-jointed.

Flagellum of antenna is almost as long as scale, but is unsegmented.

All pereiopods are fully developed so that there are 7 pairs of functional exopodites. Endopods of legs 1 and 2 are segmented and have rudimentary chelae at the tips ; those of legs 3 and 4 are small and unjointed. Leg 5 remains as it was in the preceding stages.

Abdominal somites have small pleopods which are biramous.

There is only one more stage in the collection belonging to which there are 4 specimens measuring 6—6.2 mm. in length. They have large pleopods with the rami having rudimentary setae so that they should certainly belong to the last larval stage. The difference in size between stage VII and these specimens and the difference in the size of the pleopods seem to show that they do not belong to the stage immediately following the former but probably to the next, in which case this species also passes through 9 stages.

Carapace is similar to that of stage VII.

Antennule—Fig. 95.—Peduncle has all three segments marked out, the first being much longer than the others and has a rudimentary stylocerite. Inner flagellum is longer than the outer, and both are segmented.

Antenna—Fig. 96.—Peduncle has no spine. Flagellum is much longer than scale and is distinctly segmented, the first segment being very large.

Maxilla I—Fig. 97.—Except for the increase in size it is much the same as that of stage II.

Maxilla II—Fig. 98.—There are still only 3 endites ; but they are broader than those of stage II ; Proximal endite has a single seta at its distal end while the middle has 2 or 3 spine like ones in the same portion so that the major part of these two endites are smooth. Endopodite an unsegmented process with 2 terminal setae. Scale is long, but apparently has setae only at the front and hinder ends.

Maxilliped I—Fig. 99.—There is a bilobed epipodite, otherwise the appendage is similar to that of stage II.

Maxilliped II—Fig. 100.—The two terminal segments of the endopodite are larger than the others. A small epipodite is also present.

Maxilliped III.—Is as it was in stage II.

Leg 1.—*Fig.* 101.—Endopod consists of 4 joints, second of which is very short ; chela is well developed with both fingers practically equal in size. Exopodite similar to that of maxilliped III. An epipodite is present in this as well as the 3 succeeding ones.

Leg 2.—Endopod is thinner than that of leg 1, but is otherwise similar.

Legs 3 *and* 4.—Exopods similar to those of the front legs. Endopods four-jointed; dactyli are pointed, but without setae.

Leg 5 is unaltered.

All legs have each a gill close to their bases.

Pleopods are well developed with large protopdite and the rami are tipped with rudimentary setae (Fig. 102).

Both rami of the uropods are fully fringed with setae.

Telson—Fig. 103.—Posterior part is much narrower than the anterior and carries terminally 8 spines, the outermost on each side being much larger than the others.

Alpheidae, species A.

Stage III—Fig. 104—*Length* 1.8 *mm.*—The smaller size of these larvae and the greenish white colour of their cephalothorax (preserved material), especially of its ventral side, will serve to distinguish this species from the former.

Carapace is quite similar to that of the early stages of the first.

Antennule—Fig. 105.—It is generally similar to that of the same stage of the previous species. There is, however, no spine on the peduncle. Inner flagellum is much shorter than the outer and the latter has apparently only 2 aesthetes.

Antenna—Fig. 106.—This appendage differs from that of the first in having no spine at the extremity of the outer margin of scale and in the absence of spine or seta at the tip of flagellum.

Maxilla I—Fig. 107.—Distal endite has 2 large spines and 2 small setae. Palp is short and unjointed and is tipped with 2 stout setae.

Maxilla II—Fig. 108.—Only 3 endites. Endopodite is unjointed and has 2 setae terminally. Scale has 5 setae.

Maxilliped I—Fig. 109.—Protopodite segments are practically unarmed since there is only a single seta at the base of the basipodite and in this respect shows a greater degree of reduction than *Alpheus.* Endopod is a short unjointed rod having 4 terminal setae. Exopodite has 4 terminal setae and 2 lateral ones.

Maxilliped II—Fig. 110.—It is so similar to that of the previous species that no description is necessary.

Maxilliped III.—Terminal joint of endopodite (Fig. 111) does not have a long seta as in species 1, being armed in the same way as that of maxilliped II.

Leg 1.—It is biramous as in *Alpheus* with an exopodite that is much smaller than those of the maxillipeds, but carrying the same number of setae. Endopodite has 5 joints, the most proximal being but indistinctly separated from the next.

Behind it there are rudiments of legs 2, 3 and 4, all of which are uniramous.

Leg 5 has the characteristic styliform appearance, its tip reaching beyond the antennules.

Abdominal somites have no spines and pleopods.

Uropods (Fig. 112) are present and are similar to those of the first species at this stage.

Posterior margin of telson is straight and that is the only difference in this respect between the two species.

The characters of this larvae are exactly those of the third stage of the typical Caridean development and it could not therefore be wrong to ascribe it to that stage.

Next stage—Fig. 113—*Length about* 3.5 *mm.*—Carapace is identical with that of the previous stage in appearance ; there is no supraorbital spine.

Antennule—Fig. 114.—Peduncle has 3 clearly marked segments ; the basal has a well marked triangular stylocerite. Flagella are more or less equal in length, but unjointed ; inner carries 3 slender setae, outer has 4 or 5 aesthetes.

Antenna—Fig. 115.—Peduncle bears the small spine present in the previous stage. Scale is bordered with 16 setae and a small spine is borne at the tip of its outer margin. Flagellum is as long as the scale and has a large segment at the base and 3 at the tip marked out.

Maxilla I—Fig. 116.—It is practically unaltered.

Maxilla II—Fig. 117.—Same number of endites as in the previous stage, but they are broad now. Endopod short, broad and unsegmented with 2 apical and 1 inner setae. Scale is strikingly shorter than that of the last stage of species 1 and has apparently only 8 setae, borne on the outer margin.

Maxillipeds I, II and III—Figs. 118, 119 *and* 120 are more or less as they were in the previous stage.

Leg 1 is biramous with the exopodite as in the former stage. Endopodite is chelate at the tip, the two fingers of the chela being approximately equal.

Leg 2 has no exopodite ; endopodite segmented and subchelate terminally.

Legs 3 *and* 4 are also without exopodites ; enopodites are unjointed.

Leg 5 is unchanged ; its tip projects beyond the extremities of the antennules. There is a gill rudiment at the base of the first 4 legs.

Abdominal somites have short biramous pleopods.

Uropods.—They have distinct basal segments and 2 more or less equal rami bearing setae at the tips and distal parts of the inner edges.

Telson is narrow posteriorly and has 4 spines on each side of the hinder margin.

There is a single specimen belonging to the next stage measuring approximately 4 mm. in length. So far as can be made out from the entire specimen it does not show any marked difference from the previous stage. Maxilliped I has a well developed epipodite while maxilliped II has a smaller one. Maxilliped III and the legs do not show any trace of epipodites. Gills are larger. So too are the pleopods.

Comparing this larva with the last stage of *Alpheus* described previously it is clear that it is in the same stage of development. The difference in size between it and the previous stage and between the latter and stage III, together with the extent of development of the appendages undergone between them seem to point to the probability of the development being as prolonged as in *Alpheus*.

The identity of these larvae presents a more difficult problem. The differences between them and those of *Alpheus* are obvious and are enough to exclude it from the present discussion. So far as *Athanas* is concerned no opinion can be confidently expressed, since I have had no opportunity of going through Sars's paper containing an account of the later stages of this genus. From the summary of characters given by Miss Lebour (1932) we know that its larvae develop exopods on the first and second legs, whereas in the present species only the first has an exopod. It is not possible to add anything more regarding this question.

The absence of epipodites from the walking legs is an important character for consideration in this connection. They are clearly developed in the last stage of *Alpheus* and such may therefore be the case with regard to other forms also that have epipodites in the adult condition. If that is true the larvae in question could belong only to a genus that has no epipodites on the walking legs and only 3 such genera are known at present. One of the 3 is *Synalpheus* and its larvae differ from the present series in the shape of the telson, number of exopods on the walking legs, etc. These larvae therefore should be referred to one of the remaining 2 genera namely *Ogyrides* and *Cheirothrix*, in case the negative character on which we started is true. Until that is established what has been said above may be nothing more than an interesting speculation.

Family Palaemonidae.

Our knowledge of the larvae belonging to this family is fairly extensive, but unfortunately in the case of a number of genera it is limited to the first one or two stages. Besides those of known parentage, several more have been described by various authors under the names *Retrocaris* and *Mesocaris*, the identity of which has yet to be determined. As remarked on a

previous page the larval characters of the family, so far as available, point to a close relationship with the Alpheidae. The reduction of the mouth parts is a characteristic of this family also and in *Retrocaris* there is the same hypertrophy of the fifth leg. But within the family there is much variation among larvae of different groups of genera which is unknown in the previous family.

