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FURTHER NOTES ON BRACHYURAN LARVA.

(With 36 Text-figures and 4 Tables)

By

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Further Notes on Brachyuran Larvae

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(With 4 Tables and 36 Text-figures)

CONTENT

The writer has already described the zoeas of some Japanese crabs together with the undetermined zoeas that were collected among plankton, and discussed their larval characters to enable their determination (AIKAWA, 1929, 1933). Since then zoeas of thirty more species have been reared from berried crabs, and the writer here has again attempted to define the larval characters of some of the important families, including zoeas of Japanese crabs as well as those of foreign countries. It seems almost impossible to classify zoeas by their features alone as is done in the case of adults, because the larva, besides its simple construction, undergoes marked changes through metamorphosis a number of times. The writer shows, nevertheless, that zoeas can be classified very satisfactorily as a rule by the characters of the 2nd antenna and telson, the presence or absence of carapacial spines, and by the hair formula. From these features it is possible to determine the genera or even the species to which a zoea belongs, although in some cases neither genera nor even family can be determinable. In the latter case, pigmentations of the maxillipedes and the abdominal somites are useful characters, although hardly any author seems to have so far concerned himself with chromatophores.

Furthermore, the writer attempts to ascertain whether or not these larval characters have any phylogenic significance and whether or not the grouping of zoeas in accordance with these characters is a natural one. Lastly, a key to some of the important families has been constructed and applied in determining zoeas that have previously been described.

The writer is greatly indebted to Prof. I. AMEMIYA for his kind advices in preparing this paper, and to Messrs. Y. OSIMA and H. NAKAMURA, who loaned him valuable materials for study.

Part I. The larval characters of zoea

1. The 2nd antenna (Fig. 1). The 2nd antenna of all crustacean larvae is generally a permanent feature. In the 1st larval stage of all macruran and anomuran larvae, the 2nd antenna has a single basal part, flagellum (endopodite), and scale (exopodite). The scale, which is foliaceous, has no trace of segmentation, and bears some densely plumose hairs around it. Throughout its whole larval stage (Fig. 1, 1–3), this does not undergo any marked change. The flagellum, which is smaller than the scale, is peduncular. Its proximal part is only pointed or armed with teeth, or sometimes tipped with plumose setae or with short strong spinules. The endopodite, which is segmented, also changes in appearance during metamophosis. The basal part usually bears 1 or 2 small spinules on its distal edge, its structure also remaining unchanged even in the final larval stage. The 2nd antenna is of the same type in all macruran and anomuran larvae, at least in the first larval stage. The 2nd antenna of both macruran and anomuran larvae differs from that of brachyuran zoea in the following points: (1) one of the spinules on the basal part develops into a large peduncle and becomes an important part of the brachyuran antenna, (2) the foliaceous exopodite is much reduced and has a simple spinous process, not differing from the peduncle, and (3) the endopodite is usually absent in the 1st larval stage of brachyuran larva, although it

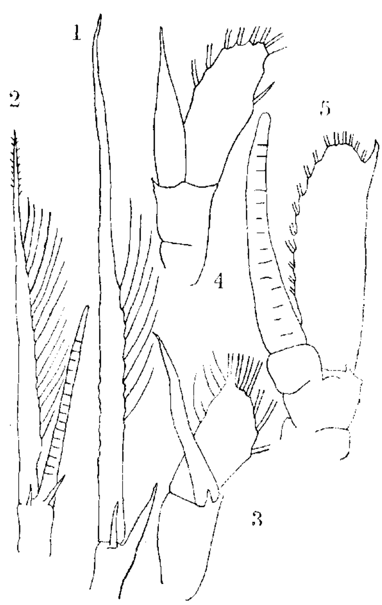


Fig. 1. 2nd antennae of Macrura and Anomura

1. *Galathea rugosa* 1st stage
2. ,, last stage
3. *Hippolyte varians* 1st stage
4. ,, 2nd stage
5. ,, 4th stage

attains to considerable length at a later stage. The difference in the brachyuran antenna from those of macruran and anomuran larvae however becomes indistinct owing to the presence of certain transitional types of antenna. The spinule on the basal part, which is usually very small in the macruran larva, becomes more or less distinct in anomuran larvae, such as *Galathea* and *Lithodes*, attains medium length in the larvae of the Homolidae, and becomes very long in the zoeas of Brachyura. The endopodite, which is always present and very large in the macruran larva, is very small or even absent in some larvae of Anomura, as in *Galathea rugosa*. All macruran larvae have well developed, flattened, and foliaceous exopodites. This has been observed in the larva of *Galathea rugosa*, in which it is long and peduncular, resembling that of the brachyuran larva, although it is still provided with plumose hairs around it. In the brachyuran larva, the single peduncular exopodite is covered by a foliaceous sheath at the prezoeal stage, just after hatching. A similar transformation is thus traceable through its ontogenetic development. Although both the exopodite and the endopodite of macruran and anomuran antennae are gradually reduced toward the brachyuran antenna, in contrast to it, the small spine of the basal part increases in size from Macrura to Brachyura. CANO regarded the long exopodite as a primitive feature, it being homologous to the antennal scale of Caridea (CANO, 1892; cited from LEBOUR, 1928).

Of the 2nd antenna, the exopodite is most developed in type A of antenna, reduced considerably in type B, and wholly disappeared in type C. Comparing the degrees of exopodite development, type A is probably the most primitive, type C highly developed, and type B intermediate between the two. Type D may be a mere deviation. They can thus be arranged in stages of development. Actually, type A is found among the Oxystomata, types A and B among the Majoidea, and all the three types in Cancroidea. Type C, the most developed, occurs in the most highly developed group, and type A, the most primitive, in the much lower group. The D-type of antenna is found widely distributed in several groups, zoeas with antenna of this type belonging to families that are supposed to have deviated from their allied families.

2. Telson (Fig. 2). Compared with the relative uniformity of the 2nd antenna, the larval telsons of Macrura and Anomura comprise several types. As the six principal types we may mention the telsons of *Penaeus*, *Pasiphaë*, *Pandalus*, *Astacus*, and *Porcellana*. In Macrura

and Anomura, the larval telson in the early stage differs from that in the later mysis stage. The writer, following GURNEY, mainly refers to telson in the 1st larval stage, seeing that the early larva retains the primitive features, while later, development is retarded more or less as the result of early acquisition of adult characters (GURNEY, 1927).

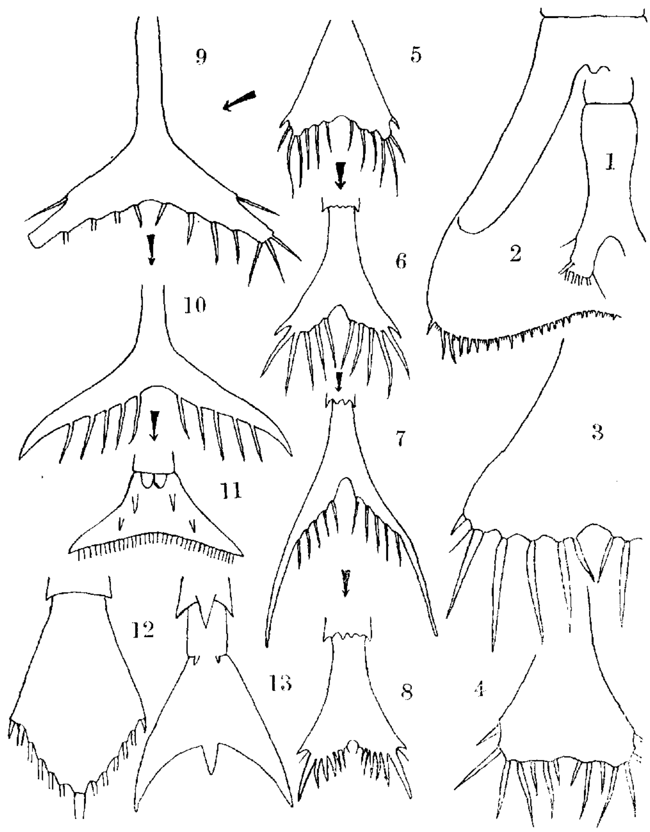


Fig. 2. Telsons of Macrura and Anomura at 1st stage

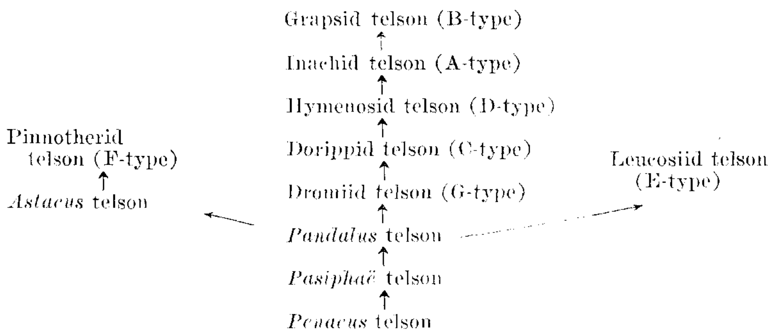
1. *Penaeus* sp.
2. *Pasiphaë tarda*
3. *Gebia littolaris*
4. *Hippolyte varians*
5. *Pandalus propinquus*
6. *Galanthea dispersa*
7. *Galathea rugosa*
8. *Lithodes maia*
9. *Crangon norvegicus*
10. *Taxea noctura*
11. *Homola* sp.
12. *Porcellana longicornis*
13. *Astacus americanus*

The type differences in these larval telsons are as follows: The *Penaeus* telson (*Penaeus* sp. Fig. 2, 1) has 2 quadrate lobes, greatly resembling that of Copepods. With these lobes expanded and the middle emargination consequently shallow, this telson becomes the larval telson of *Pasiphaë* (*Pasiphaë tarda*, 2). This *Pasiphaë*-telson can also be correlated with the B- and C-types of the brachyuran telson, being related through such transitional telsons as observed in the 1st larval stage of *Gebia littolaris* (3), *Hippolyte varians* (4), *Pandalus propinquus* (5), *Galathea dispersa* (6), *G. rugosa* (7), and *Lithodes maia* (8). These transitional types of telson will be referred to here as the *Pandalus* telson. On the other hand, *Pasiphaë* telson can also change to telsons of Dromiidae and Homolidae, and even to that of the Leucosiidae, following the course of transition from *Pandalus* telson (*Pandalus propinquus*) to *Taxea nocturna* through *Crangon norvegicus* (13). The telson of *Astacus americanus* (13), which has a median spine, resembles the F-type telson of the Pinnotheridae. Through the telson of *Callianassa*, *Calocaris macandreae*, and *Axius stirhynchus*, this telson of *Astacus* is also related to the *Pandalus* telson. In *Crangon*, the mysis has a telson with a median spine (*Astacus* type of telson), while the zoea has a *Pandalus* type of telson. It is also noteworthy that the D-type of telson in the Hymenosomidae does not resemble any telson in the 1st larval stage of Macrura and Anomura, but resembles instead those at the mysis stage of the last two.

Porcellana telson (*Porcellana longicornis*, 12) is also related to *Pandalus* telson through those of *Pagurus chiroacanthus*, *Palaemon fabricii*, and lastly *Pandalus propinquus*.

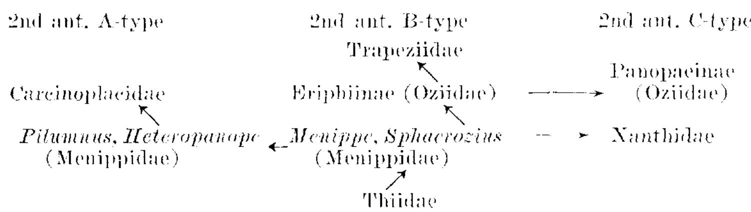
In this way, decapod larval telson of whatever type are communicated by the transitional types of telson to primitive types, so far as concern the larval stage, so that with any telson, it is possible to postulate a still more primitive type. None of them are therefore independent of the series of decapod transformations.

Among the Dromiidae and the Homolidae is a G-type of telson that resembles most the *Pandalus*-type. We find both types E and C among the Oxystomata, types A and D among the Majoidea, and type B among the Catametopa. Type F is also found among the Pinnotheridae of the Catametopa. Type G resembles therefore the fundamental *Pandalus*-type and is also most primitive. while types C and E are slightly more developed, ranking next to the *Pandalus*-type. The B-type of telson is most highly developed, while the A- and D-type may be the intermediate. The relationships between these types may be assumed to be as in the following scheme:

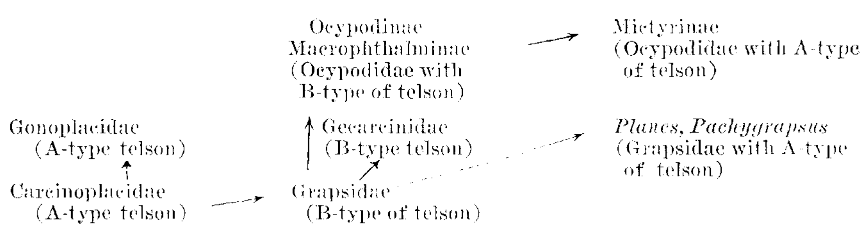


There occur simultaneously several types of telson and 2nd antenna in a small limited group, for example, in the larvae of the Xanthini and Grapsini.

(1) Xanthini....Telson always A-type.



(2) Grapsini.



From the fact that the adult diverges increasingly from its ancestoral form, the conclusion is that type A of the 2nd antenna can transform to type B, and eventually to type C. In addition, the B-type of telson usually dominates more in the highly developed group Grapsini than in the less developed Xanthini. The phylogenic development of the 2nd antenna can not only be traced by comparing those of all decapods at the 1st larval stages, but is also found on a smaller scale in these limited groups. The differences in the degree of development is almost always parallel to the phylogenic relationships between their adult forms.

3. Phylogenic significance of the 2nd antenna and telson. In view of the successive changes in structure of both the 2nd antenna and telson from Macrura to Brachyura, it may safely be said that the 2nd antenna and telson retain their ancestral characters preserving the phylogenic significance, although opinions differ on the relative importance of the secondary larval characters.

HEIDER, following CLAUS, regarded the zoea as an interposed larval form that does not belong to the direct series of transformation in the Malacostraca, seeing that it has assumed a certain independence because of the secondary changes in structure, chief of which is the retarded development of the hind thoracic region. The zoea, which is thus regarded as a secondary modified larval form related to the peculiar conditions of larval life, cannot be classed with the series of hypothetical ancestors of the Malacostraca. R. DANIEL (1930) in discussing the significance of the persistence of the adult type of muscular system in the larval form, arrived at the same conclusion. The presence of the adult abdominal muscular system of *Crangon vulgaris* in its zoea may support CLAUS view that this larval form has no ancestral significance, since it means that, in addition to the external secondary modification to the larval life, there is also present a complicated system that is typical of the adult. There is also the adult system of masculature in the mysis stage, which is generally accepted as representing a schizopod ancestor. The presence of the adult system in these larval forms can be explained by its being due to the simplification in metamorphosis by the tendency toward obliteration of characteristics of the special ontogenetic stages. Zoea stage appears altered by anticipating certain peculiarites in the ensuing stages. Development is hindered by early acquisition of adult characters. DANIEL also says that the occurrence of the adult system of masculature in zoea and mysis is additional indication of this gradual suppression of the complicated larval series in the higher crustacea.

However, if this conclusion is accepted, the author is of the opinion that the anticipation is necessarily qualified by the original nature of the larval characters. Consequently, if the larval characters are affected by secondary modification and if they show precocious development, they possess ancestral significance to a considerable extent. CLAUS also pointed out that the segments in the middle region of the body in zoea are not altogether wanting, although being compressed they are difficult to recognize externally, so that, as might be supposed, the way in which the segment forms is not so opposed to that of other larvae of Entomostraca and Malacostraca. This point therefore might not deter one from accepting BALFOUR's view that the zoea is an ancestral form, since a true zoea is found in all those Malacostracan group in which the larva leaves the egg in an imperfect form. The unity of plan here expresses a relationship just as strongly as it does in adult forms. Certain features can at any rate indicate ancestral structure, although there may occur some modifying tendencies that obscure the ancestral significance.

Should the zoeal features, as a whole, not retain the ancestral characters, it is certainly possible to select from them some features of phylogenic significance. These characters may be useful in determining the zoeas and in tracing the relationship between their adult forms. The muscular system and the number of segments, as CLAUS and DANIEL noticed, may not be suited for this purpose.

The present writer is convinced that the 2nd antenna and telson may have phylogenic significances, seeing that they show direct series of transformations from Macrura to Brachyura, and which, in addition, are traceable ontogenetically.

4. Other larval features. Zoeas of the same or nearly allied families are also similar in other faeatures. HYMAN noted that pigmentation, being a constant feature, is often of diagnostic value, although the earlier paper does not refer to it except in the most general terms (HYMAN, 1925). Zoeas differ from one another in character and in the grouping of chromatophores in the maxillipedes. In the primitive group, the maxillipedal chromatophores are generally of primary character, while in the higher group they are secondary. The hair formula, especially the modes of serration on the endopodites of both maxillae, are also peculiar to each group. The endopodite of the 2nd maxilla is 2-jointed in the most primitive group, such as the Dromiidae, while it is bifurcated in the higher group. In the matter of presence or absence of carapacial spines, there is a similarity among the zoeas of the same group, although the grouping based on it is not always parallel to the relationship between their adult forms. Neverthless, it is possible to detect the successive changes in disappearance or development of spines among the nearly allied groups. For example, in the development of the lateral spines, the zoea of *Herbstia* is intermediate between the 1st and 2nd groups of the Majidae, as mentioned in (9), Part III.

Part II. Description of zoeas newly obtained

1. *Latreillia phalangium* DE HAAN. 1st zoea. Fig. 3.

Characters: Only rostrum present; 2nd ant. E-type; telson G-type; no stable brown chromatophore present in maxilliped and adbomen; hair formula 5-1, 3-4 (7), 5-2-0-0.

Rostrum 0.85 mm, carapace 0.53 mm; abdomen 0.85 mm long, 0.21 mm wide, telson 0.23 mm.

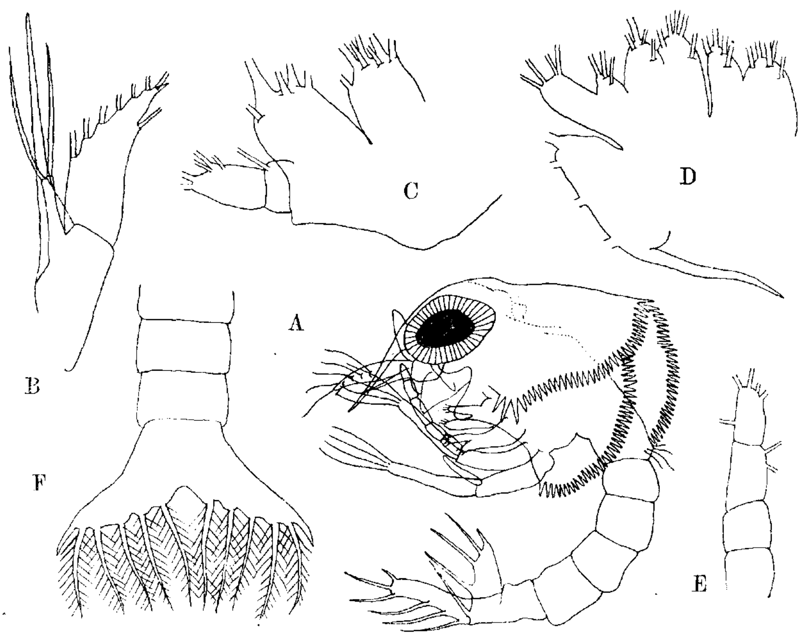


Fig. 3. *Latreillia phalangium* D. HANN. 1st larva.
(A) lateral view × 61. (B) 2nd ant. × 120. (C) 1st mx. × 233. (D) 2nd mx. × 233. (E) enp. of 2nd mxp. × 233. (F) abdomen × 61.

Zoea resembles larvae of Macrura and Anomura. Lateral part of carapace double lapped, both laps closely toothed along their lower margins; teeth fairly large in part of upper lap where the lateral spine is usually expected in other brachyuran zoea. Both laps unite behind. 1st ant. of usual form; 2nd ant. E-type. Foliaceous enp. tipped with small tooth, with 8 densely plumose hairs around it. Enp. short, attaining only half the length of exp., ending in 2 spinules. Spinous process (peduncle) very long, nearly twice length of enp. and equal to exp. In this way, E-type of 2nd ant. can be distinguished from the usual macruran antenna. Enp. of 1st mx. 2-articulate, mode of serration here expressed by 5–1. Enp. of 2nd mx. has 2 joints, its proximal joint with 4 hairs, distal joint with 3. Other podites well bifurcated. Scaphognathite similar to usual brachyuran ones, with 4 long plumose hairs along lateral side, ending in pointed projection. 1st mxp. similar to those observed in usual brachyuran zoea, while 2nd mxp. has 4-jointed enp. 1st and 2nd joints hairless, 3rd 2, distal 4 each. No lateral knob on abdomen, but 2 long dorsal hairs on 1st somite. Size of all abdominal somites similar, wider than long. Telson G-type, resembling that of *Crangon norvegicus* (fig. 2, 5) or *Taxea nocturna* (6). Short but strong tooth present on corner and lower margin concave. 4 pairs of spines of same length, plumose. Middle depression fairly deep.

2. *Parahomola japonica* PARISI. 1st zoea. Fig. 4.

Characters: All similar to *Latreillia phalangium*, except hair formula 5–1, 6–2 (8), 5–2–1–1.

Rostrum 0.55 mm, carapace 0.79 mm; abdomen 0.98 mm long, 0.22 mm wide, telson 0.30 mm.

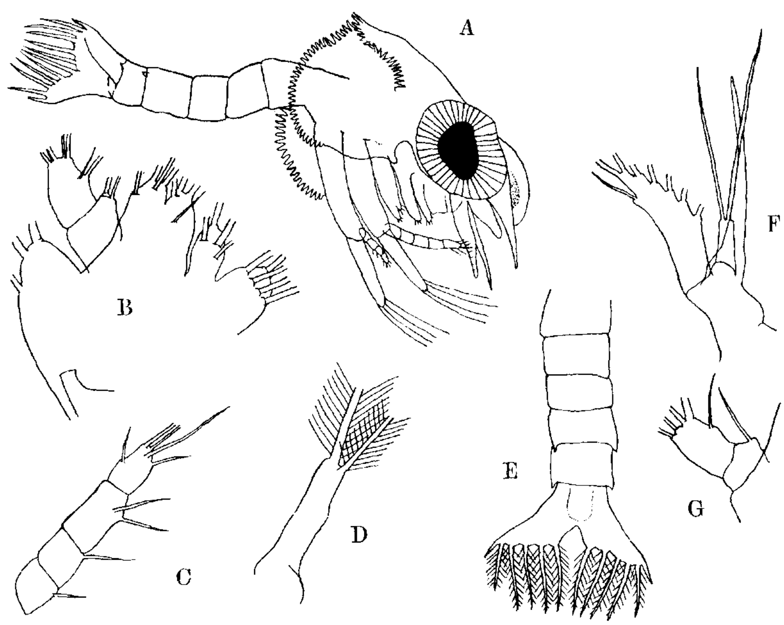


Fig. 4. *Parahomola japonica* PARISI. 1st zoea.
(A) lateral view ×40. (B) 2nd mx. ×213. (C) enp. of 2nd mxp. ×213.
(D) enp. of 2nd ant. ×213. (E) abdomen ×39. (F) 2nd ant. ×87.
(G) enp. of 1st mx. ×213.

This zoea resembles in every respect that of *Latreillia phalangium*. Carapace also double, although upper lap not so expanded as in *Lat. phal.*, toothed along their margins. 2nd ant. has no tooth on tip of exp., but in other points same as that of *Lat. phal.* Enp. of 1st mx. also similar to *Lat. phal.*, while enp. of 2nd mx. differs in mode of serration, 6–2 (8), from *Lat. phal.* Scaphognathite has only 3 lateral hairs, being 1 less than *Lat. phal.* Enp. of 2nd mxp. has also 4 joints. Both 1st and 2nd joints with 1 hair each, 3rd 2, distal 5. No lateral knob on abdominal somite. Lateral ends of 4th and 5th somites slightly pointed. 4 pairs of inner spines, middle depression slightly deeper in this larva than in *Lat. phal.*

3. *Homola* sp. 4th zoea to megalopa. Fig. 5.

Characters: Only rostrum present, but very short; in addition a single median horn and paired sublateral ones in frontal region, 2nd ant. E-type, telson G-type, hair formula 5–1, 2–4 (6), 5–3–1–3–0.

Large zoeas of 4th stage and a megalopa were collected in Sagami Bay on September 12, 1933. Rostrum short, thick, pointed. Lateral and median horns also short, thick, branched. Lateral horns projecting in direction perpendicular to median horn. Carapace large and double lapped as seen in *Latreillia* and *Parahomola*. Both laps toothed along their lower margins. Many thick hairs on middle dorsal part, some tubercles on postero-dorsal part. 1st ant. usual form. At 4th zoeal stage, basal part 2-jointed, enp. single, exp. incompletely 5-jointed. 2nd ant. E-type. Peduncle much shorter than observed in larvae of *Parahomola* and *Latreillia*. Exp. slender, bearing 12 long plumose hairs along inner side, 7 along outer, but no tooth on tip. Enp. nearly same length as exp., but not yet segmented at last stage. Comparison of antennae of these 3 species shows 2nd ant. of *Homola* sp. most primitive in character, although distinguished from usual macruran antenna by fairly long spine on basal part. Mandible has wide chewing surface, haired along outer margin. Palp single joint. Enp. of 1st mx. has 2 joints; 1st joint has 1 hair on distal edge, the 2nd 1 lateral and 4 terminal hairs. Coxo- and basipodites of 2nd mx. deeply bifurcated, all lobes densely serrated. Enp. has 2 joints. 1st joint has 1 hair, 2nd has 4 each. Scaphognathite fairly large, closely serrated all around its margin. Expds. of both 1st and 2nd mxpds. has only 6 swimming hairs at last zoeal stage. Enp. of 2nd mxp. has 5 joints. 1st joint hairless, 2nd, 3, 3rd only 1, 4th 4, last 5. 3rd mxp.

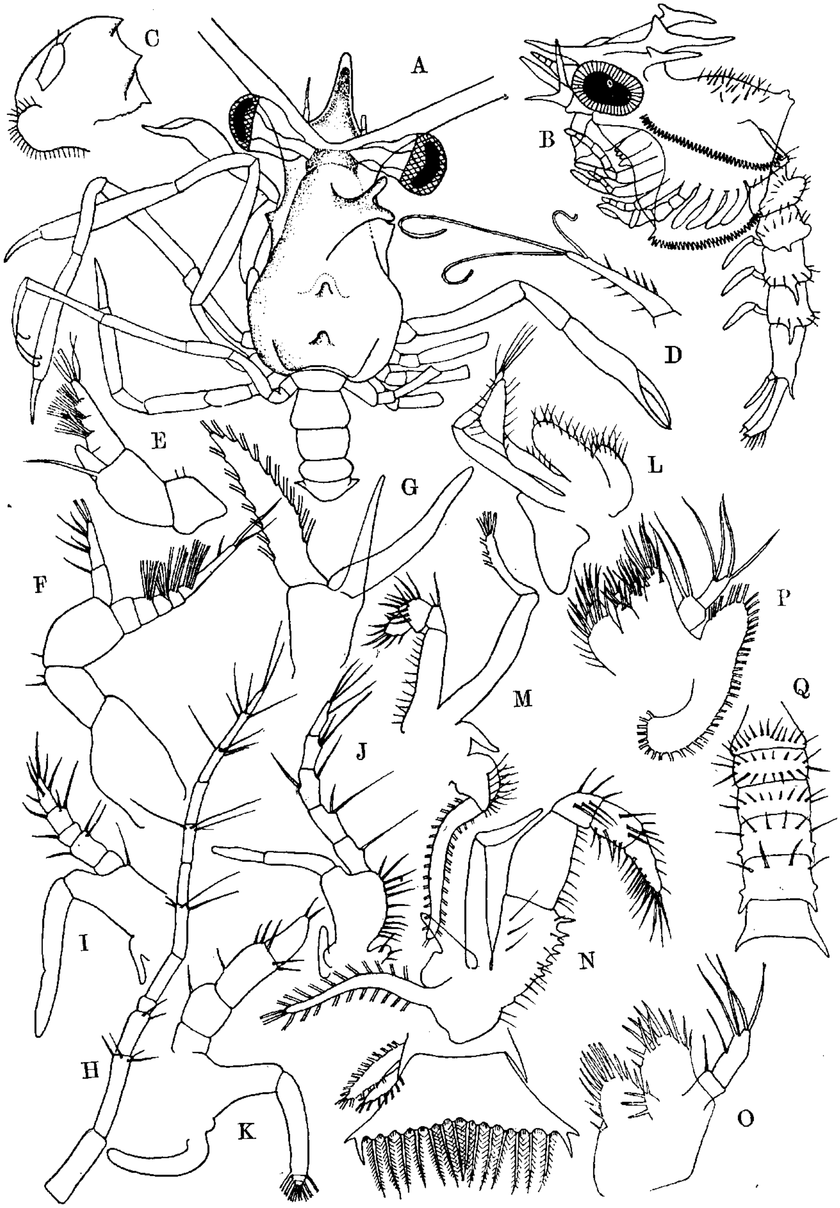


Fig. 5. *Homola* sp. Last zoea and megalopa.
(A) dorsal view (megalopa) ×9. (B) lateral view (zoea) ×14. (C) mandible (zoea) ×40. (D) dactylus of last leg (magalopa) ×39. (E) 1st ant. (zoea) ×43. (F) 1st ant. (megal.) ×35. (G) 2nd ant. (zoea) ×43. (H) 2nd ant. (zoea) ×21. (I) 1st mxp. (zoea) ×34. (J) 2nd mxp. (zoea) ×34. (K) 3rd mxp. (zoea) ×61. (L) 1st mxp. (megal.) ×26. (M) 2nd mxp. (megal.) ×26. (N) 3rd mxp. (megal.) ×26. (O) 1st mx. (zoea) ×63. (P) 2nd mx. (zoea) ×63. (Q) abdomen (zoea ×14.

well developed. Enp. has 4 joints, exp. 2. Exp. has 8 swimming hairs. Cheliped fairly well developed, but other 4 feet only incompletely segmented. Abdomen composed of 6 somites and telson. Lateral knobs on 4th and 5th somites. Lateral ends of 5th and 6th somites very prominent, but those of 3rd and 4th somites only slightly projected. Single bands of stiff hairs on 1st and 3rd to 5th somites, 2 bands on 2nd somite. Telson G-type, trapezoidal, with long spine and small denticle on lateral corner. Lower margin with 14 long plumose hairs close together. Uropod of last somite has 2 terminal hairs.