There is a single specimen of a larva belonging apparently to the fourth stage which shows striking resemblance to a group of larvae described by Gurney (1938) under the name *Cryptoleander*. His specimens were obtained from the Great Barrier Reef and the Red Sea. The present form undoubtedly comes within the same group but cannot possibly belong to any of the 3 species he has described.

Stage IV—Fig. 121—*Length about* 2·5 *mm.*—Carapace has a long rostrum, the tip of which seems to be finely serrated below. At its base there is a large dorsal tooth and behind it there is a similar tooth and a papilla on the middle line of the carapace ; both are not serrated. Small supra-orbital and pterygostomial spines are present. Abdominal somite 5 has a pair of lateral spines.

Antennule.—Peduncle consists of 2 segments. Outer flagellum carries aesthetes ; inner is a minute papilla.

Antenna.—Flagellum is as long as scale with two hair-like setae at the tip. Scale has a small spine at the tip of the outer margin.

Maxilla II—Fig. 122.—Only 3 endites are present. Palp has a single terminal seta. Scale seems to bear setae on the whole of its outer margin.

Maxilliped I—Fig. 123.—Basipodite is produced into a large lobe carrying slender setae. Endopodite is short and apparently unjointed. Exopodite seems to have only 4 terminal setae. Epipodite rudiment present.

Maxilliped II—Fig. 124.—Basipodite has 2 large spines, the distal of which is larger. Endopod of 3 segments ; the propod has 2 terminal spines and the dactylus has a large spine and 3 setae terminally exactly as in *Palaemon* (Menon, 1938, Figs. 16, 17, 18 and 19).

Maxilliped III—Fig. 125.—Basipodite similar to that of maxilliped II ; endopodite fourjointed ; terminal joint armed as in maxilliped II.

Legs 1 *and* 2 are biramous with jointed endopodites and functional exopodites. Propodite has 2 terminal spines and dactylus has a large spine and a hairlike seta terminally as in *Palaemon*.

Legs 3 *and* 4 are quite small rudiments, the anterior being biramous.

Leg 5 is without exopodites and reaches beyond the eyes. Propod has 2 large distal spines (Fig. 126) ; dactylus has a similar basal spine.

Abdominal somites have minute pleopod rudiments. Uropods well developed with distinct protopodite and with setose inner margins.

Telson is entirely different from those of Gurney's specimens (Fig. 127). It is long and triangular with a slightly concave posterior margin bearing 5 pairs of spines of which the outermost is the largest. A pair of small lateral spines are also present.

This larva resembles the form from the Barrier Reef described as B.R. IX; but it is much larger in size and has a different telson.

It is not possible to add much to what Gurney has said about the identity and relationship of these larvae. He recognized their general resemblance to the larvae of the Palaemoninae; but was unable to refer them to any known genus of that family. Because of fundamental differences they could not possibly belong to the other 2 subfamilies, namely, Pontoninae and Anchistioidinae. He therefore thinks that they may be the larvae of some yet undiscovered genus, or genera which are at present included in some other family like the Gnathophyllidae. The form described here is strikingly similar in appearance to that of *Palaemon carcinus*, the only difference being in the absence of the dorsal spines. Regarding the appendages, so far as is known, the only difference worth noting, is the absence of a basal lobe on the palp of maxilla II in this form. These larvae may therefore belong to some genus closely related to *Palaemon*. It is also interesting to note here that the later larva of *Leander tenuicornis* described recently by Gurney (1939) is strikingly similar to the present form.

Suborder REPTANTIA.

Tribe THALASSINIDEA.

It has been pointed out on a previous page that among the Anomura only the Thalassinidea pass through a regular Mysis stage possessing exopods on all or some of the thoracic legs, an evidence which points unmistakably to the primitiveness of the tribe. A median spine on the posterior margin of the telson is present, except in the family Laomediidae though in some forms it appears only in the later stages.

Family CALLIANASSIDAE.

This family consists of two subfamilies, namely, Callianassinae and Upogebinae and the larvae belonging to them are remarkably different. Those of the former are hatched out as a zoea with all three pairs of maxillipeds biramous and functional, a character in which they differ not only from the other subfamily but also from the remaining tribes of Anomura. (In Axiidae also there are 3 maxillipeds).

The general characters of the subfamily have already been enumerated by the above-mentioned author (1924) and there is therefore no necessity to repeat them here since I have already done so in a previous paper (1933).

Callianassa.

Two types of larvae belonging to this genus have been shown to exist (Gurney, 1937) of which a species having larvae of type II has been already described from this locality (Menon, 1933). Two stages of a species belonging to type I are present in this material and they are briefly described below so as to elucidate the difference between the two.

Stage I—Fig. 128—*Length* 2.5 *mm.*—Carapace is drawn forwards into a long rostrum, the tip of which projects beyond the extremity of the antennae. It is broad and flat proximally, and tapers to a point distally where it has 10-11 spinnules on either edge. The ventral margins are also serrated in front.

Abdominal somite 2 has a large backwardly projecting median spine on the dorsal side which is hollowed out below; somites 3-5 have small spines in the same positions. The middle parts of the terga of all these segments are raised up into longitudinal keel-like processes, the spines being only their backward extensions. These keels are usually serrated, though in this species they are not. Spines on these abdominal somites may be present in Axiidae also, but they have not the characteristic keels of *Callianassa.*

Antennule—Fig. 129.—Peduncle is unsegmented and carries at its tip 5 aesthetes and 1 seta.

Antenna.—Peduncle has a large serrated spine between the flagellum and scale. Former is a small slender rod tipped with 3 plumose setae. Latter is long and narrow bearing 8 setae on inner margin and tip and a large spine at the extremity of outer margin. A small seta is present at the base of the same margin.

Mandible—Fig. 130.—Cutting edge has teeth as shown in figure.

Maxilla I—Fig. 131.—Proximal endite has several slender setae; distal has 2 large spines and 3 setae. Palp has 3 segments though the suture between 2 and 3 is not very distinct; joints 1 and 2 have 2 setae each and joint 3 has 4 at the tip.

Maxilla II—Fig. 132.—Protopodite has 4 setose endites. Endopod is unjointed and has 8 setae on inner margin and 5 terminally. Scale is short and carries 5 setae, 3 at the front and 2 at the hinder ends.

Maxilliped I—Fig 133.—Both joints of protopodite are armed with several setae. Endopod has 4 segments bearing 3, 2, 2 and 4 setae respectively. Exopod is tipped with 4 setae.

Maxilliped II—Fig. 134.—Protopodite segments much narrower than those of maxilliped I and have a smaller number of setae. Exopod and endopod are similar to those of the former except in the presence of an additional seta on segment 4 of endopod.

Maxilliped III—Fig. 135.—Protopodite still more reduced. Endopod has only 3 segments; exopod has 5 terminal setae.

In older forms very small rudiments of the next 2 or 3 appendages are present behind maxilliped III.

Abdominal somites are without pleopods.

Telson—Fig. 136.—It is broad and triangular. The posterior edge has a distinct central notch and carries a small median spine and 7 large spines on either side, the second of which from the outer margin has the hairlike form characteristic of Anomura.

Stage II—Length 4 *mm.*—Both rostrum and ventral margins of carapace have a few more spinules. Dorsal keels of abdominal somites 3-5 are now serrated.

Antennules, antennae and mandibles are but little altered.

Distal endite of maxilla I (Fig. 137) has now numerous spines.

Maxilla II—Fig. 138.—Scale has increased in size and is fringed with about 13 plumose setae, the hinder end of the outer margin being without them.

Maxilliped II—Fig. 139.—Endopod is made up of 5 segments carrying 3, 2, 0, 2 and 5 setae respectively. Besides these each segment has a large seta on the outer margin also. Exopod has 6 setae at the tip.

Maxilliped III —Endopod has 5 segments, of which 2, 3 and 5 have each a seta on the outer margin. Exopod is similar to that of maxilliped II.

Small rudiments of all the remaining thoracic appendages are now present.

Abdominal somites are still without pleopods.

Telson—Fig. 140.—The median spine is now several times the size of that of stage I.

Subfamily Upogebine.

More or less full accounts of the larvae of 3 European species belonging to this subfamily are available to us. They are *Upogebia littoralis* (Cano, 1891), *Calliadne* (*Gebiopsis*) *deltaura* (Sars, 1884, Webb, 1919) and *Upogebia stellata* (Webb, 1919). Gurney (1924) has described all larval stages and the post-larval stage of a species which he has identified as *Upogebia danai* and in a recent paper he has shown how larval life is practically absent in *U. savignyi*, a species from the Red Sea. Besides these I have described fully larvae of a species from Madras (1933) which show several striking differences from all others. Two species are represented in the present collection, one of which belongs to *Upogebia* and the other to *Calliadne*.