Megalopa. Carapace longer in megalopa than in zoea, narrowing anteriorly. Armatures of carapace similar to those of zoea. Lateral horns markedly elongated (though broken in this specimen). Rostrum and median horn show no noticeable change in shape. Small tubercle on lateral side behind eye. Cheliped and 4 legs markedly long and slender. 1st ant. 2-branched and long. Basal part 3-jointed, enp. 2-jointed, exp. 5-jointed. Sensory tubes on distal edge of 2nd to 4th joints and basal part of 5th joint. 5th joint very slender, ends in 2 unequal hairs. 2nd ant. single, slender, separable into 3 parts. Basal part has 3 thick joints, middle part 5 joints. 4th joint very small, but other 4 long, slender. Distal part has 4 joints. Ring of 4 long stiff hairs on distal edge of 6th, 8th, 10th, and 11th joints. Distal joint has 2 terminal hairs. Mandible with palp of single joint, its chewing surface roughly tuberculed, its outer margin serrated. Enpds. of both mxls. markedly reduced. Enp. of 2nd mx. ends in short hair, has 3 long smooth hairs along outer side, 1 on inner. Epipodite (Epip.) of 1st mxp. flattened, triangular. Enp. hammer-shaped process, 2-jointed. Enp. of 2nd mxp. has 5 joints, exp. 2. The epip., which is long, flattened, is a peduncular process, with serrations all around it. Enp. of 3rd mxp. has 5 joints, basal 1st joint provided with toothed ridge along its inner side. Epip. resembles that of 2nd mxp. Propodite (prp.) of 2nd and 3rd legs widened distally. Dactylopodite (dactyl.) of last leg short, slender, bearing 2 terminal and 1 lateral curly feelers. Abdomen composed of 6 somites and telson. All somites smooth. Uropod of last somite has 2 terminal hairs. Lateral side of last somite prominent ventrally.

4. *Dorippe granulata* DE HAAN. 1st zoea. Fig. 6.

Characters: Dorsum and rostrum present, 2nd ant. A_3-type, telson C-type, no stable brown chromatophores present in abdomen and in mxpds., hair formula 4–0, 4, 2–1–0.

Dorsum 3.10 mm, rostrum 4.50 mm, perpendicular distance between their tips 8.44 mm, carapace 0.84 mm long; abdomen 1.88 mm long, 0.12 mm wide; telson 0.74 mm.

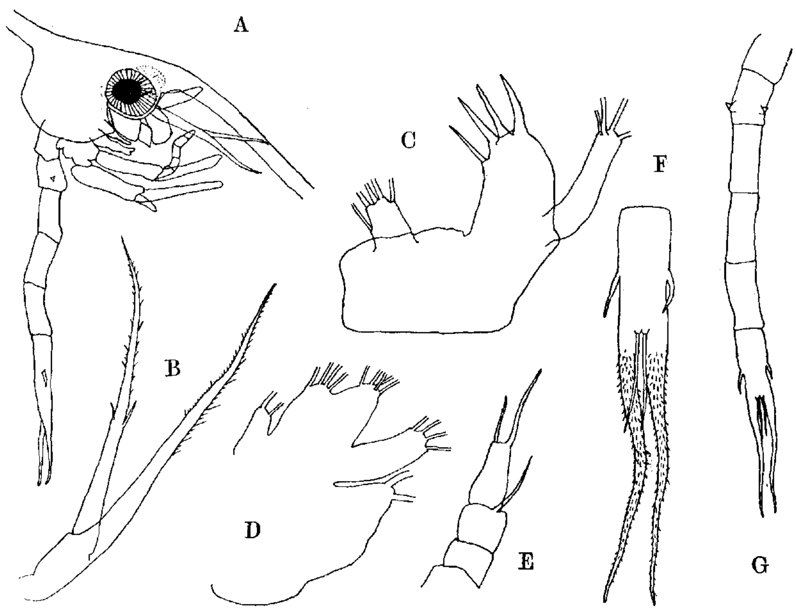


Fig. 6. *Dorippe granulata* D. H. 1st zoea.
(A) lateral view ×21. (B) 2nd ant. ×87. (C) 1st mx. ×177. (D) 2nd mx. ×177. (E) enp. of 2nd mxp. ×177. (F) telson ×61. (G) abdomen ×35.

Larva very large already at 1st stage; rostrum, dorsum, and abdomen markedly long and slender. 1st ant. usual form, slender. 2nd ant. A_3-type. Peduncle and exp. nearly same length, slender, long, armed with fine teeth on both sides. Exp. bears 2 large spinules on middle part. Enp. of 1st mx. of single joint with 4 long hairs on tip. Coxopodite of 1st mx. far apart from other 2. Only the basipodite of 2nd mx. bifurcated, other 2 single. Coxopodite with 2 hairs, enp. with 4. Basipodite has 5 hairs on inner lobe, 4 on outer. Scaphognathite with 2 hairs near its upper corner. Enp. of 2nd mxp. has 3 joints; 1st joint hairless, 2nd 1 on its distal edge, 3rd 2 on its tip. Small rudiments of 3rd mxp. and 5 pairs of pereiopods present behind 2nd mxp. Abdomen composed of 5 somites and telson. All somites long, similar in shape. Lateral knobs only on 2nd somite. Telson C-type. Telson-fork covered all over with fine serrations. Large spine on each side of telson. Pair of inner spines thick, nearly 1/3 of telson-fork.

5. *Dorippe* sp. A 2nd zoea. Fig. 7.

Characters: Dorsum and rostrum present, 2nd ant. A_3-type, telson C-type, no brown chromatophore present, hair formula 4–0, 4, 3–1–0.

Many zoeas from the 2nd to the last stage were collected among sardine larvae off Watanoha, Miyagi Pref. in August, 1935.

At 2nd stage, dorsum 6.55 mm, rostrum 5.40 mm, perpendicular distance between their tips 13.2 mm, carapace 1.25 mm, abdomen 3.03 mm long, 0.14 mm wide, telson 1.08 mm.

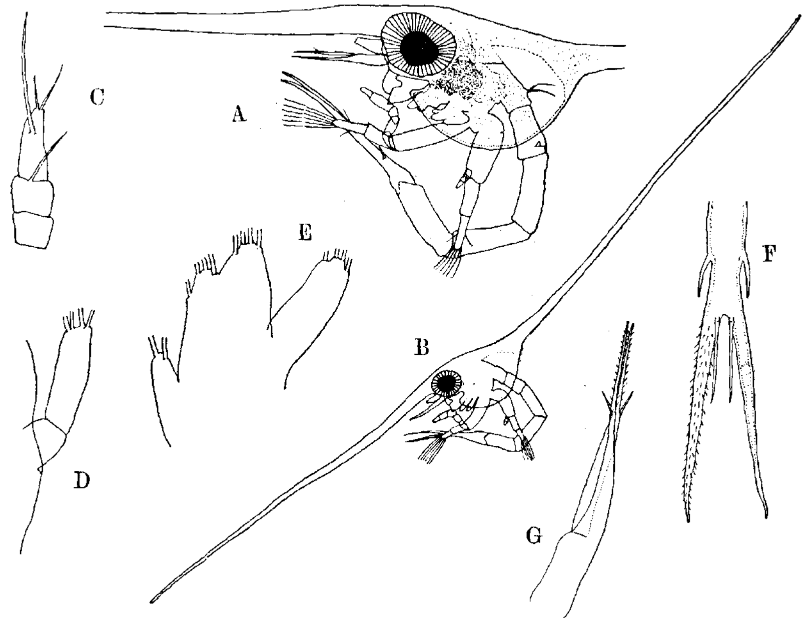


Fig. 7. *Dorippe* sp. A. 2nd zoea.
(A) lateral view ×21. (B) total view ×9. (C) enp. of 2nd mxp.×180. (D) enp. of 1st mx. ×180. (E) 2nd mx. ×180. (F) telson ×39. (G) 2nd ant. ×61.

Dorsum and rostrum unusually long. Carapace oval laterally. Its lower margin coarsely serrated. 1st and 2nd ants. long, slender, resembling that of *Dorippe granulata*. Enp. of 2nd ant. not yet in appearance at 2nd stage. Enp. of 1st mx. has 2 joints, only distal 2nd joint tipped with 4 hairs. 2nd mx. exactly the same as that of *Dor. gran.* Scaphognathite has 4 long plumose hairs near upper corner, 2 on lower lateral margin. Exp. of mxpds. 2 jointed, with 6 swimming, 2 accessory hairs. Enp. of 2nd mxp. has 3 joints; 1st joint hairless, 2nd 1 on its distal edge, 3rd 3 on tip. 3rd mxp. and 5 pairs of pereiopods not yet in eviednce at 2nd stage. Abdomen composed of 5 somites and telson, as 6th somite not yet separated from telson. Lateral knobs on 2nd somite, 2 dorsal hairs on 1st. Telson resembles much that of *Dor. gran.*, although more densely chitinized than that of latter.

6. *Dorippe* sp. B. Fig. 8. Last zoea.

Characters: Similar in every respect to the preceding, except the hair formula 4–0, 4, 4–1–0.

Dorsum and rostrum very prominent. Both antennae and maxillae similar to those of *Dor. gran.* and *Dor.* sp. A. Enp. of 2nd mxp. has 3 joints, mode of serration here expressed by 4–1–0, thus differing from other 2 larvae. Abdomen very long, slender. Lateral knob wholly absent. Telson also resembles that of *Dor. gran.*

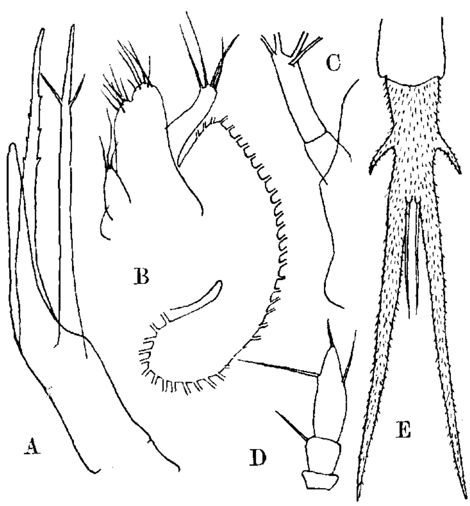


Fig. 8. *Dorippe* sp. B. Last zoea.
(A) 2nd ant. ×43. (B) 2nd mx. ×61. (C) 1st mx. ×72. (D) enp. of 2nd mxp. ×72. (E) telson ×26.

7. *Calappa lophos* (HERBST) 1st zoea. Fig. 9.

Characters: All kinds of carapacial spines present, 2nd ant. B_2-type, telson A_2-type, no stable brown chromatophores present, hair formula 6–0, 2–5 (7), 4–1–1.

Zoea medium size. Dorsum 0.45 mm, rostrum 0.11 mm, perpendicular distance between tips 1.18 mm; carapace 0.50 mm long, 0.36 mm wide, lateral spine 0.18 mm; abdomen 1.05 mm long, 0.12 mm wide, telson 0.37 mm.

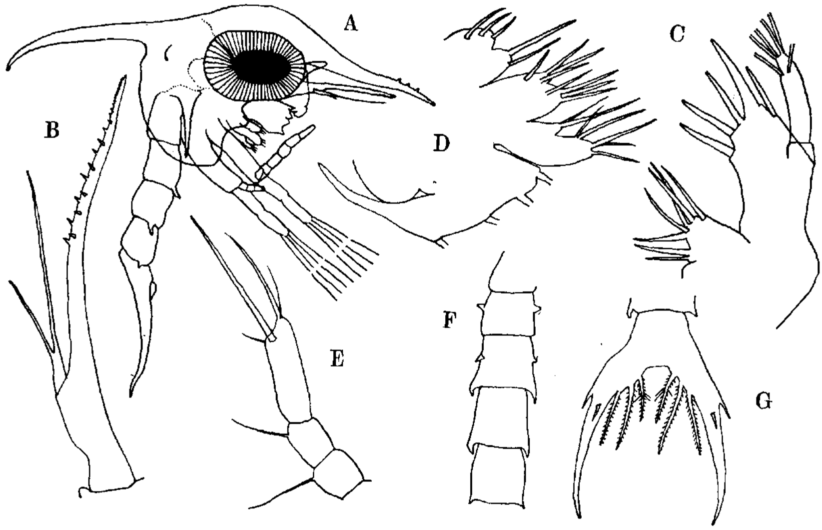


Fig. 9. *Calappa lophos* (HERBST). 1st zoea.
(A) lateral view ×43. (B) 2nd ant. ×233. (C) 1st mx. ×287. (D) 2nd mx. ×287. (E) enp. of 2nd mxp. ×377. (F) abdomen ×61. (G) telson ×72.

Dorsum and rostrum thick, fairly long, pointed. Rostrum has denticles on dorsal side of distal part. Lateral spine rather slender, pointed. Eye large. 1st ant. usual form. 2nd ant. B_2-type; peduncle thick at base, pointed at end, armed with fine teeth at distal half. Exp. small, ending in very long stiff hair, with a hair on basal part. Mandible has large teeth on chewing surface. Enp. of 1st mx. has 2 joints; 1st joint hairless, but 2nd has 4 terminal hairs and 1 lateral. All podites of 2nd mx. slightly bifurcated. Outer lobe of enp. smaller than inner; former with 2 stiff hairs, latter with 5. Scaphognathite rather small, tapering, with 4 lateral plumose hair. Enp. of 2nd mxp. has 3 joints; both 1st and 2nd joints with 1 hair each, 3rd with 4 terminal hairs. 3rd mxp. and 5 pairs of pereiopods not yet in evidence. Abdomen composed of 5 somites and telson. Lateral knobs on 2nd and 3rd somites. Lateral ends. of 3rd to 5th somites more or less projected. All abdominal somites of same size. Teslon A_2-type, with 1 lateral and 1 dorsal denticle on middle part of telson-fork; last named long and slender. Lengths of 3 pairs inner spines unequal, 2nd pair being longest and 3rd shortest. 3rd pair has 2 long hairs among the short ones on inner side and 1 long one on outer side. Middle depression shallow but wide.

The zoea of Calappidae is easily distinguished from other larvae of Doromiidea and Oxystomata. The Calappid zoea greatly resembles the usual brachyuran zoea, except that no stable brown chromatophore is present. Of the Oxystomata, the Calappid zoea alone has the B-type of 2nd ant. Its phylogenic position may be the highest among the Oxystomata.

8. *Ebalia longipedata* ORTMANN. 1st zoea. Fig. 10.

Characters: Only short lateral spines present, 2nd ant. D-type, telson E-type, hair formula 4, 3, 3.

Lateral spine 0.05 mm, carapace 0.51 mm; abdomen 0.78 mm long, 0.14 mm wide, telson 0.18 mm.

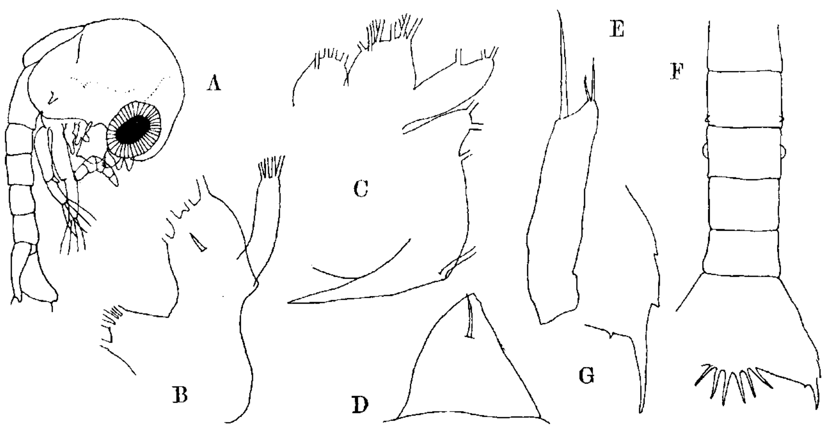


Fig. 10. *Ebalia longipedata* ORTMANN. 1st zoea.
(A) lateral view ×39. (B) 1st mx. ×233. (C) 2nd mx. ×233. (D) 2nd ant.. ×233. (E) enp. of 2nd mxp. ×467. (F) abdomen ×72. (G) lateral corner of telson ×233.

Lateral spines present on postero-lateral part of carapace. 1st ant. usual form, 2nd ant. much reduced, D-type, with a short hair near its side. Enp. of 1st mx. only of singel joint, tipped with 4 hairs. Enp. of 2nd mx. also single with 2 terminal hairs and 1 lateral. Enp. of 2nd mxp. also of single joint with 1 long and stout hair and 2 short ones on tip. Lateral knobs on 2nd and 3rd somites; that on 2nd somite usually absent in Leucosiid zoea, whereas in this zoea, they are very small and triangular. Those on 3rd somite very large and semicircular.

In other respects all abdominal somites similar other. Telson E-type, almost semicircular, with large tooth on lateral corner, also 2 small denticles above and 1 below it. 3 pairs of inner spines closely arranged on middle part of lower margin.

9. *Pleistacantha sancti-johannis* MIERS. Prezoea. Fig. 11.

Characters: Only lateral spines absent, 2nd ant. A_3-type, telson A_3-type, hair formula 6–1, 5, 4–1–0.

Larva, being in prezoeal stage, difficult to measure, but rather large compared with those of the Inachidae. Abdomen about 1.43 mm long. Dorsum long, pointed, bends backwards. Rostrum rather straight. 2nd ant. A_3-type. Peduncle and exp. almost same length; both smooth, except 2 spinules on middle part of exp. Enp. on 2nd ant. not yet observable at this pre-zoeal stage, but small rudiments of 3rd mxp. and perciopods present. Enp. of 1st mx. 2-articulate. 1st joint has 1 hair on distal edge, 2nd 6 on tip. Enp. of 2nd mx. single, tipped with 6 terminal hairs. Enp. of 2nd mxp. has 3 joints; 1st joint hairless, 2nd 1 hair, 3rd 4. Lateral knobs only on 2nd somite; lateral ends of 3rd to 5th somites slightly prominent. Telson A_3-type. 3 pairs

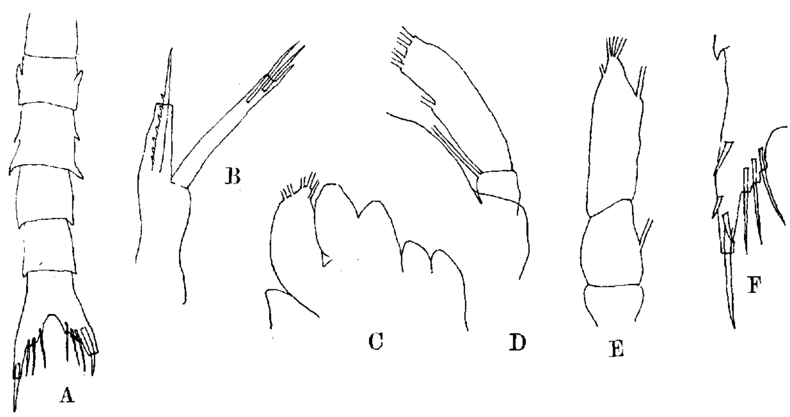


Fig. 11. *Pleistacantha sancti-johannis* MIERS. Prezoea.
(A) abdomen ×39. (B) 2nd ant. ×83. (C) 2nd mx. ×233. (D) enp. of 1st mx. ×233. (E) enp. of 2nd mxp. ×233. (F) telson-fork ×72.

of inner spines arranged so closely that middle depression cannot be recoginzed. Telson-fork thick at base, pointed at end, covered with longitudinal rows of fine serrations.

10. *Paratymolus pubescens* MIERS. 1st zoea. Fig. 12.

Characters: Dorsum and rostrum present, 2nd ant. B_2-type, mxpdal chrom. absent, 1 large longitudinal chrom. involves the 1st and 2nd somites and one also with 5th and telson (probably with 5th and 6th somites in later stage), and a pair in 3rd and 4th somites each, telson A_1-type, hair formula 6–1, 3–5 (8), 2–0–0.

Dorsum 0.62 mm, rostrum 0.39 mm, perpendicular distance between tips 1.30 mm; carapace 0.42 mm long, 0.39 mm wide; abdomen 0.83 mm long, 0.13 mm wide, telson 0.27 mm.

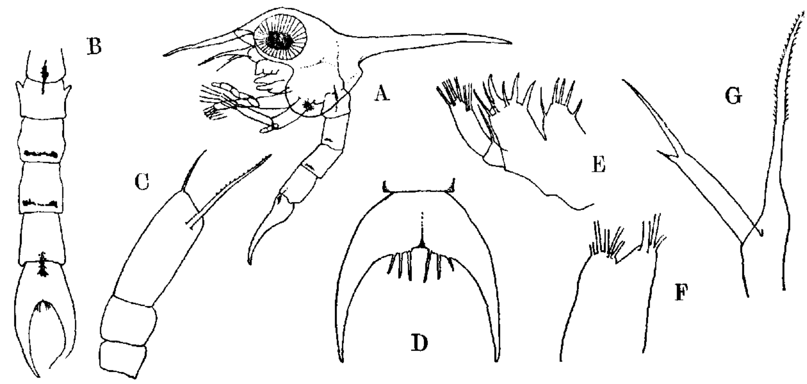


Fig. 12. *Paratymolus pubescens* MIERS 1st zoea.
(A) lateral view ×39. (B) abdomen ×61 mm. (C) 1st mx. ×287. (D) enp. of 2nd mxp. ×420. (E) telson ×83. (F) 1st mx. ×180.
(G) enp. of 2nd mx. ×420. (H) 2nd ant. ×180.

Zoea rather small at 1st stage. Dorsum thick, long; rostrum rather slender. Both projecting almost straight. Large carapacial chrom. present in lower part of carapace. 1st ant. usual form, long. 2nd ant. B_2-type. Peduncle slender, toothed on both sides at distal half. Exp. only slightly shorter than peduncle with tooth on middle part, where it becomes abruptly slender to end. Mandible densely pigmented. Enp. of 1st mx. has 2 joints, 1st joint has 1 hair on distal edge, 2nd tipped with 4 hairs in addition to 2 lateral hairs. All podites of 2nd mx. moderately bifurcated. Enp. provided with 3 hairs on inner lobe with 5 on outer. Enp. of 2nd mxp. has 3 joints, its distal joint bearing 2 stiff hairs. 3rd mxp. and 5 pairs of pereiopods not yet developed. Abdomen composed of 5 somites and telson. Lateral knobs present only on 2nd somite. Telson crescent-shaped. Telson-fork thick at base, pointed at end. 3 pairs of inner spines of different lengths, 1st outer pair shortest, 3rd inner longest. Middle depression thickly chitinized.

11. *Achaeus* sp. A. 1st zoea. Fig. 13.

Characters: Only dorsum present, 2nd ant. A_3-type, telson A_1-type, hair formula 4–0, 4, 4–0–0.

Dorsum 0.59 mm, carapace 0.64 mm, abdomen 1.50 mm long, 0.19 mm wide, telson 0.54 mm.

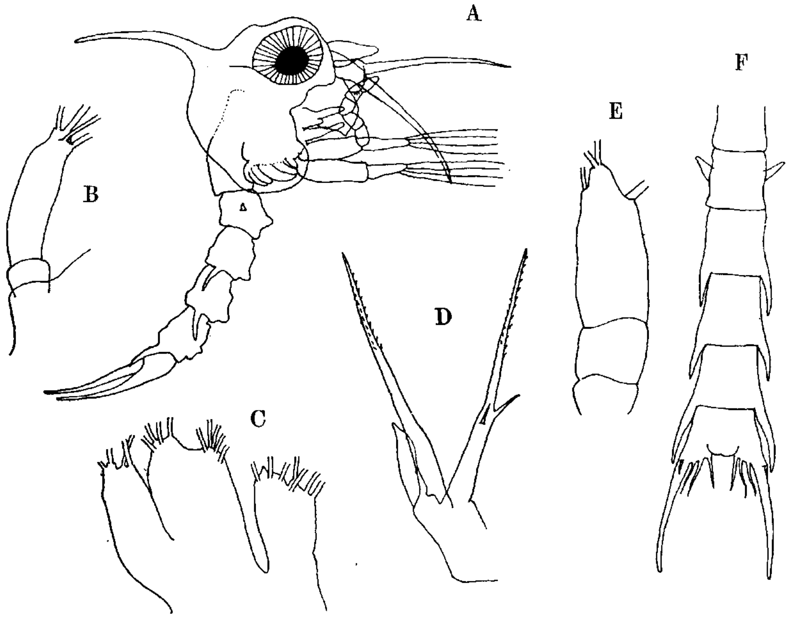


Fig. 13. *Achaeus* sp. A. 1st zoea.
(A) lateral view ×33. (B) enp. of 1st mx. ×233. (C) 2nd mx. ×233.
(D) 2nd ant. ×72. (E) enp. of 2nd mxp. ×233. (E) abdomen ×41.

Dorsum long, pointed, curved posteriorly. 1st ant. usual form; 2nd ant. A_3-type, very large. Peduncle and exp. almost same length, both closely toothed on two sides at their distal halves. Exp. has in addition 2 spinules on middle part. Enp. already ⅓ of peduncle at this 1st stage. Enp. of 1st mx. 2-articulate, mode of serration here expressed by 4–0. Enp. of 2nd mx. single, but other podites bifurcated. Enp. tipped with 4 long hairs, that of 2nd mxp. has 3 joints, distal 3rd joint provided with 4 hairs, but others with none. Rudiments of 3rd mxp. and pereiopods large. Lateral knobs present only on 2nd abdominal somites; lateral ends of 3rd to 5th somites very prominent. Telson A_1-type, with denticle on dorsal side of telson-fork, which long, slender. Middle depression wide but shallow. 3 pairs on inner spines short.

13. *Achaeus* sp. B. 1st zoea. Fig. 14.

Characters: Similar to *Achaeus* sp. A., except hair formula 3–0, 4, 4–0–0.

Dorsum 0.52 mm, carapace 0.66 mm; abdomen 1.47 mm long, 0.19 mm wide, telson 0.47 mm.

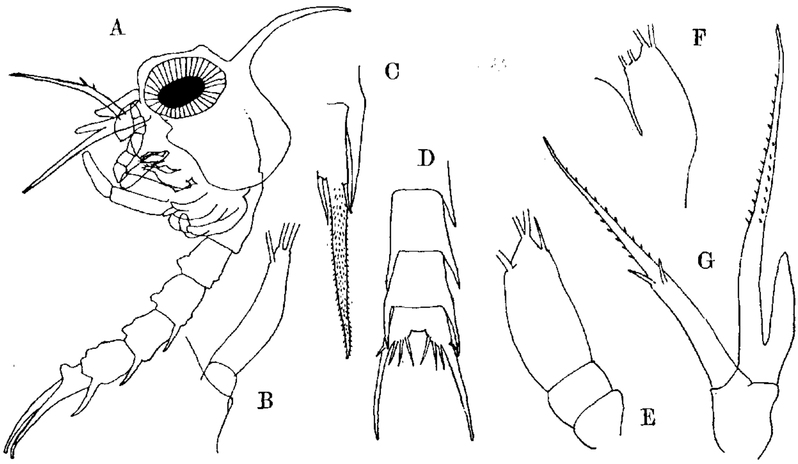


Fig. 14. *Achaeus* sp. B. 1st zoea.
(A) lateral view ×33. (B) enp. of 1st mx. ×233. (C) telson-fork ×72. (D) abdomen ×39. (E) enp. of 2nd mxp. ×233. (F) enp. of 2nd mx. ×233. (G) 2nd ant. ×83.