Upogebia sp.

Only the last larva and the first post-larval stage are present.

Last stage—Fig. 141—*Length* 3 *mm.*—Rostrum is broad proximally, narrows suddenly in the distal part. Ventral margin of carapace is smooth. Abdominal somites are unarmed ; length of last somite is slightly more than total length of the preceding 3 somites.

Antennule—Fig. 142.—Peduncle has distal segment marked out and is swollen at the base. Its inner margin and tip carry long plumose setae. Inner flagellum is smaller than outer and is tipped with a small spine and two setae ; the latter has 3 large and 3 slender aesthetes and a short seta.

Antenna.—Peduncle has 2 serrated spines. Flagellum is slightly longer than scale, obscurely segmented and carries at its extremity a spine and a small seta. Scale bears 12 setae along inner margin and tip and a spine at the extremity of outer margin.

Mandible—Fig. 143.—It is as shown in figure.

Maxilla I—Fig. 144.—Proximal endite is slightly smaller than distal. Palp is three jointed ; first and second joints have 2 setae each and the last 4 at the tip.

Maxilla II—Fig. 145.—Four endites of which the 2 in the middle are smaller than the others. Palp is unjointed and tipped with 6 setae. Scale is fringed with 13-14 plumose setae, the proximal part being bare, a character which these larvae share with those of Paguridae.

Maxilliped I—Fig. 146.—Endopodite is five jointed. Besides the setae borne on the inner margin the second and fifth have each a ciliated seta on the outer margin, that of the former being large, a feature which is common to all of the species mentioned above. Exopod is shorter than endopod and carries terminally 5 setae.

Maxilliped II—Fig. 147.—Endopod is only four jointed, second joint having no outer seta, and in this respect it resembles *G. deltaura.* Exopodite carries seven terminal setae.

Maxilliped III.—Endopod springs from base of basipodite and is jointed. Exopodite similar to that of maxilliped III.

All pereiopods are well developed ; the first 3 pairs are biramous, exopodites bearing 7, 7 and 6 setae respectively. Endopodites are segmented, the first having no trace of a chela and in this respect it agrees with *U. danai* and differs from the European forms.

Abdominal somites 2—5 have well developed pleopods, having protopodites and exopodites, but not endopodites.

Uropods—Fig. 148.—There is a well marked basal segment. Both rami have setae on inner margin, exopodite having a spine also at extremity of outer margin.

Telson is roughly oblong, about 1½ times as long as broad, slightly broader at posterior end and has a small median spine and 8 more on either side, the fourth of which from the outer margin being the largest.

First Post—Larval stage—Fig. 149—*Length* 3 *mm.*—The animal has assumed the adult appearance. Carapace has a short rostrum rounded at the tip and bearing a small median tooth and 2 others on each side (Fig. 150). A cervical groove is clearly seen, but no "linea thalassinica."

Antennule—Fig. 151.—Protopodite is three jointed, the middle segment being much smaller than the other 2 ; first is swollen and excavated for the statocyst. Inner flagellum is stout and 3 jointed, the 2 distal joints having setae. Outer flagellum is thinner and unsegmented and is tipped with 4 setae.

Antenna.—It is a slender jointed rod, the four proximal joints being larger.

Mandible—Fig. 152.—Cutting edge has a few minute teeth. Palp is not distinctly jointed and carries 4 very small setae at the tip.

Maxilla I—Fig. 153.—Both endites have few setae. Palp is apparently unarmed and unjointed.

Maxilla II—Fig. 154.—Proximal endite is quite naked and second has only 1 seta. Palp has a single subterminal seta. Scale is fringed with numerous setae.

Maxilliped I—Fig. 155.—Both segments of protopodite have only few setae. Exopodite has 3–4 plumose setae on its outer margin. Epipodite is not very clearly developed.

Maxilliped II—Fig. 156.—Endopodite has 5 joints, the fourth having 2 large plumose setae and an ordinary seta on its outer margin. Exopodite is unarmed. A small epipodite is present.

Maxilliped III—*Fig.* 157.—Endopodite of 5 segments, the last 2 being armed with several setae. Exopodite has no setae. A small epipodite and 2 gills are present.

Leg 1.—It is subchelate. Fixed finger (Fig. 158) is very short and arises from the inner edge of the protopodite some distance behind the articulation with the dactylus. It carries 2 minute teeth on its inner margin. Dactylus is shorter than the propodite and is acute at the tip. It carries a number of short setae, but no teeth or spines. The 3 proximal joints also have spines and setae.

Other legs of the usual form. All are beset with numerous setae. Each of the first four legs has 2 gills at its base.

Abdomen.—Somite 1 has no pleopods. The latter are biramous, having large exopodites bearing setae all round their margins and small endopodites carrying but few setae.

Uropods—Fig. 159.—Endopodite is narrower than exopodite and has no setae on outer margin.

Telson is slightly longer than broad and narrows somewhat at the hinder end. Posterior margin shows a slight median concavity and on either side of this there are numerous short setae.

Remarks.—In the collection there is another specimen also belonging to the last larval stage. It is approximately 4 mm. in length. Excepting the larger size and the presence of a few more setae on the endopodites of the uropods it shows practically no difference

from the one described above. A post-larva of correspondingly large size is absent but there is a specimen about 3·25 mm. long and as far as can be judged by a study of the entire animal it seems to belong to the first stage. The most interesting character of this animal is the nature of its chela in which the fixed finger arises close to the articulation with the dactylus in marked contrast to that of the specimen described above. Its inner margin has 3 well developed pointed teeth and 2 smaller tubercles (Fig. 160). Although there is no direct evidence for it, its size makes it highly likely that this specimen may be the product of the metamorphosis of a larva in the last stage similar to the one mentioned above. Miss Webb has shown that the 2 types of claw are representative of the two sexes, the first of the female and the second of the male and also that specimens with the first type are produced by metamorphosis of larvae belonging to the third stage, while those with the second type are produced by larvae of the fourth stage. The characters of the larvae described above are clearly those of the last stage so that in the present species it would seem that the two sexes are derived from the last larval stage, but from specimens of different size.

Among the other characters of the post-larva mention should be made of the partial degeneration of the mouth parts as illustrated by the two maxillae and the first maxilliped and in this respect it differs from *U. danai*, but approach the species described by Miss Webb. Similarly the presence of a small epipodite on the second maxilliped is also a point of difference with those species, although Sars has noticed a similar epipodite in the same position in the species he described, which is regarded by Gurney as identical with *Gebiopsis deltaura*. It is also interesting to notice that in the absence of setae on endopodite of maxilliped I and exopodites of maxillipeds II and III and from the extremity of endopodite of maxilliped II and exopodite of maxilliped I this species resembles the European species.

Calliadne (Gebiopsis) sp.

Stage III—Length 3·5 *mm.*—The animal is quite similar in appearance to the larva previously described. Excepting the rostrum, carapace has no spines or teeth. Abdominal segments are also unarmed.

Antennule—Fig. 161.—Peduncle is unsegmented; base is slightly swollen. Outer flagellum is stout but is shorter than inner; the former has 6 aesthetes and a seta, the latter has only 2.

Antenna—Fig. 162.—Peduncle carries 2 serrated spines, one at the base of flagellum and the other at the base of scale. The latter bears 14 setae along inner margin and tip and a strong spine, the seta next to it being much smaller than the others. Flagellum is unjointed, as long as the scale and is tipped with 2 spines and a short seta.

Mandible—Fig. 163.—As in figure.

Maxilla I and Maxilla II.—They are practically identical with those of the last stage of the previous species.

Maxilliped I—Fig. 164.—Inner margin of basipodite has numerous setae. Endopodite is 5-jointed ; only the last joint has a small outer seta. In the absence of a plumose seta on the outer margin of the second joint this species differs from both *U. deltaura* and *U. stellata.* Exopod is short and carries 5 plumose setae.

Maxilliped II—Fig. 165.—Coxa is reduced ; basipodite has only 2—3 setae. Endopodite has 4 joints ; joints 2 and 4 have each an outer seta, and thus resemble the larvae of *U. stellata.* Exopodite has 7 setae.

Maxilliped III—Fig. 166.—Endopodite is unsegmented and has a single plumose seta on the outer margin at the base. Exopodite is similar to that of maxilliped II.

Leg 1—*Fig.* 167.—Endopodite is practically unjointed and is not chelate. Exopodite similar to those of maxillipeds II and III.

Legs 2 *and* 3 are also with well developed functional exopodites. The remaining legs are uniramous rudiments.

Abdominal somite 1 has no pleopods. Others have small uniramous rudiments.

Uropods—Fig. 168.—The rami are not distinct from the peduncle. Exopodite has a large spine at the tip of its outer margin and is fringed with 13 plumose setae on the inner margin and tip. Endopodite is small and without setae.