Dorsum slender, pointed, curved backwards. Carapace so small that extremities remain uncovered. 1st and 2nd ants. similar to those of *Achaeus* sp. A. Enp. of 1st mx. has also 2 joints, but its distal joints bears only 3 hairs, being less by 1 than those of *Achaeus* sp. A. 2nd mx., mxpds., abdomen also nearly similar to those of *Achaeus* sp. A. Telson-fork more slender, attaining to nearly ¾ the total length of the telson, being covered all over with fine hairs.

13. *Huenia proteus* DE HAAN. 1st zoea. Fig. 15.

Characters: Dorsum and rostrum present, 2nd ant. A_3-type, telson A_1-type, primary chrom. present in 2nd mxp. and 1 abdominal chrom. involving 1st and 2nd somites, hair formula 5–0, 4, 4–1–0.

Dorsum 0.18 mm, rostrum 0.10 mm, perpendicular distance between tips 0.77 mm, carapace 0.66 mm, abdomen 1.00 mm long, 0.14 mm wide, telson 0.43 mm.

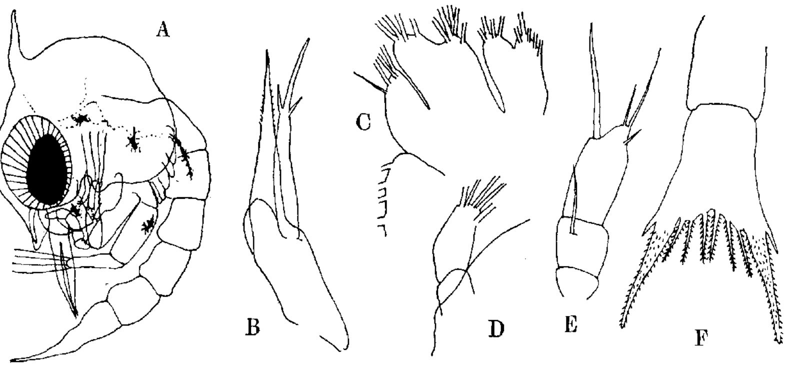


Fig. 15. *Huenia proteus* D. HAAN. 1st zoea.
(A) lateral view ×40. (B) 2nd ant. ×83. (C) 2nd mx. ×233. (D) enp. of 1st mx. ×233. (E) enp. of 2nd mxp. ×233. (F) telson ×72.

Zoea rather small. Both dorsum and rostrum short, pointed. Carapace nearly spherical. 2nd ant. A_3-type. Both peduncle and exp. long, thick. Exp. bears 2 spinules on middle part. Enp. attains nearly ¼ of peduncle length. Enp. of 1st mx. has 2 joints, mode of serration here expressed by 5–0. Enp. of 2nd mx. similar to that of *Achaeus*. Enp. of 2nd mxp. has 3 joints. Distal 3rd joint with 4 hairs, 2nd with 1, but 1st with none. Small rudiments of 3rd mxp. and pereiopods observed. Primary chrom. present only in protopodite of 2nd mxp.

Lateral knobs only on 2nd abdominal somite. Lateral ends of all somites rather rounded. Telson A_1-type, with denticle laterally near base of telson-fork. Telson-fork thick at base, pointed at end, being covered all over with fine hairs. As 3 pairs of inner hairs closely arranged, middle depression hardly recognizable.

14. *Naxia hystrix* MIERS. 1st zoea. Fig. 16.

Characters: Dorsum and rostrum present, 2nd ant. A_3-type, telson A_1-type, hair formula 6–1, 5, 4–1–0.

Dorsum 0.48 mm, rostrum 0.12 mm, perpendicular distance between tips 0.82 mm, carapace 0.55 mm, abdomen 1.07 mm long, 0.17 mm wide, telson 0.38 mm.

Dorsum pointed, curved backwards. Rostrum short, straight. 2nd ant. A_3-type. Both peduncle and exp. thick, smooth, except 2 spinules

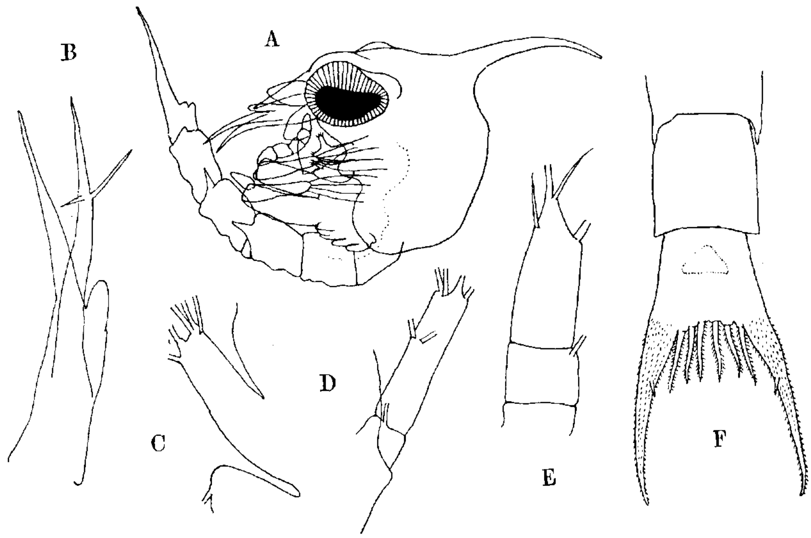


Fig. 16. *Naxia hystrix* MIERS. 1st zoea.
(A) lateral view ×33. (B) 2nd ant. ×83. (C) enp. of 2nd mx. ×233. (D) enp. of 1st mx. ×233. (E) enp. of 2nd mxp. ×233. (F) telson ×61.

on middle part of exp. Enp. very small, that of 1st mx. 2-articulate, mode of serration here expressed by 6–1. Enp. of 2nd mx. single, tipped with 5 hairs, that of 2nd mxp. similar to that of *Huenia proteus*. Small rudiments of 3rd mxp. and pereiopods observed.

Lateral knobs only on 2nd abdominal somite, lateral ends of 3rd to 5th somites slightly projected. Telson A_1-type, denticle dorsally on middle part of telson-fork, which is long, pointed, covered all over with fine hairs. 3 pairs of inner hairs so closely arranged that middle depression hardly recognizable.

15. *Chionecetes opilio* FABRICIUS. Prezoea. Fig. 17.

Characters: All carapacial spines present, 2nd ant. B_6-type, telson A_2-type, hair formula 5–1, 2–3 (5), 5–?–?.

The writer, in his previous paper (AIKAWA, 1), reported that sometimes lateral spines may or may not be present, which however was an error. All extremities, including the carapacial spines, are usually not fully developed in the larva, seeing that the larva is obtained as a rule only at the prezoeal stage. There really occur 3 kinds of carapacial spines.

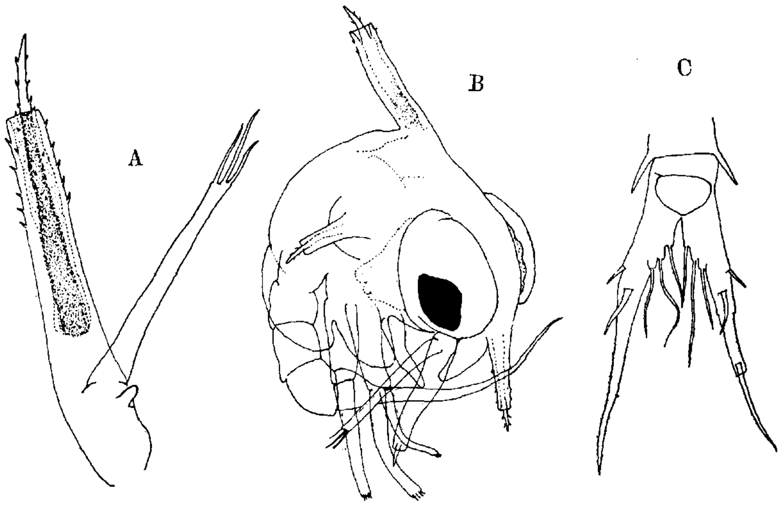


Fig. 17. *Chionoecetes opilio* (FABRICIUS). Prezoea.
(A) 2nd ant. × 72. (B) lateral view × 40. (C) telson × 39.

K. STEPHENSEN (1935) described the later zoeal stage of *Chionoecetes opilio,* which he obtained among plankton samples collected near Greenland, but it differs in important respects from that obtained by the present writer from berried crabs.

Carapacial spines coarsely toothed, although smooth in zoea described by STEPHENSEN. 2nd ant. B_6-type. Peduncle long, with small denticles all over it. Exp. attains to only ⅓ of peduncle, ending in 3 soft hairs. Enp. not yet in evidence at this prezoeal stage. 2nd ant. in STEPHENSEN's zoea differs greatly from that just mentioned. Exp. nearly ⅔ of peduncle, ending in 2 unequal hairs. It is exactly of B_4-type.

Enp. of 1st mx. 2-jointed, mode of serration here expressed by 5–1. Enp. of 2nd mx. biramous, mode of serration here 2–3(5). Enp. of 2nd mxp. has 3 joints; distal 3rd joint with 5 hairs, but serration on 1st and 2nd joints not ascertainable at prezoeal stage. Rudiments of 3rd mxp. and pereiopods already observable. Lateral knobs present only on 2nd somite, lateral ends of 3rd to 5th somites prominent. Telson A_2-type, since it has 2 denticles dorsally on middle part of telson-fork. Middle depression fairly deep. Whereas in STEPHENSEN's zoea, enp. of 2nd mxp. has 5 joints notwithstanding that all zoeas of Inachidae and Majidae have enp. of 1 or 3 joints. Lateral knobs present on both

2nd and 3rd abdominal somites, although occurring only on 2nd somite in the zoeas of both Inachidae and Majidae. Telson also A_2-type; only 1 spinule present dorsally on middle part of telson-fork, but the other, attaining to nearly same length as telson-fork, present laterally near base of telson-fork. Therefore telson resembles that of *Erimacrus einsenbeckii* (Fig. 23, G), which has enp. of 3 joints in 2nd mxp. Thus the differences in their detailed structures, such as the mode of serration, type of 2nd ant., and abdominal structure, are many. The zoea described by STEPHENSEN may not belong to *Chionecetes opilio*. At the same time the genus or family of this zoea cannot be determined owing to the fact that Grapsizoeas provided with B-type of 2nd ant. and A-type of telson are found in several families.

16. *Tiarinia cornigera* (M.-EDWARDS) 1st zoea. Fig. 18.

Characters: Rostrum and dorsum present, 2nd ant. A_3-type, telson A_3-type, hair formula 6–1, 3–5 (8), 6–1–1.

Dorsum 0.29 mm, rostrum 0.12 mm, perpendicular distance between tips 0.82 mm, carapace 0.55 mm; abdomen 1.07 mm long, 0.17 mm wide, telson 0.38 mm.

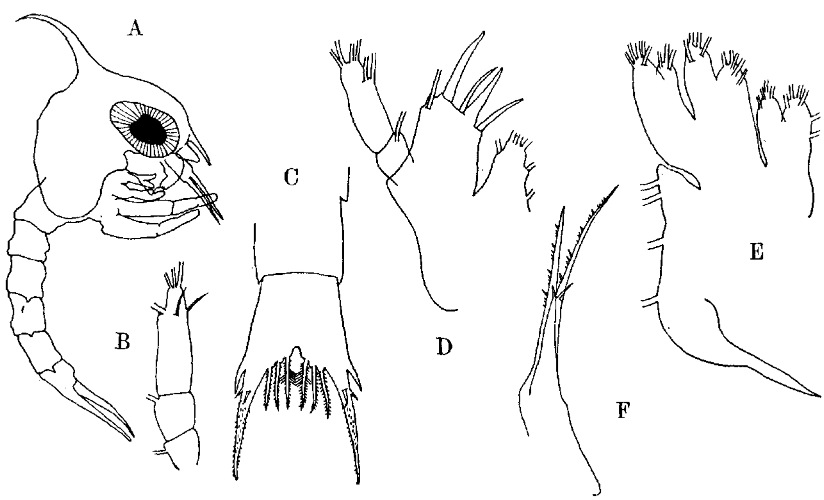


Fig. 18. *Tiarinia cornigera* (M.-EDWARDS) 1st zoea.
(A) lateral view ×37. (B) enp. of 2nd mxp. ×233. (C) telson ×72.
(D) 1st mx. ×233. (E) 2nd mx. ×233. (F) 2nd ant. ×121.

This zoea differs from those of the Majidae in several respects. Rostrum short, pointed. Dorsum curves markedly backwards. Eye depressed. 2nd ant. A_3-type, longer than rostrum. Exp. also longer than peduncle, has 2 spinules on middle part. Both peduncle and exp. have small teeth at distal half. Enp. of 1st mx. very small, mode of serration 6–1. Enp. of 2nd mx. biramous, mode of serration 3–5 (8). Enp. of 2nd mxp. has 3 joints, both 1st and 2nd joints with 1 hair each, 3rd with 6 on tip, although in zoeas of both Inachidae and Majidae 1st joint hairless.

Lateral knobs only on 2nd somite, lateral ends of 3rd to 5th somites slightly projected. Telson A_3-type, 2 lateral and 1 dorsal denticles on telson-fork, which is slender and covered all over with fine hairs. 3 pairs of inner spines of same length, inner 3rd pair has 6 long hairs among short ones on inner side, 2 or 3 ones on outer side. Middle depression narrow but fairly deep.

17. *Lambrus validus* DE HAAN. 1st zoea. Fig. 19.

Characters: All kinds of carapacial spines present, 2nd ant. B_1-type, telson A_1-type, no mxpdal. chrom. present, hair formula 6–1, 2–5 (7), 3–1–1.

Dorsum 0.31 mm, rostrum 0.30 mm, perpendicular distance between tips 0.99 mm, lateral spine 0.13 mm; carapace 0.49 mm. long, 0.29 mm wide; abdomen 0.65 mm long, 0.14 mm wide, telson 0.21 mm.