Telson is broad and triangular, the length being much greater than the breadth. Its posterior margin has a small median spine and 8 spines on either side of it, the second from the outer end being hairlike. There is an anal spine.

Stage IV—Length about 4 *mm.*—Except for the larger size the animal is unchanged in appearance.

Antennule.—Distal joint of peduncle is marked out as in the previous species.

Antenna.—Flagellum is longer than scale and is obscurely segmented as in that of the first but has no setae or spine at the tip.

Maxilla and mandibles are more or less as they were in the previous stage.

Maxilliped I is practically unaltered and in the absence of an outer seta on the second segment of the endopodite it differs not only from the European species noticed before but also from the New Zealand form and species 1 of the present collection.

Maxilliped II—Fig. 169.—Endopodite is now 5-jointed and in this respect differs from all of the foreign species and also species I of Madras. Second joint has an outer plumose seta and in this respect differs from the first species and agrees with *U. stellata.*

Maxilliped III—Fig. 170.—Endopodite has now 5 well marked joints and the outer seta of the previous stage is now borne by the second joint, a point of difference from the first species and also the 3 foreign forms.

Endopodites of all legs are now segmented ; the first is not yet chelate.

Pleopods are larger, but still uniramous.

Uropods.—Protopodite is now distinct from the rami ; both of the latter have setae as in the first species.

Telson (Fig. 171) is narrower than that of the previous stage and the posterior margin has the same number of spines.

This stage resembles the last stage of the other forms mentioned above and the previous stage also obviously belongs to stage III. A comparison of the latter, particularly its maxillipeds and peraeopods, with the larvae described by Miss Webb shows that it corresponds with larvae of class A which moults directly into the post-larval stage without passing through the fourth stage. Gurney also has noticed specimens belonging to stage III of *U. danai* about to metamorphose into the first post-larval stage so that this premature metamorphosis is apparently very common in species of *Upogebia.* Whether the present species also behaves in the same manner remains to be determined, and meanwhile no guess can be hazarded since the available material gives no indication of it.

First Post-larval stage—Length roughly 3 mm.—Rostrum (Fig. 172) is similar to that of species 1, but there are no supra-orbital processes. Carapace shows only the cervical groove.

Antennules and antennae are similar to those of species 1.

Mandible Fig. 173.—Palp is distinctly segmented and has numerous short setae.

Maxilla I—Fig. 174.—Endites have numerous setae and in this respect differ from those of the first species.

Maxilla II—Fig. 175.—All endites are armed with numerous setae.

Maxilliped I—Fig. 176.—Unlike that of the previous species the protopodite is well armed with setae on both joints. Endopodite is an unsegmented process carrying about 8 plumose setae on its inner margin. Exopodite is much larger and bears 5 plumose setae at the middle of its outer margin and 2 at the tip, one of which is large and plumose. In the presence of setae on endopodite and tip of exopodite this species differs from the European species and resembles *U. danai.* There is a clearly developed epipodite.

Maxilliped II—Fig. 177.— It differs from that of the previous species in the greater number of setae on the endopodite. There is an epipodite rudiment.

Maxilliped III—Fig. 178.—It is quite similar to the same appendage of the foregoing species except for the difference noticed for maxilliped II. Two gills are present at its base.

Leg 1 is chelate. Fixed finger (Fig. 179) is as long as the other and has 3 small teeth on its inner margin ; the same margin of the movable finger having only a few tufts of short setae. All joints have numerous setae on the inner side.

Dactylus of legs 2—5 is triangular and pointed at the tip, and the other segments are beset with long setae on inner edge. Two gills are present at the base of the first four legs.

Abdominal somites 2—6 have large pleura. Somite 1 has no pleopods ; the others have well developed biramous ones quite similar to those of the previous species.

Uropods and telson are wider than those of the previous species. The presence of a rudimentary epipodite on the first maxilliped is the most interesting feature of this species since in all others it is absent in the first post larval stage, with the exception of *U. danai* in which Gurney supposes them to be present though too small to be seen. The animal cannot possibly belong to a later stage because of its size (much smaller than the last larva) and presumably therefore the peculiarities noted may be specific characters.

Tribe GALATHEIDEA.

Family PORCELLANIDAE.

Larvae belonging to this family are easily distinguished by their enormously elongated rostrum and posterior spines of carapace and the peculiarly shaped telson. They are also remarkable in the complete suppression of uropods during larval life. The only exception to this type is the one described by Gurney (1924) which has an entirely different telson and develop uropods. In the previous paper (1937) I have described larvae belonging presumably to 6 species, 3 of which, however, were incomplete, since the post-larval stages and one or more larval stages also were absent. In the present collection there is a single specimen of a larva belonging to the last stage identical with " form 3 " of that paper. This and 2 specimens of the first post-larval stage were found in the same day's collection and I therefore add a brief description of the latter on the assumption that all belong to the same species.

Porcellana serratifrons Stimpson.

First Post-larval Stage—Fig. 180.—Carapace is clearly longer than broad (length 1·5 mm., width 1 mm.). Its front is prominent and projects far beyond the eyes and has 4 large processes, 2 on each side. The lateral margins carry 3 well-developed spines.

Antennule—Fig. 181.—Basal segment of peduncle as in other species is enormously swollen and carries 3 large teeth on its anterior margin. Distal joint has 2 rows of plumose setae terminally. Both flagella are jointed but aesthetes are borne only by the outer.

Antenna.—Proximal segment of the peduncle has a strong spine.

Mandible—Fig. 182.—Crown has a smooth cutting edge. Palp is 3-jointed ; the terminal joint carries a few short setae.

Maxilla I—Fig. 183.—Endites are thickly beset with setae. Palp is unjointed and unarmed. Arising from outer margin of proximal endite there is a large bag-like process which is easily seen because of its swollen condition and yellow colour in preserved specimens. Its surface is much wrinkled up and has a group of hairs at the base. The figures of the same appendage of *Petrolisthes* (Fig. 103, pl. IV) and *Porcellanella* (Fig. 123, pl. IV) given in the previous paper also show this structure though they were unnoticed at that time, probably because they were attached at both ends to the protopodite. A similar structure is described by Gurney in the first maxilla of *Upogebia danai* and regards it as an exite corresponding to the similar plate of the Euphausids.

Maxilla II shows the usual characters. Palp has only a single sub-terminal seta.

Maxilliped I—Fig. 184.—Both protopodite joints have inner lobes bearing numerous setae. Exopodite has 6 plumose setae on outer margin distally. Endopodite is faintly 3-jointed and has a single seta at the base.

Maxilliped II is similar to that of *Petrolisthes.*

Maxilliped III—Fig. 185.—Basipodite has a small tooth externally. Exopodite is without setae. Endopodite has 5 joints ; ischium, merus and carpus are flattened and have small inner lobes, that of the first having several setae while those of the other 2 have each a tooth in the middle. Two gills are present at its base.

Cheliped—Fig. 186.—Meropodite has a single tooth at the extremity of its inner margin. Carpus has 3 large ones on the same margin and the distal portion of the posterior edge of the propodite (including the fixed finger of the chela) is strongly serrated. The fingers of the chela are not even half as long as the palm and the latter is longer than the carpus.

All the remaining legs are broken off. One of them alone was present in the tube containing the larvae and a figure of its tip (Fig. 187) is given to show the nature of the last joint.

Abdominal somite 1 has no pleopods ; they are present on somites 2—6 and consist of protopodites, setose exopodites and endopodites without setae, but having 4 hooks on inner margin. Uropods and telson are similar to those of *Petrolisthes.*

Remarks.—The appendages do not show any striking difference from those of the 2 species described before. The identification of the specimen is a somewhat difficult matter, especially because the characters on which the classification of the family is based are not sharply marked. The general shape and the dimensions of the carapace and the strongly dentate front are characters belonging to the genus *Porcellana*. There is general agreement between the characters of the specimen and those of the genus as given by Henderson (1888), the only noticeable difference being in the absence of a projecting lobe near the inner margin of the carpus. In *Porcellana* the dactyli of the ambulatory legs have only a single claw, but that which is figured here is practically identical with that of the specimen identified as *Porcellanella* in the previous paper. But this seems to be not a diagnostic character since, as has been shown by Gravely (1927), gradations " from a single claw preceded by four hair-like ventral spines, through forms in which these spines are thickened, the distal ones more so than the proximal, to forms with two and three claws " exist. In the key given by him *Porcellana* has a claw followed by spines of which the distal ones are thicker. The characters of the claw figured here agree with this description and so there can be no serious objection against referring the present larvae to this genus. Two species have been recorded from the Krusadai islands in the Gulf of Manaar, with one of which, namely *P. serratifrons*, this specimen exhibits considerable resemblance, particularly in the nature of the dactyli of the ambulatory legs. I have therefore referred it to this species.