Dorsum thick, pointed, curved backwards. Rostrum shorter than

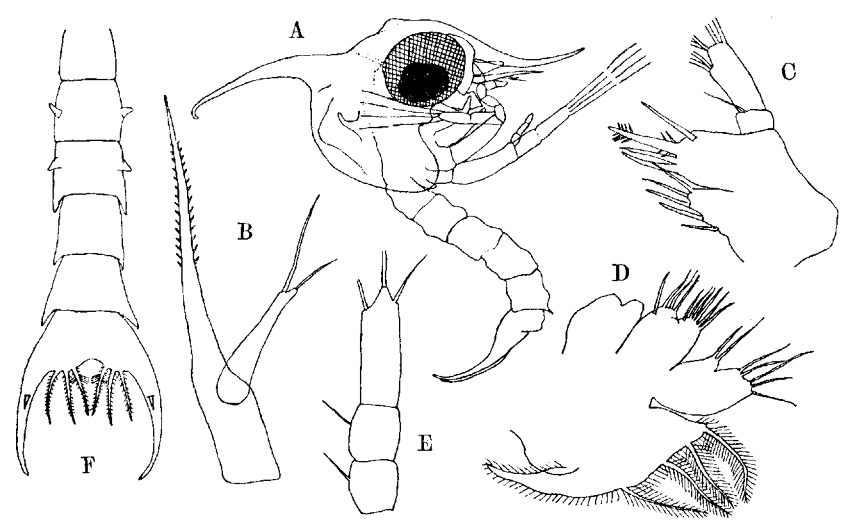


Fig. 19. *Lambrus validus* D. HAAN. 1st zoea.
(A) lateral view ×61. (B) 2nd ant. ×287. (C) 1st mx. ×287. (D) 2nd mx. ×287. (E) enp. of 2nd mxp. ×420. (F) abdomen ×87.

dorsum, curves concavely. Lateral spine short, curved. Fine hair between dorsum and lateral spine, small tubercle on frontal region. 1st ant. usual form, few sensory hairs on tip. 2nd ant. B_4-type, shorter than rostrum. Peduncle straight, pointed, armed with fine teeth along both sides of distal half. Exp. nearly half the length of peduncle, tipped with 2 unequal stiff hairs. 1st mx. has 2-jointed enp., 1st joint bears 1 hair on distal edge, 2nd with 4 long hairs on tip, with 2 a little below them. All podites of 2nd mx. fairly bifurcated. 2 lobes of enp. unequal in size, smaller outer lobe with 2 hairs, larger inner with 5. Scaphognathite medium size, 4 long plumose hairs laterally, ending in pointed horn. Exp. of mxp. slightly segmented at this 1st stage. Enp. of 2nd mxp. has 3 joints, both 1st and 2nd joints with 1 hair each, 3rd with 3 on tip. Abdomen of 5 somites and telson. Lateral knobs present on 2nd and 3rd somites, fairly large. Lateral ends of 3rd and 4th somites somewhat prominent. Telson A_1-type, dorsal denticle on middle part of telson fork. 3 pairs of inner spines of same length, inner 3rd pair has 4 long hairs among short ones on inner side, 1 long hair on outer side. Middle depression wide but shallow. Telson-forks converge towards their ends.

18. *Charybdis 6-dentata* HERBST. 1st zoea. Fig. 20.

Characters: All kinds of carapacial spines present, 2nd ant. B_2-type, telson A_2-type, secondary chrom. present in 1st mxp, abdominal ones in all somites except telson, hair formula 6–1, 2–4 (6), 4–1–1.

Dorsum 0.44 mm, rostrum 0.35 mm, perpendicular distance between tips 1.16 mm, lateral spine 0.14 mm, carapace 0.48 mm; abdomen 0.75 mm long, 0.10 mm wide, telson 0.34 mm.

Larva rather small. Dorsum curves backwards, hooked at end. Rostrum rather straight. Lateral spine short, thick at base, pointed at end. 2nd ant. B_2-type. Peduncle same length as rostrum, armed with fine denticles along both sides in distal half. Exp. short, ends in 2 unequal hairs. Enp. of 1st mx. 2-articulate, mode of serration here expressed by 6–1. All podites of 2nd mx. bifurcated, although enp. only slightly, its inner lobe has 4 hairs, outer only 2. 1st mxp. has secondary chrom. in its protopodite. Enp. of 2nd mxp. has 3 joints. Both 1st and 2nd somites bear 1 hair each, 3rd 4 on tip. Rudiments of 3rd mxp. and 5 pairs of pereiopods present at this 1st stage, as seen in 1st zoea of both Inachidae and Majidae. Lateral knobs present only on 2nd somite. Abdomen slender, lateral ends of both 3rd and 4th

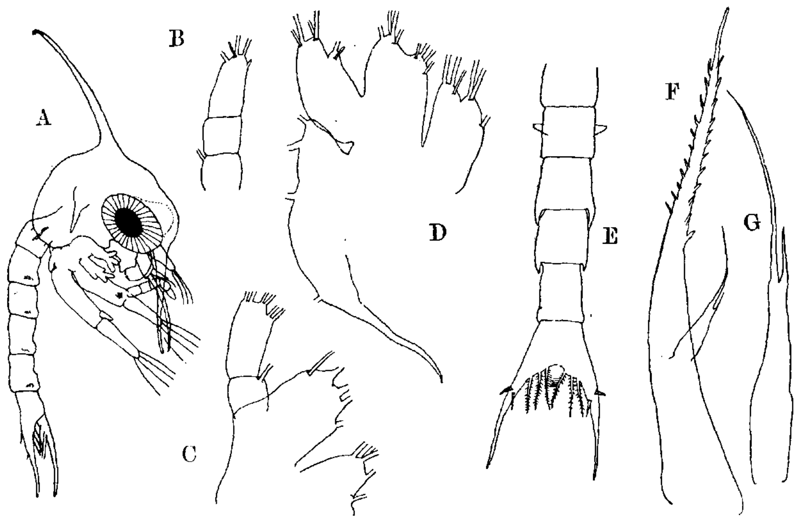


Fig. 20. *Charybdis 6-dentata* HERBST. 1st zoea.
(A) lateral view ×39. (B) enp. of 2nd mxp. ×233. (C) 1st mx. ×233. (D) 2nd mx. ×233. (E) abdomen ×72. (F) 2nd ant. ×233. (G) enp. of 2nd ant. ×467.

somites slightly prominent. Telson-forks diverge, very slender. 2 outer denticles present dorsally on telson-fork. Middle depression shallow. 3 pairs of inner spines of same length, inner 3rd pair has 6 long hairs among short ones on inner side.

19. *Charybdis bimaculata* MIERS. 4th zoea to megalopa. Figs. 21, 22.

Characters: All kinds of carapacial spines present, 2nd ant. B_2-type, telson A_2-type, hair formula 6–1, 2–4 (6), 5–1–1.

At a station (123°–48′ E.L., 31°–00′ N.L.) in the Chinese Eastern Sea, later zoeas, megalops, and young crabs were collected during September and October on board M.S. "Hizyun-maru". These larvae, which probably formed a swarm near the bottom, were found to belong to *Charybdis bimaculata* MIERS, resemble in zoeal stage that of *Charybdis 6-dentata* described above.

Rostrum 0.67 mm, dorsum broken, carapace 1.02 mm, lateral spine 0.13 mm; abdomen 1.73 mm long, 0.29 mm wide, telson 0.52 mm.

Rostrum nearly straight, pointed, but dorsum probably curves backwards. Lateral spine short. 2nd ant. B_2-type. Exp. longer than ½ of peduncle, becomes abruptly slender at ⅓ of distal part. Peduncle provided with fine teeth at ⅓ of distal part. Enp. only ⅓ of peduncle

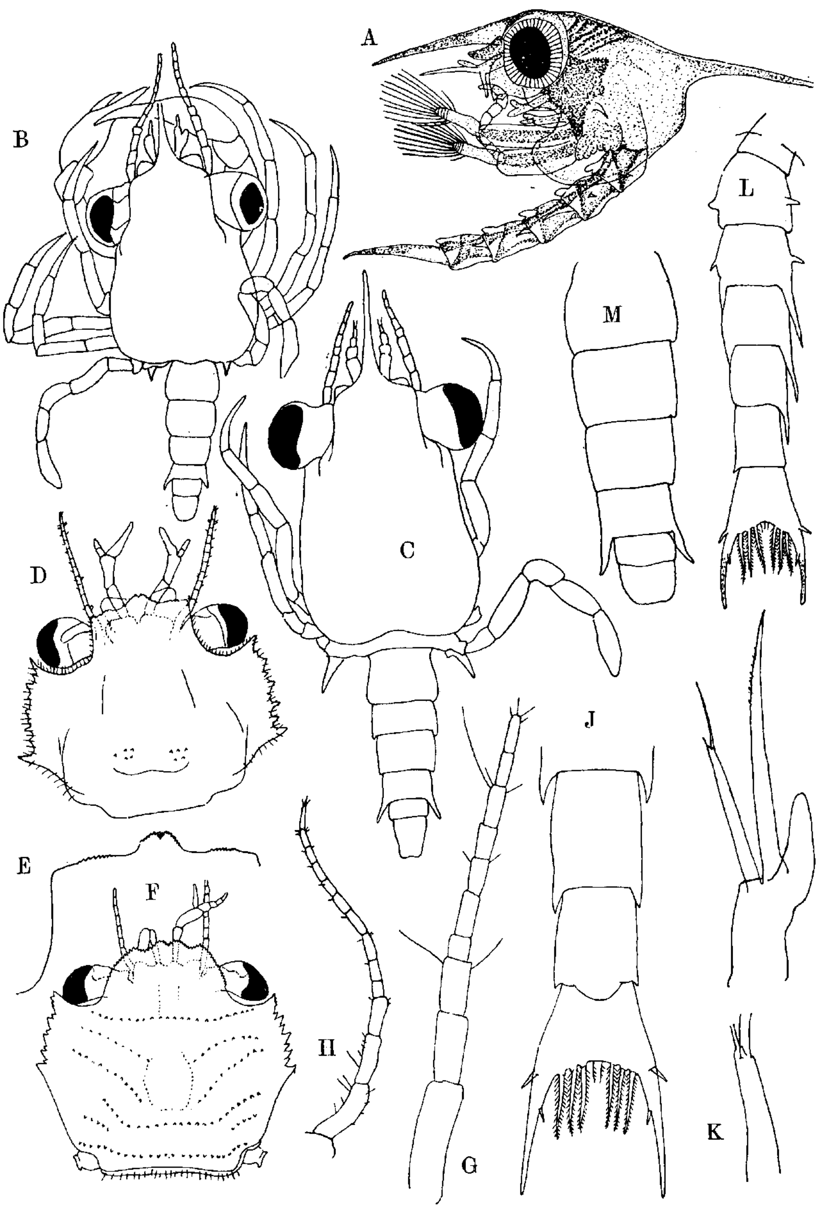


Fig. 21. *Charybdis bimaculata* MIERS. Later zoeas and megalopa.

(A) lateral view (V zoea) ×26. (B) dorsal view (I megalopa) ×17. (C) dorsal view (II megal.) ×13. (D) dorsal view (young crab) ×13. (E) frontal margin (crab) ×13. (F) dorsal view (crab) ×13. (G) 2nd ant. (I megal.) ×42. (H) 2nd ant. (young crab) ×21. (I) 2nd ant. (V zoea) ×72. (J) abdomen (IV zoea) ×41. (K) enp. of 2nd ant. (V zoea) ×233. (L) abdomen (V zoea) ×26. (M) abdomen (I megal.) ×40.

at this last stage. Rudiments of 3rd mxp. and pereiopods also very small. Enp. of 1st mx. similar to that of *Chary. 6-dent.* Enp. of 2nd mx. of only slightly bifurcated, mode of serration here also similar to *Chary. 6-dent.* Enp. of 2nd mxp. has 3 joints; both 1st and 2nd joints provided with 1 hair each, 3rd with 5. Abdomen composed of 6 somites and telson. Lateral knobs present on both 2nd and 3rd somites, lateral ends of 3rd to 5th somites slightly projected. Telson A_2-type, 1 denticle laterally near base of telson-fork, 1 dorsally on middle part. 3 pairs of inner spines of same length, 3 or 4 accessory hairs present.

Megalopa. Megalopa changes to young crab after passing through 2 stages as assumed from the occurrence of 2 modes in the width of carapace and the length of the abdomen.

Stage	Carapace		Abdomen	
	length mm	width mm	length mm	width mm
I	2.16	1.13	1.27	0.42
II	3.57	1.17	2.04	0.73

Carapace usually quadrate. Rostrum long, slender. No other spine present on carapace. Viewed dorsally, 1st ant. covered under carapace and eye-stalk. 1st ant. 2-branched. Basal portion 3-articulate, triangular at young crab stage, although undergoes no change. Exp. single at I megalopa stage, 2-articulate at II megalopa stage and in young crab. 2nd ant. simpler in structure in megalopa stage than in zoea, and consists of 3 parts. Terminal part only 2-articulate, articulation does not increase in young crab stage. Middle part 5-articulate at I megalopa, but 7-articulate in II megalopa and in young crab. 1st mx. greatly simplified in structure. Both coxo- and basipodites remain unchanged except increase in serration. Enp. becomes rather rudimentary, only scaphognathite well developed. Both mxls. show adult structure already at I megalopa. 1st mxp. has 3-articulated basal portion, on which epip. present, being thin, hammer-shaped, and serrated around it. Exp. 2-articulate, both joints connected rectangularly to each other. Distal joint smaller than basal, tipped with 4 long hairs in addition to 1 lateral hair. Enp. thin, twisted along its long axis, expanded to its end. 1st mxp. shows no remarkable change in young crab stage. 2nd mxp. has unsegmented basal portion.

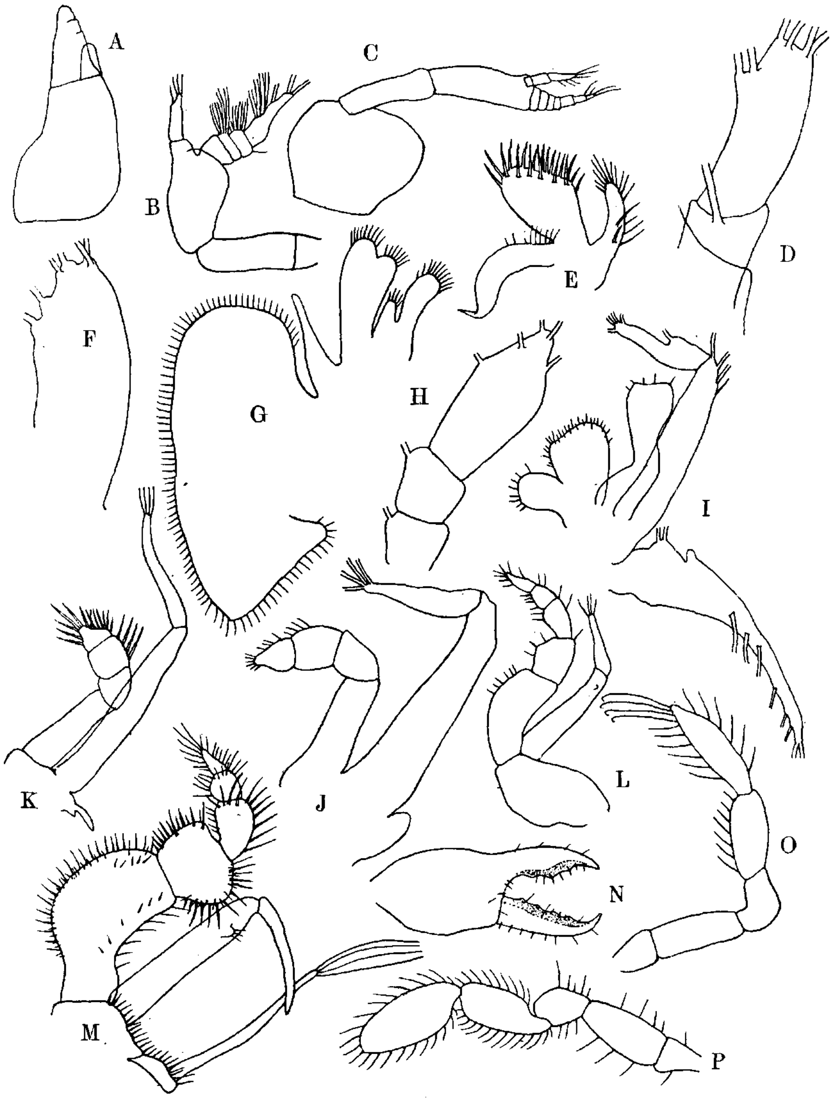


Fig. 22. *Charybdis bimaculata* MIERS. Zoea and megalopa.

(A) 1st ant. (zoea) × 72. (B) 1st ant. (megalopa) × 41. (C) 1st ant. (young crab) × 39. (D) enp. of 1st mx. (zoea) × 233. (E) 1st mx. (megalopa) × 72. (F) enp. of 2nd mx. (zoea) × 233. (G) 2nd mx. (megalopa) × 72. (H) enp. of 2nd mxp. (zoea) × 72. (I) 1st mxp. (megalopa) × 120. (J) 2nd mxp. (megalopa) × 72. (K) 2nd mxp. (young crab) × 33. (L) 3rd mxp. (megalopa) × 72. (M) 3rd mxp. (young crab) × 33. (N) cheliped (megalopa) × 26. (O) last leg (megalopa) × 21. (P) last leg (young crab) × 13.

Exp. 2-articulate, bears 4 terminal hairs. Enp. 4 articulate, distal 2 joints densely serrated, although basal joints smooth. 2nd mxp. also shows no change in later stages. 3rd mxp. becomes functional at first at I megalopa stage. Basal part unsegmented, epip. very slender, ending in 4 hairs. Enp. of 5 articulations. All joints only coarsely serrated at 1st stage, but very densely at 2nd stage and at young crab stage. Exp. 2-articulate, small projection on distal part of 1st joint. All mxpds. take adult form precociously at I megalopa.

Cheliped has no longitudinal ridge, rather rounded at I megalopa. Basipodite more or less swollen at its distal part, has no spine. First 3 ambulatory legs show usual structure, dactylus more or less pointed. Last leg differs from preceding ones. Dactylus paddle-shaped, bears 4 curly feelers near tip, with fine hairs all around it. Carpus curves distinctly. Coxopodite has large spinule on ventral side. Dactylus to propodus gradually flattened, resembling those of young crab already at II megalopa. Abdomen composed of 6 somites and telson. 1st somite largest, last one smallest. LEBOUR noted that the number of terminal hairs on the uropod tip of the last somite is peculiar to each species, while in the case of *Chary. bimac.*, the number of hairs gradually increases with development.

The characters of *Chary. bimac.* are as follows: (1) 2nd ant. composed of 2-articulate distal, 3-articulate basal, and 5 articulate middle parts at I megalopa, although middle part is 7-articulate at later stages, (2) paddle-shaped dactylus of last leg bears 4 curly feelers, (3) rostrum present throughout all megalopa stages, (4) abdomen composed of 6 somites, 1st somite largest, the last smallest, (5) lateral end of 5th somite very prominent.

20. *Portunus trituberculatus* MIERS. 1st zoea. Fig. 23.

Characters: All kinds of carapacial spines present, 2nd ant. B_4-type, secondary chrom. only in 1st mxp. abdominal chrom. in 1st and 3rd to 5th somites each, telson A_2-type, hair formula 6–1, 2–4 (6), 4–1–1.

Dorsum 0.45 mm, rostrum 0.39 mm, perpendicular distance between tips 1.13 mm, carapace 0.47 mm, lateral spine 0.07 mm; abdomen 0.93 mm long, 0.17 mm wide, telson 0.42 mm.

Lateral spine very short, although present writer reported in his previous paper (AIKAWA, 1929) that the lateral spine is absent. Rostrum nearly straight, but dorsum curves backwards. 2nd ant. B_4-type. Length of exp. nearly $\frac{2}{5}$ of peduncle, thick at base, abruptly

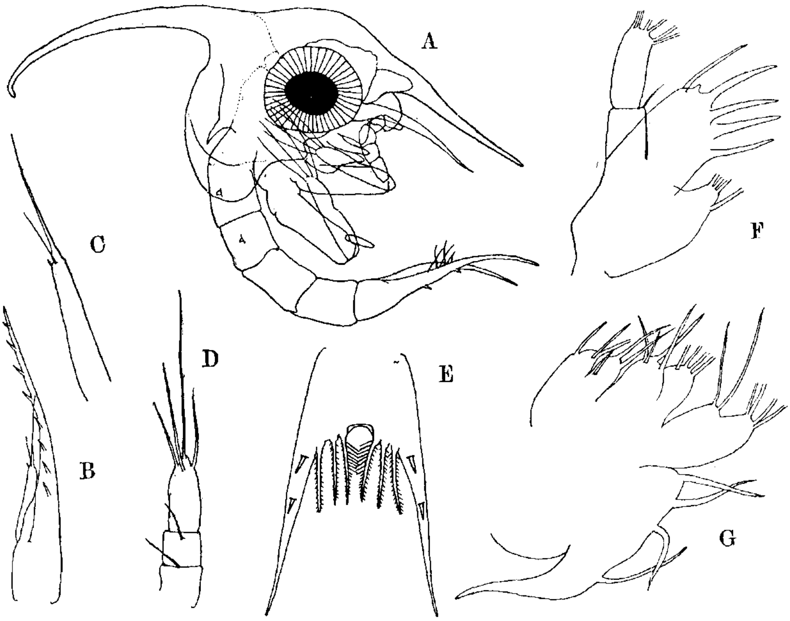


Fig. 23. *Portunus trituberculatus* MIERS. 1st zoea.
(A) lateral view ×37. (B) 2nd ant. ×121. (C) enp. of 2nd ant. ×233. (D) enp. of 2nd mxp. ×233. (E) telson ×72. (F) 1st mx. ×233. (G) 2nd mx. ×233.

slender to end. Peduncle furnished with fine teeth along one side. Enp. of 1st mx. has 2 joints, mode of serration here expressed by 6–1. All podites of 2nd mx. well bifurcated, mode of serration 2–4 (6) as usually seen in portunid larvae. Secondary chrom. present only in protopodite of 1st mxp. Enp. of 2nd mxp. has 3 joints. 1st and 2nd joints with 1 hair each on their distal edges, 3rd joint with 4 on tip. Abdominal chroms. present in 1st and in 3rd to 5th somites. Lateral knobs present on both 2nd and 3rd somites, lateral ends of all somites rather rounded. Telson A_2-type, 2 dorsal denticles on telson-fork. Telson-fork long, slender, smooth. 3 pairs of inner spines of same length, inner 3rd pair with 6 or 7 long hairs among short ones on inner side. Middle depression fairly deep.

21. *Portunus pelagicus* LINNÉ. 1st zoea and megalopa. Fig. 24.

Characters: All kinds of carapacial spines present, 2nd ant. B_1-type, secondary chrom. present only in 1st mxp., 1 abdominal chroms. involving 1st and 2nd somites and in 3rd to 5th somites each, telson A_2-type, hair formula 6–1, 2–4 (6), 5–1–1.

Dorsum 0.48 mm, rostrum 0.36 mm, perpendicular distance between tips 1.24 mm, lateral spine 0.04 mm, carapace 0.56 mm; abdomen 1.06 mm long, 0.11 mm wide, telson 0.40 mm.

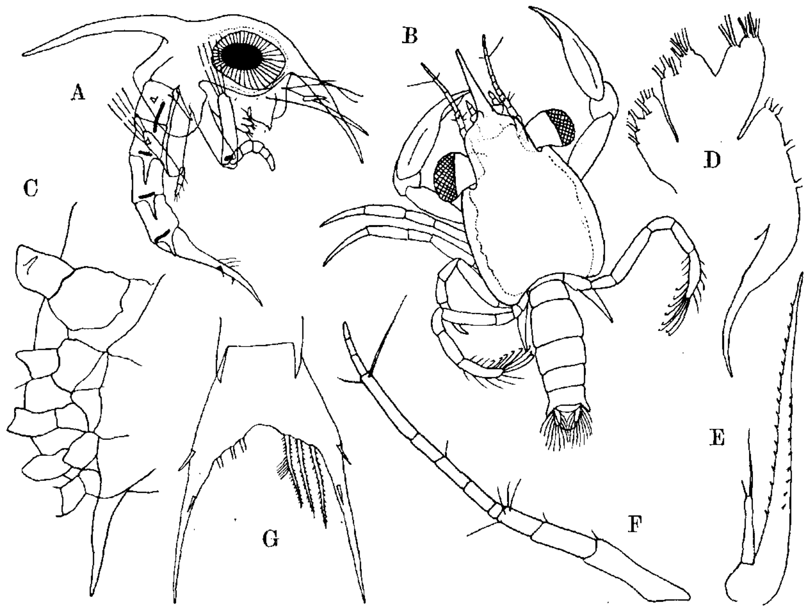


Fig. 24. *Portunus pelagicus* L. 1st zoea and megalopa.
(A) lateral view (1st zoea) ×39. (B) dorsal view (megalopa) ×10. (C) coxa of the last leg (megalopa) ×21. (D) 2nd mx. (zoea) ×233. (E) 2nd ant. (zoea) ×163. (F) 2nd ant. (megalopa) ×14. (G) telson (zoea) ×61.

Dorsum thick, bends backwards. Rostrum rather straight. Lateral spine very short, slender. 1st ant. bears only 2 aesthetes and a hair on tip. 2nd ant. B_4-type. Length of exp. only ¼ of peduncle, with 2 unequal hairs on tip. Peduncle long, slender, with fine teeth on both sides. Both mxls. similar to those of *Port. trit.* Secondary chrom. present in portopodite of 1st mxp. Enp. of 2nd mxp. has 3 joints. Both 1st and 2nd joints provided with 1 hair each, 3rd with 5 on tip. Lateral knobs present on both 2nd and 3rd abdominal somites, lateral ends of 3rd to 5th somites very prominent. 1 abdominal chrom. involving 1st and 2nd somites, and paired one in each somite from 3rd to 5th. Telson A_2-type, a denticle laterally near base of telson-fork, one more dorsally on it. 3 pairs of inner spines of nearly same length, inner 3rd pair with 6 long hairs among short ones on its inner side. Middle depression wide, but shallow.

Megalopa. Carapace rather rounded, frontal margin with long rostrum, becoming wider. 2nd ant. of 3 parts. Basal part 3-articulate, 1st joint longest, 3rd provided with ring of fine hairs near distal edge. Middle part 5-articulate, 8th joint with long stiff hair on outer distal edge, shorter hair on inner. Terminal part has 3 joints, all very small. Terminal joint tipped with 2 short stiff hairs. A very large spinous projection on coxa of last leg, and 1 hook on coxa of cheliped. Abdomen of 6 somites and telson. 2nd somite largest, narrowing to preceding and following somites. Lateral end of 5th somite prominent. Paddle-shaped dactylus of last leg with 4 long curly feelers on tip, 4 shorter ones on lateral side.

22. *Portunus* sp. Last zoea and megalopa. Figs. 25, 26.

Characters: All kinds of carapacial spines present, 2nd ant. B_1-type, secondary chrom. present in 1st mxp. abdominal chrom. distributed similarly as in zoea of *Port. pel.* L., hair formula 6–1, 2–4 (6), 5–1–1.

At last zoeal stage, dorsum measures 0.67 mm, rostrum 0.56 mm, perpendicular distance between tips 2.10 mm; lateral spine 0.06 mm,

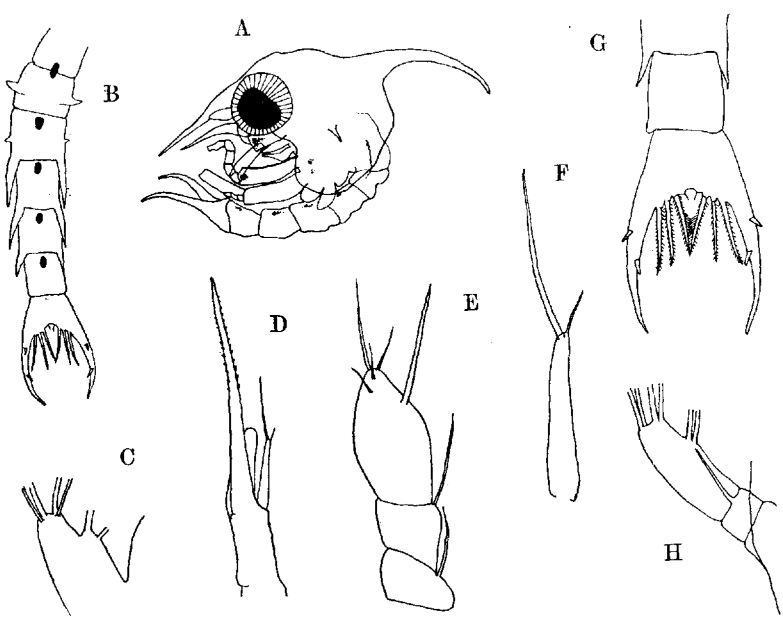


Fig. 25. *Portunus* sp. Last zoea.
(A) lateral view ×21. (B) abdomen ×17. (C) enp. of 2nd mx. ×180. (D) 2nd ant. ×43. (E) enp. of 2nd mxp. ×180. (F) enp. of 2nd ant. ×180. (G) telson ×43. (H) enp. of 1st mx. ×180.

carapace 0.99 mm; abdomen 2.86 mm long, 0.44 mm wide, telson 0.84 mm.