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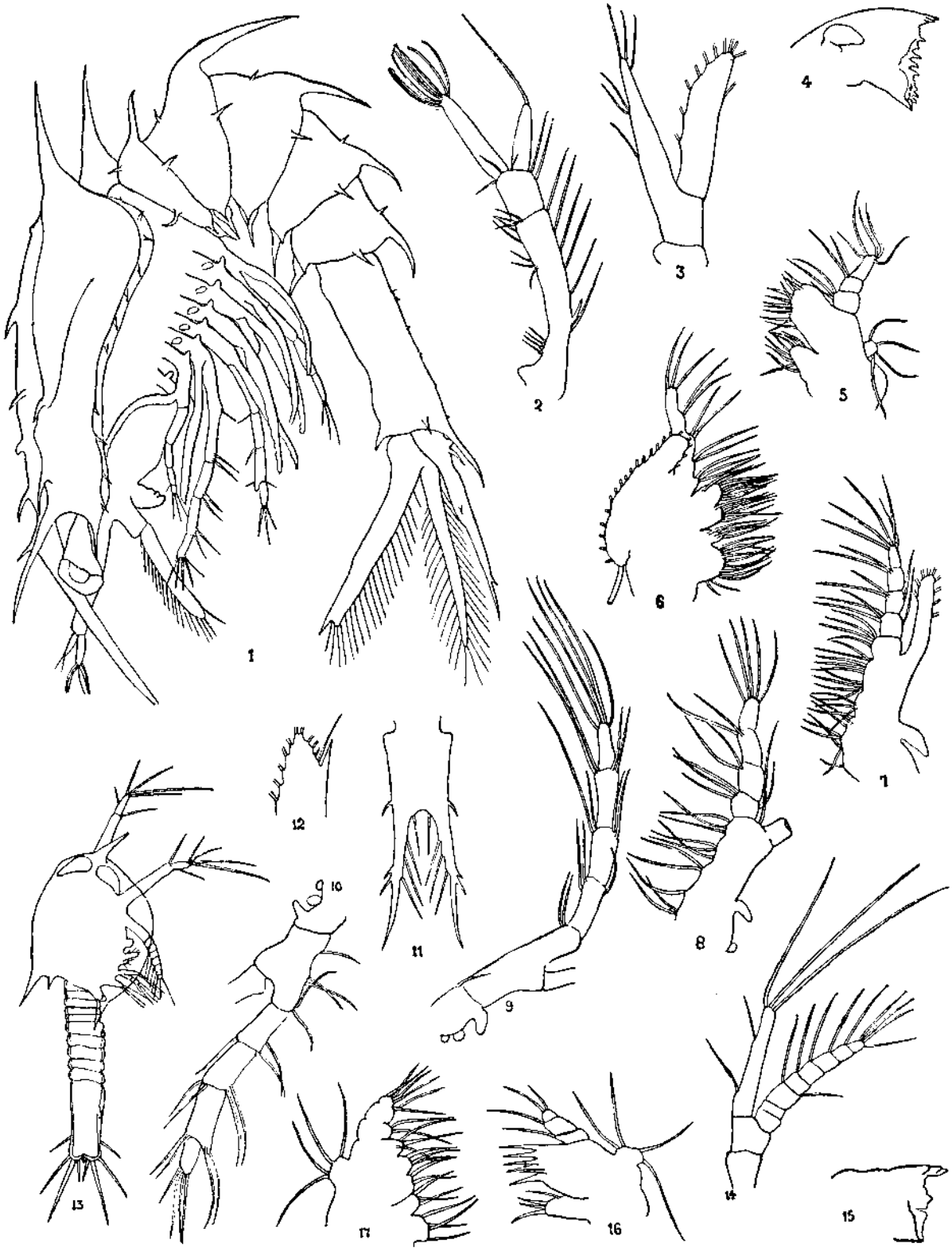
PLATE I.

Solenocera crassicornis.

Fig. 1. First stage (entire animal).
„ 2. Antennule of first stage.
„ 3. Antenna do.
„ 4. Mandible do.
„ 5. Maxilla I do.
„ 6. Maxilla II do.
„ 7. Maxilliped I do.
„ 8 Maxilliped II do.
„ 9. Maxilliped III do.
„ 10. Pereiopod I do.
„ 11. Uropods do.
„ 12. Tip of Antennal scale of last stage.

Lucifer hanseni.

Fig. 13. Protozoea, stage II (entire animal).
„ 14. Antenna of Protozoea, stage II.
„ 15. Mandible do.
„ 16. Maxilla I do.
„ 17. Maxilla II do.



SOLENOCERA AND LUCIFER.

PLATE II.

Lucifer hanseni.

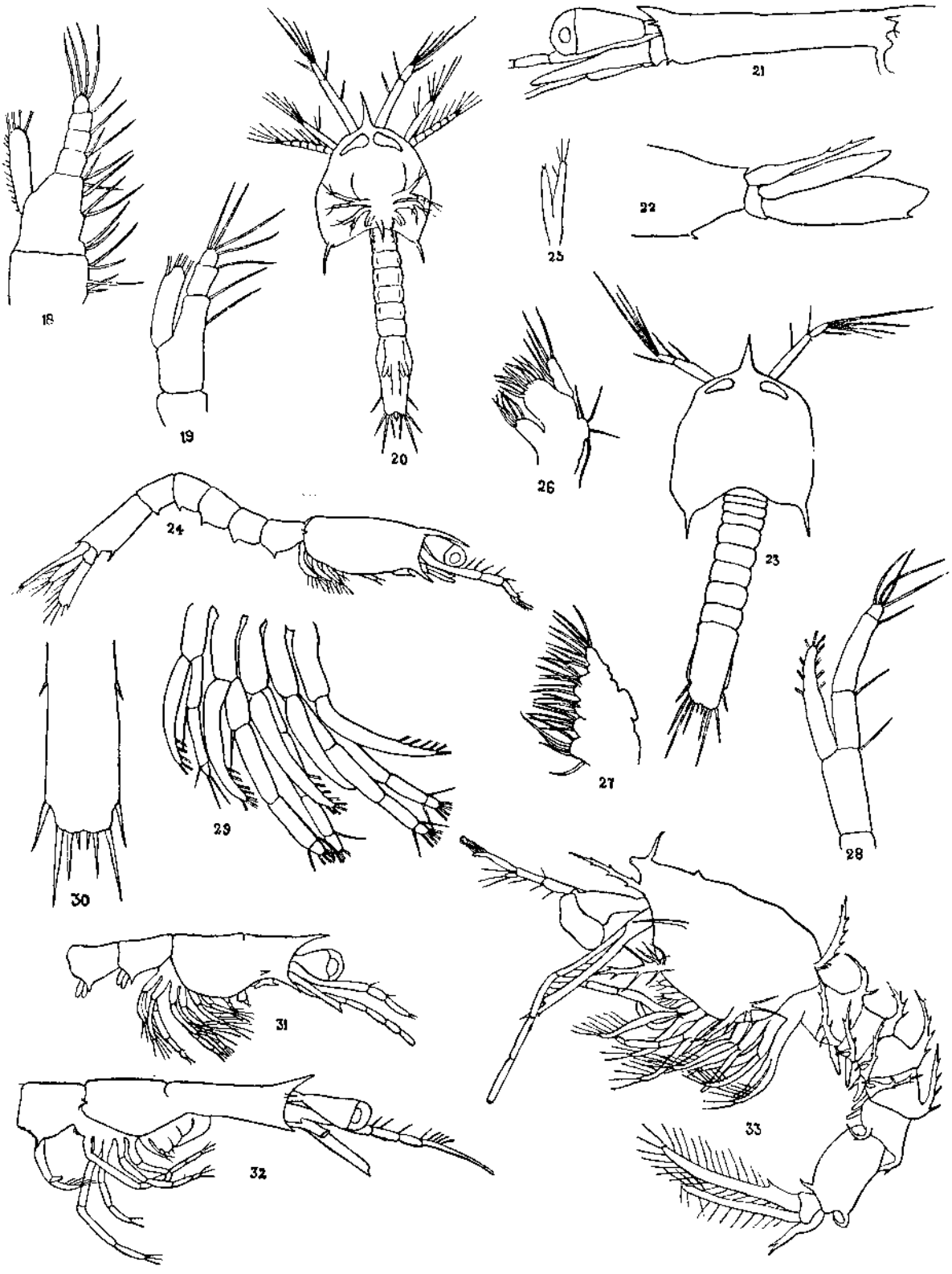
Fig. 18. Maxilliped I of Protozoea, stage II.
„ 19. Maxilliped II do.
„ 20. Protozoea, stage III (entire animal).
„ 21. Head and neck of half-grown animal
„ 22. Uropods do.

Lucifer sp.

Fig. 23. Protozoea, stage II (entire animal).
„ 24. Mysis, stage I (entire animal).
„ 25. Antenna of Mysis, stage I.
„ 26. Maxilla I do.
„ 27. Maxilla II do.
„ 28. Maxilliped II do.
„ 29. Maxilliped III and legs, stage I.
„ 30. Telson, stage I.
„ 31. Anterior part of Mysis, stage II.
„ 32. Do. Mastigopus.

Sergestes orientalis.

Fig. 33. Mysis, stage II (entire animal).



LUCIFER AND SERGESTES.

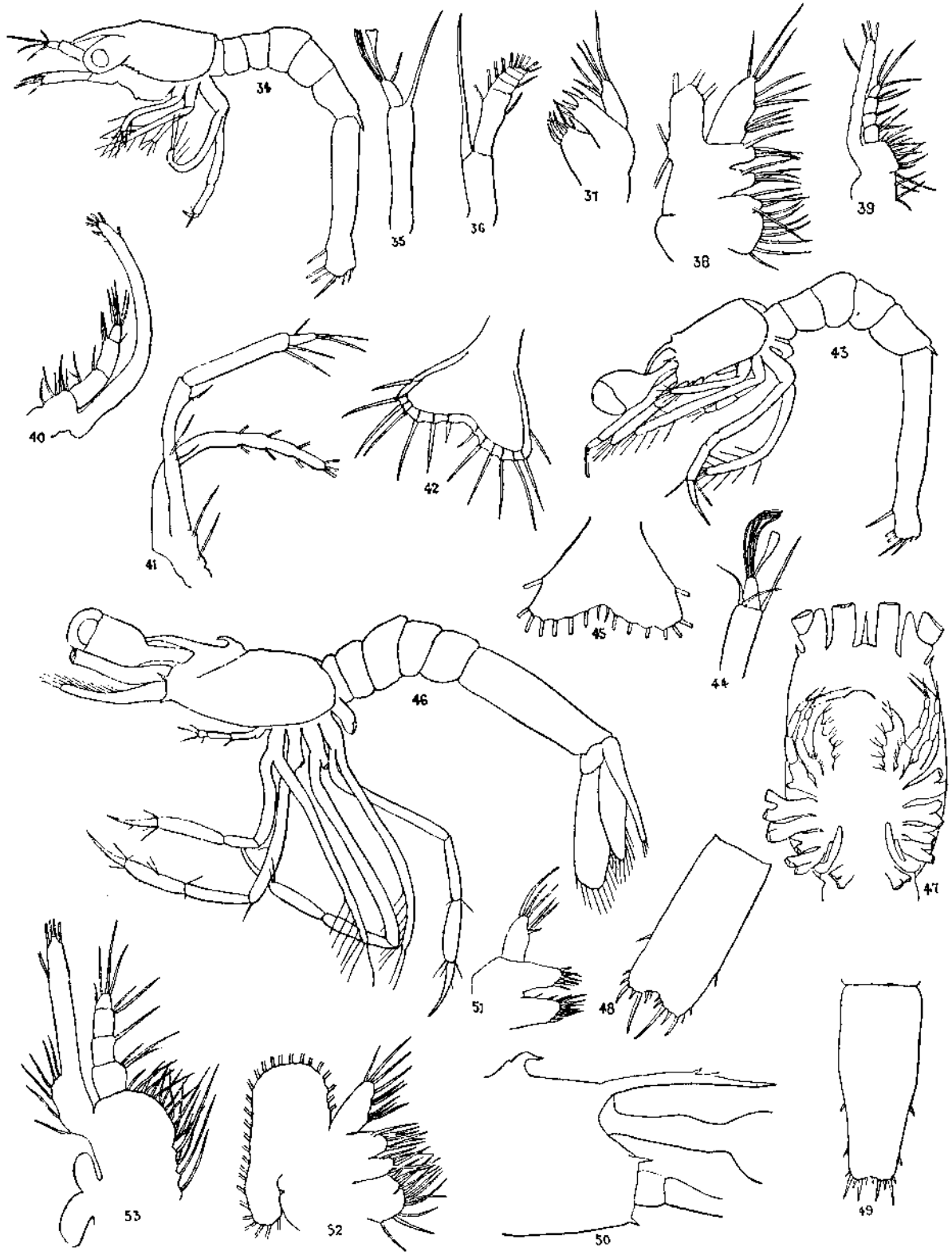
PLATE III.

Hippolysmata sp.

Fig. 34. Stage I (entire animal).
„ 35. Antennule of stage I.
„ 36. Antenna do.
„ 37. Maxilla I do.
„ 38. Maxilla II do.
„ 39. Maxilliped I do.
„ 40. Maxilliped II do.
„ 41. Maxilliped III do.
„ 42. Telson of stage I.
„ 43. Stage II (entire animal).
„ 44. Antennule of stage II.
„ 45. Telson do.

Lysmata sp.

Fig. 46. Stage IV (entire animal).
„ 47. Anterior part of stage IV (ventral view).
„ 48. Telson of stage IV.
„ 49. Telson of stage VI.
„ 50. Anterior part of stage VII.
„ 51. Maxilla I do.
„ 52. Maxilla II do.
„ 53. Maxilliped I do.



HIPPOLYSMATA AND LYSMATA.

PLATE IV.

Lysmata sp.

Fig. 54. Anterior part of stage VIII.
,, 55. Pleopod of stage IX.
,, 56. Telson do.

Hippolytidae sp. A.

Fig. 57. Entire animal.
,, 58. Antennule.
,, 59. Antenna.
,, 60. Maxilla I.
,, 61. Maxilla II.
,, 62. Maxilliped I.
,, 63. Maxilliped II.
,, 64. Maxilliped III.
,, 65. Leg I.
,, 66. Telson.

Hippolytidae sp. B.

Fig. 67. Stage I (entire animal).
,, 68. Antennule of stage I.
,, 69. Antenna do.
,, 70. Maxilla I do.
,, 71. Maxilla II do.
,, 72. Maxilliped I do.
,, 73. Maxilliped II do.
,, 74. Maxilliped III do.
,, 75. Telson do.
,, 76. Stage II (entire animal).

LYSMATA AND HIPPOLYTIDAE SPP.

PLATE V.

Hippolytidae, sp. B.

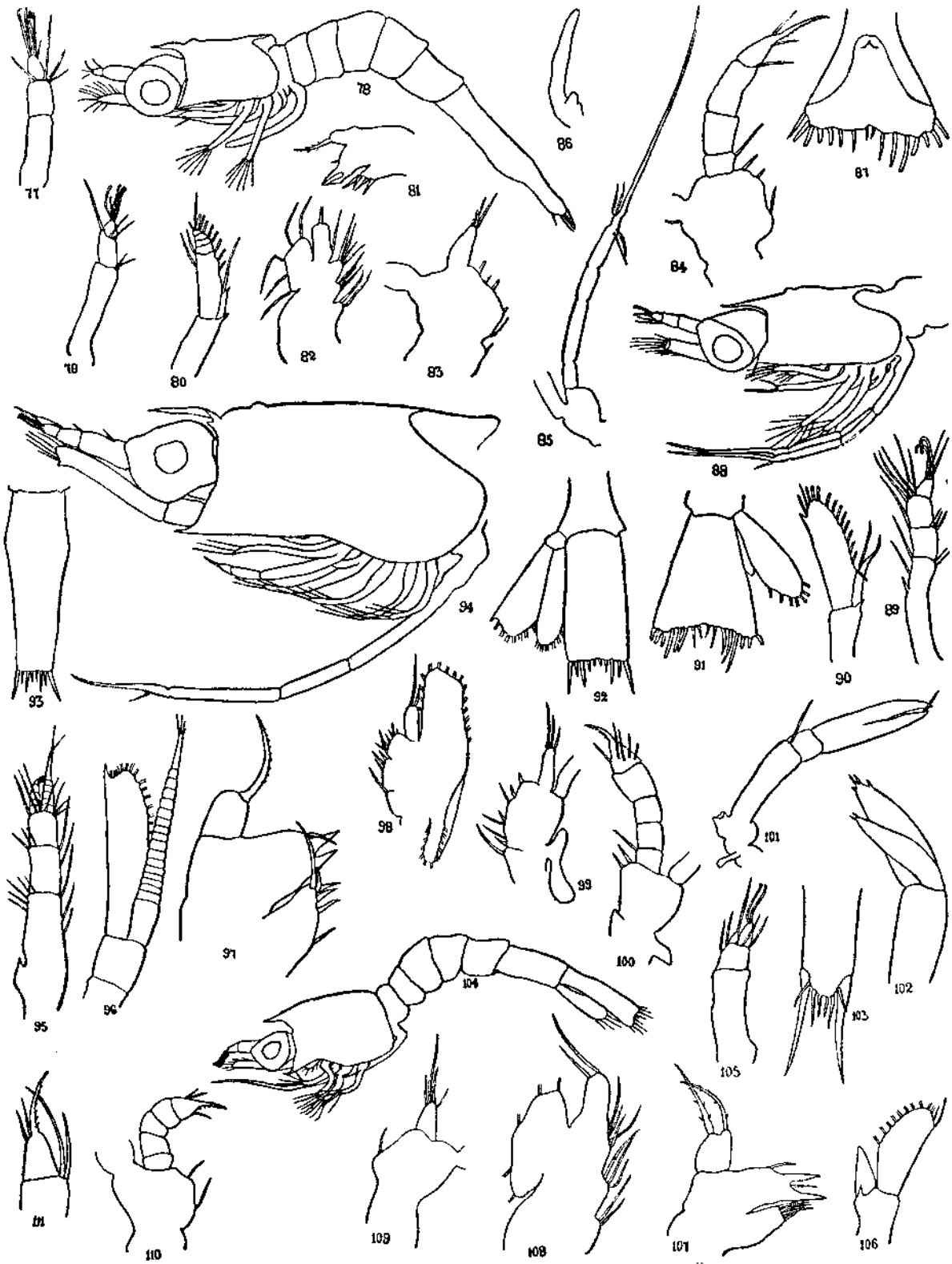
Fig. 77. Antennule of stage II.

Alpheus sp.

Fig. 78. Stage II (entire animal).
,, 79. Antennule of stage II.
,, 80. Antenna do.
,, 81. Maxilla I do.
,, 82. Maxilla II do.
,, 83. Maxilliped I do.
,, 84. Maxilliped II do.
,, 85. Maxilliped III do.
,, 86. Leg I of stage II.
,, 87. Telson do.
,, 88. Stage III (anterior part).
,, 89. Antennule of stage III.
,, 90. Antenna do.
,, 91. Uropods do.
,, 92. Uropod and telson of stage IV.
,, 93. Telson of stage V.
,, 94. Stage VIII (anterior part).
,, 95. Antennule of stage VIII.
,, 96. Antenna do.
,, 97. Maxilla I do.
,, 98. Maxilla II do.
,, 99. Maxilliped I do.
,, 100. Maxilliped II do.
,, 101. Leg I of stage VIII.
,, 102. Pleopod do.
,, 103. Telson do.

Alpheidae, sp. A.

Fig. 104. Stage III (entire animal).
,, 105. Antennule of stage III.
,, 106. Antenna do.
,, 107. Maxilla I do.
,, 108. Maxilla II do.
,, 109. Maxilliped I do.
,, 110. Maxilliped II do.
,, 111. Tip of endopod of Maxilliped III of stage III.



HIPPOLYTIDAE AND ALPHEIDAE.

PLATE VI.

Alpheidae, sp. A.

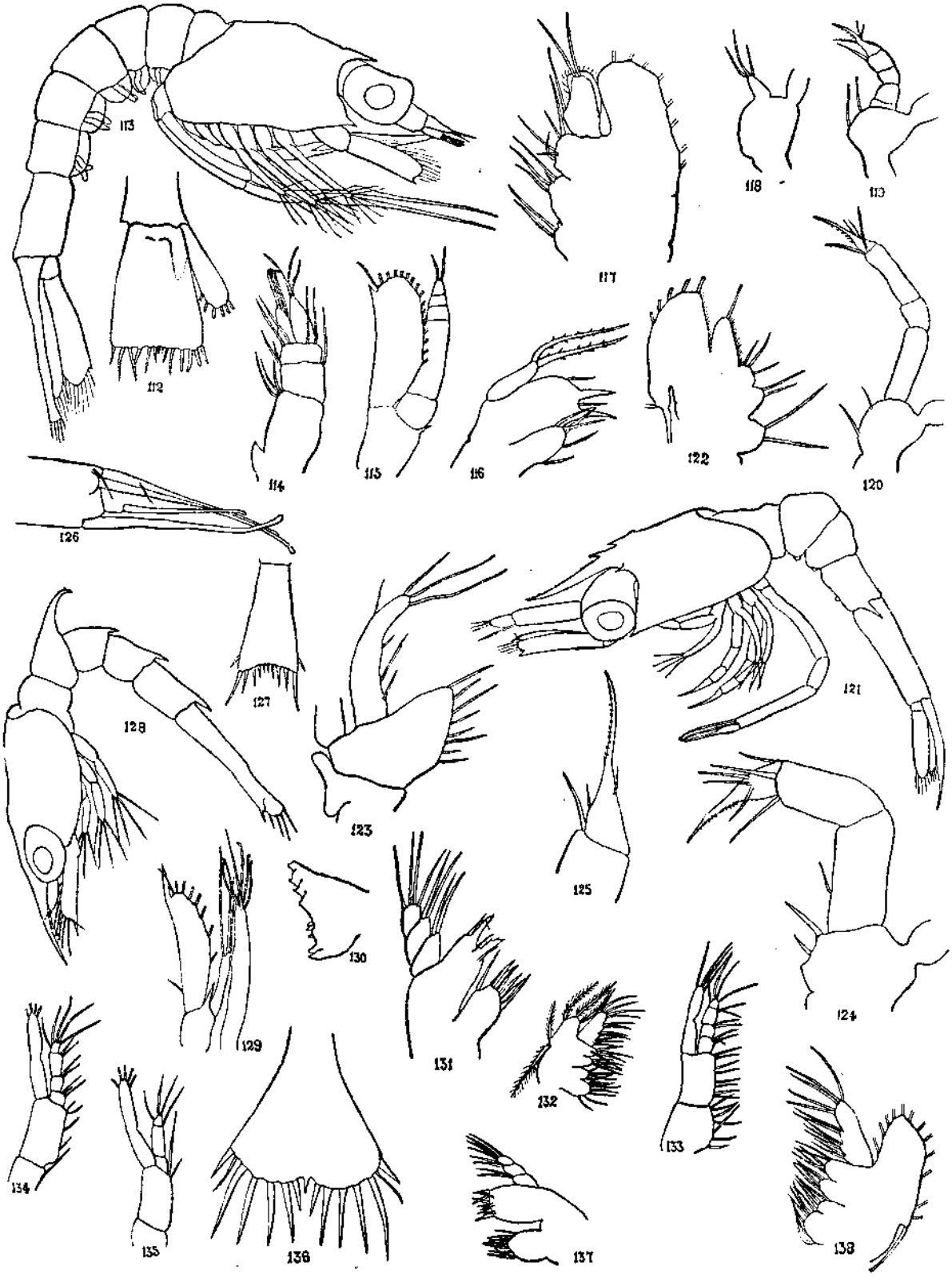
Fig. 112. Uropod of stage III.
„ 113. Next stage (entire animal).
„ 114. Antennule of next stage.
„ 115. Antenua do.
„ 116. Maxilla I do.
„ 117. Maxilla II do.
„ 118. Maxilliped I do.
„ 119. Maxilliped II do.
„ 120. Maxilliped III do.

Palaemonidae.

Fig. 121. Stage IV (entire animal).
„ 122. Maxilla II of stage IV.
„ 123. Maxilliped I do.
„ 124. Maxilliped II do.
„ 125. Maxilliped III do.
„ 126. Leg 5 of stage IV.
„ 127. Telson do.

Callianassa.

Fig. 128. Stage I (entire animal).
„ 129. Antennule of stage I.
„ 130. Mandible do.
„ 131. Maxilla I do.
„ 132. Maxilla II do.
„ 133. Maxilliped I do.
„ 134. Maxilliped II do.
„ 135. Maxilliped III do.
„ 136. Telson of stage I.
„ 137. Maxilla I of stage II.
„ 138. Maxilla II do.



ALPHEIDAE, PALAEMONIDAE AND CALLIANASSA.

PLATE VII.

Callianassa.

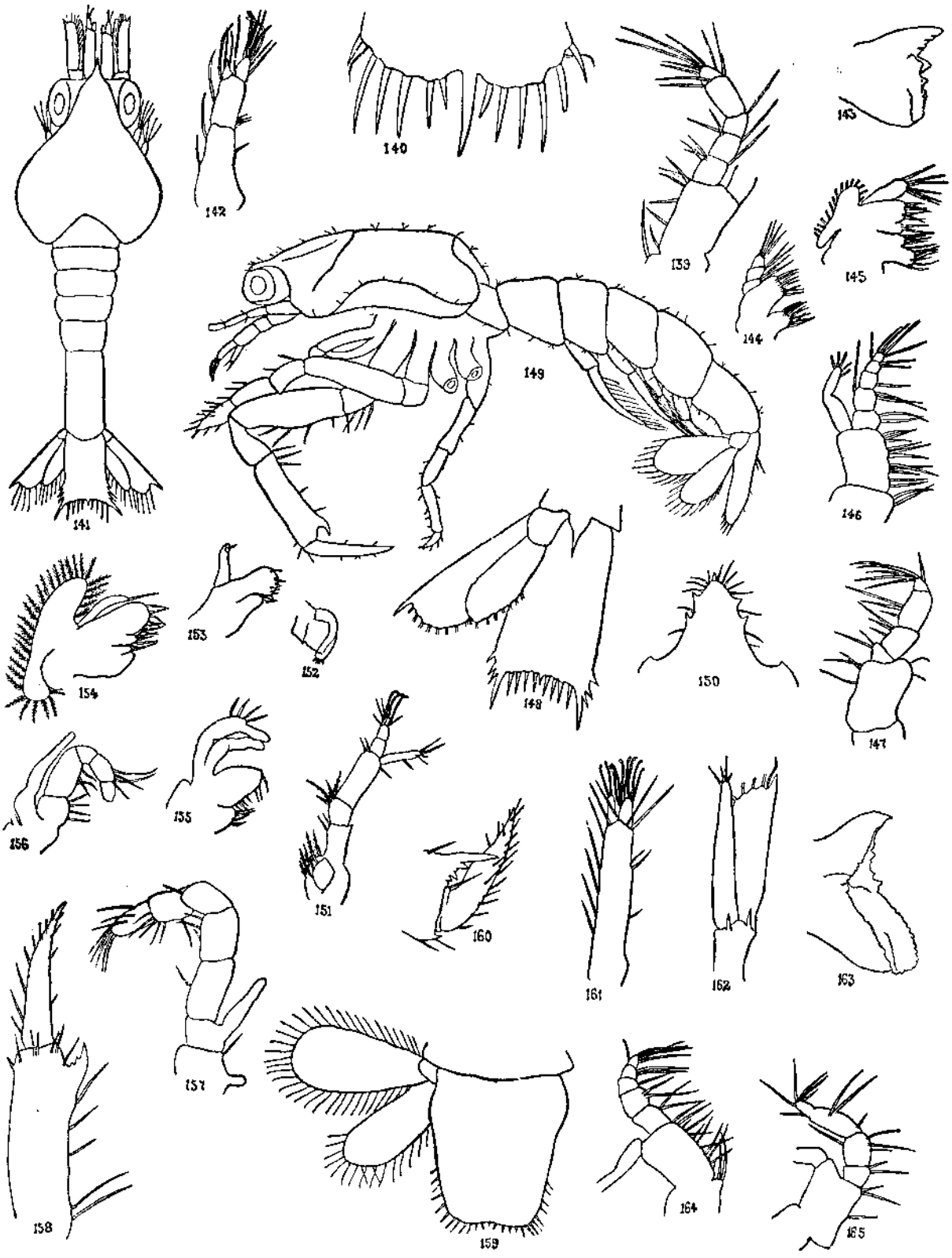
Fig. 139. Maxilliped II of stage II.
„ 140. Telson of stage II.

Upogebia sp.

Fig. 141. Last stage (entire animal).
„ 142. Antennule of last stage.
„ 143. Mandible do.
„ 144. Maxilla I do.
„ 145. Maxilla II do.
„ 146. Maxilliped I do.
„ 147. Maxilliped II do.
„ 148. Uropod do.
„ 149. First post-larval stage (entire animal).
„ 150. Rostrum of first post-larva.
„ 151. Antennule do.
„ 152. Mandible do.
„ 153. Maxilla I do.
„ 154. Maxilla II do.
„ 155. Maxilliped I do.
„ 156. Maxilliped II do.
„ 157. Maxilliped III do.
„ 158. Tip of leg I do.
„ 159. Uropod do.
„ 160. Tip of leg I of larger post-larva.

Calliadne sp.

Fig. 161. Antennule of stage III.
„ 162. Antenna do.
„ 163. Mandible do.
„ 164. Maxilliped I do.
„ 165. Maxilliped II do.



CALLIANASSA, UPOGEBIA, AND CALLIADNE.

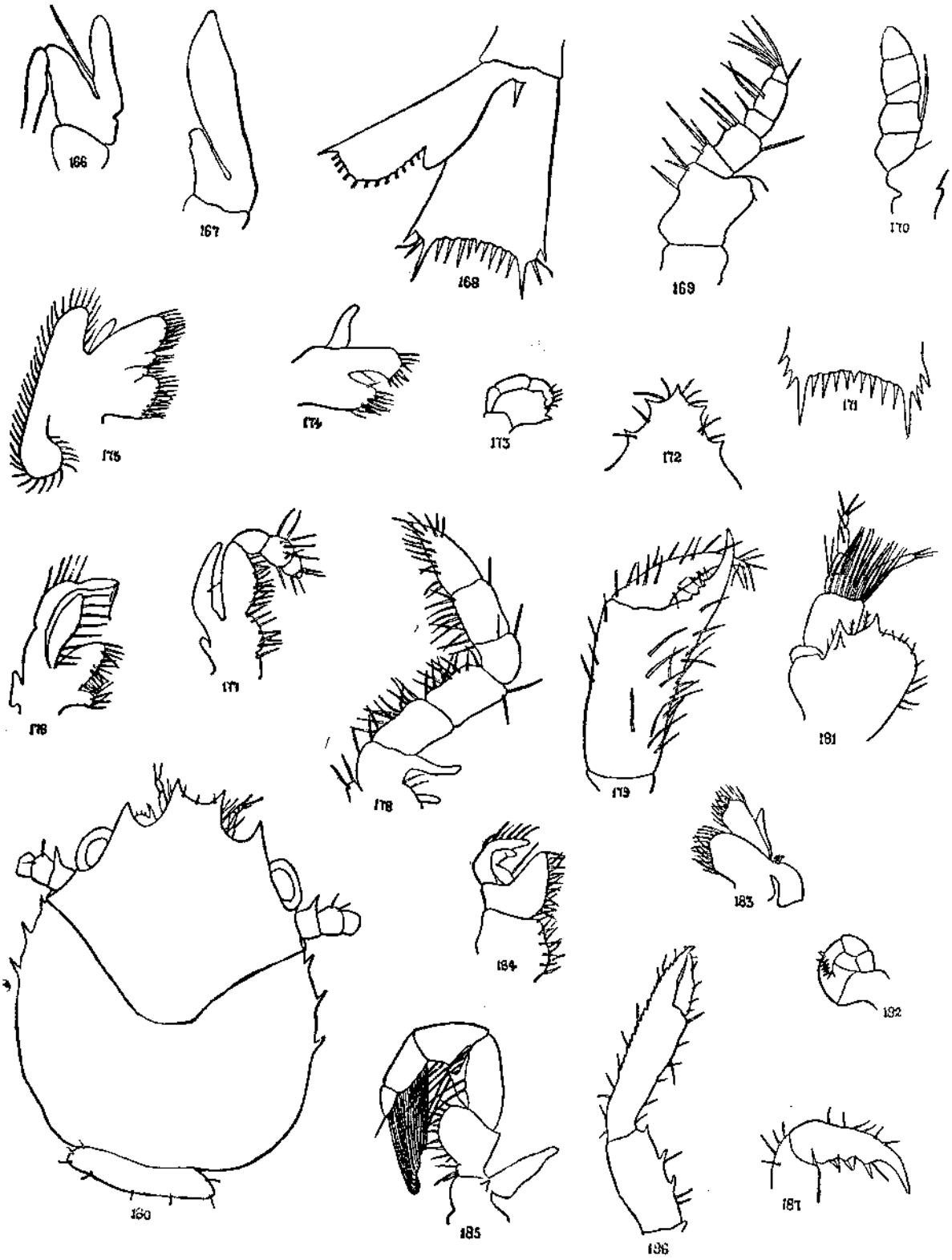
PLATE VIII.

Calliadne sp.

Fig. 166. Maxilliped III of stage III.
,, 167. Leg I of stage III.
,, 168. Uropod of stage III.
,, 169. Maxilliped II of stage IV.
,, 170. Maxilliped III do.
,, 171. Telson of stage IV.
,, 172. Rostrum of first post-larva.
,, 173. Mandible do.
,, 174. Maxilla I do.
,, 175. Maxilla II do.
,, 176. Maxilliped I do.
,, 177. Maxilliped II do.
,, 178. Maxilliped III do.
,, 179. Tip of leg I do.

Porcellana serratifrons.

Fig. 180. First post-larval stage (entire animal).
,, 181. Antennule do.
,, 182. Mandible do.
,, 183. Maxilla I do.
,, 184. Maxilliped I do.
,, 185. Maxilliped III do.
,, 186. Cheliped do.
,, 187. Tip of one walking leg do.



CALLIADNE AND PORCELLANA.

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