Dorsum curves fairly backwards, but rostrum straight. Both pointed at end. Lateral spine very short. 2nd ant. B_4-type. Peduncle pointed, straight, armed with fine teeth on both sides of distal half. Length of exp. 1/3 of peduncle, with long spinule and hair on tip. Length of enp. nearly same as that of peduncle at this last stage. Mandible densely pigmented. Enp. of 1st mx. has 2 joints and enp. of 2nd mx. only slightly bifurcated. Modes of serration on these enpds. similar to those of *Port. trit.* and *P. pel.* Secondary chrom. only in protopodite of 1st mxp. Segmentation and mode of serration on enp.

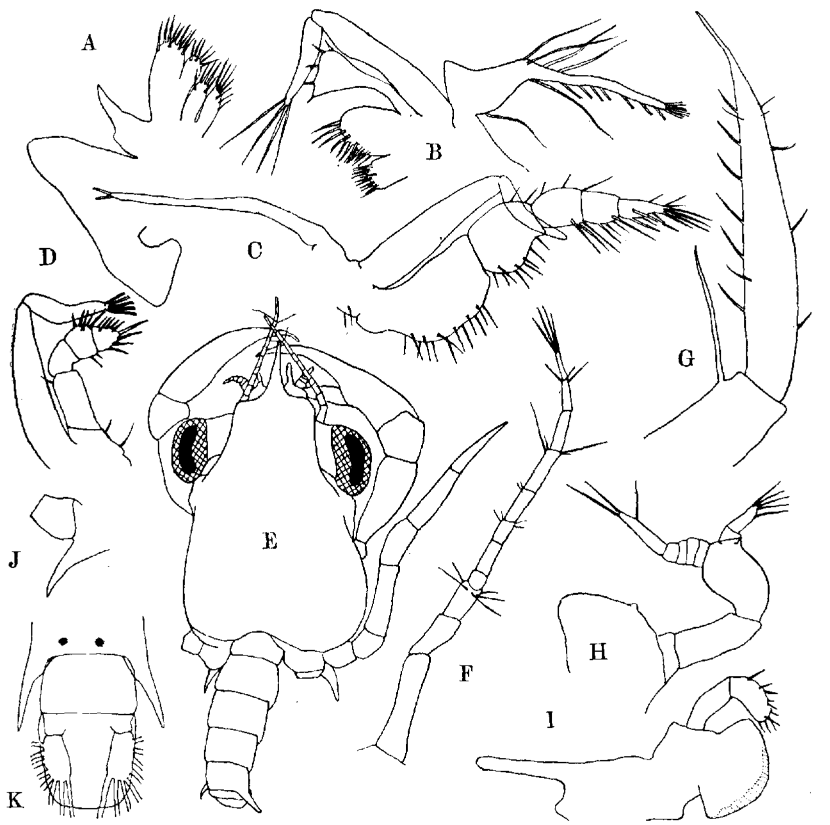


Fig. 26. *Portunus* sp. Megalopa.
(A) 2nd mx. ×61. (B) 1st mxp. ×43. (C) 3rd mxp. ×43. (D) 2nd mxp. ×43. (E) dorsal view ×17. (F) 2nd ant. ×43. (G) dactylus of last leg ×87. (H) 1st ant. ×43. (I) mandible ×61. (J) coxa of last leg ×33. (K) abdomen ×72.

of 2nd mxp. also similar to those of *Port. pel.* 3rd mxp. and 5 pairs of pereiopods well developed at this last stage. Abdomen composed of 6 somites and telson. Lateral knobs present on 2nd and 3rd somites, lateral ends of 3rd to 5th somites prominent. Telson A_2-type, with 1 denticle laterally near base of telson-fork, 1 dorsally on middle part. 3 pairs of inner spines and a pair of extra-hairs. Telson-fork slender, pointed.

Megalopa. Carapace nearly quadrate, but narrowing slightly towards front. Long pointed rostrum present, but neither dorsal nor lateral spines present. Spine on coxa of last leg very large. 1st ant. 2-branched. The basal part has 3 joints, enp. 2 and exp. 5. Sensory hairs on all segments of exp., its terminal joint with 2 long hairs on tip, 1 on lateral side. 2nd ant. single, composed of 11 joints. Basal part of 3 joints all very large. Middle part has 5 joints. Basal 4th joint smallest among antennal joints, 8th joint with 1 long stiff hair and 1 short on distal edge. Terminal part of 3-joints tapers. Last joint tipped with 4 stiff hairs. Mandible has palp of 2 joints. Enpds. of mxls. much reduced. Epip. of 1st mxp. has 4 terminal hairs. Enp. of 2nd mxp. has 5 joints. Enp. of 3rd mxp. also of 5 joints, its epip. tipped with 2 hairs. Basi-ischiopodite of cheliped bears small hook. Dactylus of last leg not paddle-shaped, without feelers. Abdomen of 6 somites and telson. Abdominal chrom. present in similar way to that observed in zoea of *Port. pel.* Uropod of last somite bears 4 terminal hairs.

23. *Erimacrus eisenbeckii* (BRANDT). V zoea. Fig. 27.

Characters: All kinds of carapacial spines present, 2nd ant. B_1-type, telson A_3-type, hair formula 6–1, 3–5 (8), 5–1–1.

MARUKAWA, H. (1933). Rakusui Kai Si., vol. 28, p. 499, pls. 1–3.

At this last stage, dorsum 1.30 mm, rostrum 0.89 mm, perpendicular distance between their tips 3.36 mm, lateral spine 0.33 mm, carapace 1.47 mm; abdomen 2.11 mm long, 0.28 mm wide, telson 0.74 mm.

2nd ant. shorter than rostrum. Peduncle thick at base, slender at distal part, where it is armed with fine teeth on both sides. Exp. very small, only 1/4 of peduncle, ending in 2 unequal hairs. Enp. of 1st mx. 2-articulate, mode of serration here expressed by 6–1. Enp. of 2nd mx. only slightly bifurcated, mode of serration 3–5 (8). Enp. of 2nd mxp. has 3 joints. Both 1st and 2nd joints with 1 hair on each distal edge.

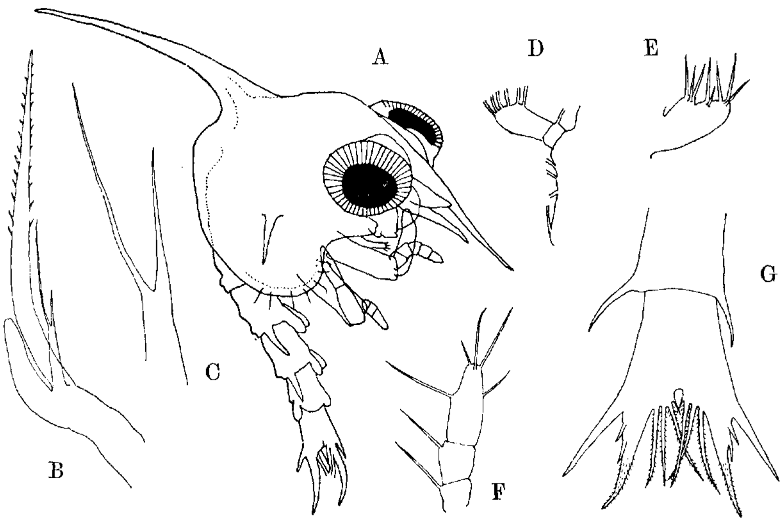


Fig. 27. *Erimacrus eisenbeckii* (BRANDT). Last zoea.
(A) lateral view ×39. (B) 2nd ant. ×61. (C) enp. of 2nd ant. ×377. (D) enp. of 1st mx. ×72. (E) enp. of 2nd mx. ×72. (F) enp. of 2nd mxp. ×72. (G) telson ×43.

3rd with 5 hairs. Lateral knobs on 2nd and 3rd somites, lateral ends of 3rd to 5th somites very prominent. Telson A_3-type, 3 outer denticulations all along lateral side. Uppermost denticulation largest, nearly equal to telson-fork, which is thick at base, pointed at end, covered with fine hairs all over distal half. 3 pairs of inner spines and 1 pair of extra-hairs. Middle depression narrow, but deep.

6th somite separated from telson at 2nd zoeal stage. Enp. of 2nd ant. first appears at 2nd stage, attaining only $1/4$ of peduncle at 3rd stage, $2/3$ at 4th stage, equal to peduncle at last stage. Swimming hairs 8 in all at 2nd stage, 10 with 2 accessory hairs at 3rd stage, 12 with 4 accessory ones at 4th stage, 14 with 4 accessory ones at last stage. Rudiments of 3rd mxp. and pereiopods appear at 2nd stage.

Megalopa stage divisible into 2 substages. Important features however show no marked changes. At I megalopa stage, long thick rostrum, short spine on antero-lateral corner, 2 spines on postero-lateral portion, 2 on median dorsal portion. At 2nd stage all these projections except those on both antero-lateral corner entirely disappear. 2nd ant. separable into 3-articulate basal portions, 2-articulate middle portion, and 2-articulate terminal portion. Number of joints in each portion do not increase in later megalopa stage. Uropods of last somite bears 4 terminal hairs.

24. *Cancer gibbosulus* (DE HAAN) 1st zoea. Fig. 28.

Characters: All kinds of carapacial spines present, 2nd ant. B_4-type, telson A_2-type, hair formula 6–1, 3–3 (6), 5–1–1.

Rostrum 0.29 mm, dorsum 0.46 mm, perpendicular distance between their tips 1.07 mm, lateral spine 0.18 mm, carapace 0.41 mm; abdomen 0.72 mm long, 0.11 mm wide, telson 0.27 mm.

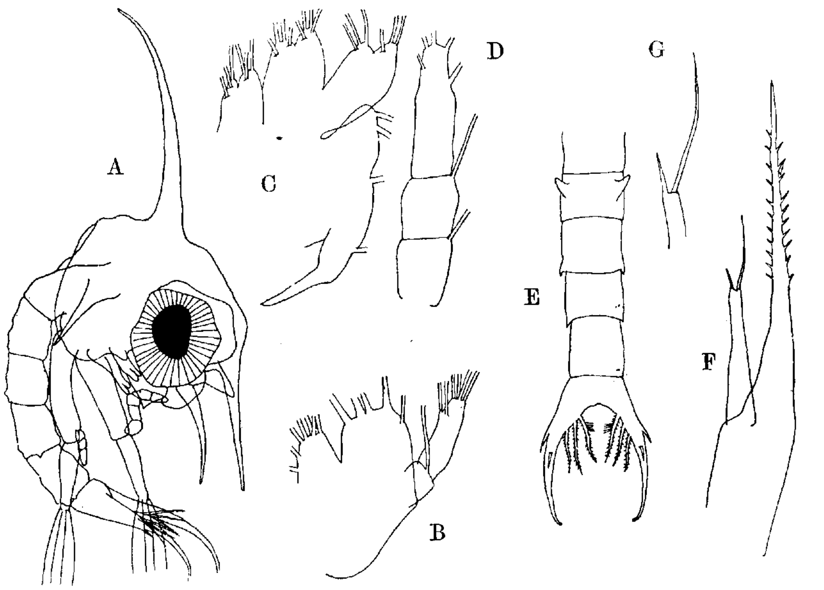


Fig. 28. *Cancer gibbosulus* (DE HAAN). 1st zoea.
(A) lateral view ×61. (B) 1st mx. ×233. (C) 2nd mx. ×233. (D) enp. of 2nd mxp. ×377. (E) abdomen ×72. (F) enp. of 2nd ant. ×467. (G) 2nd ant. ×377.

Rostrum straight, but dorsum bends backwards. Lateral spine fairly long. 2nd ant. B_4-type. Peduncle shorter than rostrum; thick at base, but pointed at end, armed with small teeth at its distal part. Exp. nearly ½ of peduncle with 2 unequal hairs on its rounded tip. Enp. of 1st mx. 2-articulate, mode of serration here 6–1. All podites of enp. of 2nd mx. deeply bifurcated, mode of serration on enp. 3–3 (6). Enp. of 2nd mxp. has 3 joints, mode of serration here expressed by 5–1–1. Zoea of *Cancer gibbosulus* greatly resembles those of Portunidae. Lateral knobs only on 2nd somite, lateral ends of 3rd to 5th somites slightly prominent. Telson A_2-type, 2 denticles on dorsal part of telson-fork, which is well developed and converges to end. Middle depression shallow, but so wide that 3 inner spines are arranged considerably apart from each other on each side. 3rd pair has 5 long hairs among short ones on inner side, 2 long hairs on its outer side.

25. *Grapsizoea rutila* AIKAWA (Atelecyclid zoea)
3rd zoea to megalopa. Fig. 29.

Characters: All kinds of carapacial spines present, 2nd ant. B_4-type, telson A_3-type, hair formula 6–1, 3–5 (8), 5–1–1.

At 3rd zoeal stage, dorsum 0.83 mm, rostrum 0.75 mm, perpendicular distance between their tips 2.50 mm, lateral spine 0.19 mm, carapace 1.04 mm; abdomen 1.91 mm long, 0.28–0.42 mm wide, and telson 0.69 mm.

Total of 8 swimming hairs on exp. of mxpds. at 3rd zoeal stage, 10 at 4th stage, 12 at last stage. Carapace fairly large. Dorsum curves backwards, pointed. Rostrum straight, lateral spine very short. In these points, this zoea closely resembles that of Portunidae. 1st ant. usual form, small projection of enp. already at 3rd stage. 2nd ant. B_4-type. Peduncle slender, armed with fine teeth on both sides of its distal half. Exp. ½ of length of peduncle at 3rd stage, more than ⅔ at last stage. Exp. tipped with 2 long smooth hairs. Mandible has broad chewing surface, densely pigmented. 1st mx. has 2-jointed enp., mode of serration here expressed by 6–1. All podites of 2nd mx. slightly bifurcated. Enp. bears 5 hairs on inner lobe, 3 on outer. Enp. of 2nd mxp. has 3 joints. Both 1st and 2nd joints with 1 hair each, 3rd with 5. 3rd mxp. and 5 pairs of pereiopods well developed at 3rd stage. Abdomen composed of 6 somites and telson, widest at 2nd somite, narrowing to preceding and following somites. Large lateral knobs present on 2nd and 3rd somites. Telson A_3-type, 2 lateral denticles near base of telson-fork, 1 on dorsal part. Telson-fork nearly straight, smooth; 3 pairs of inner spines, 2 pairs of extra-hairs.

At final stage, enp. of 2nd ant. becomes nearly of same length as peduncle. Enp. of 1st ant. increases in length, incompletely 2-jointed. Both 1st and 2nd mxpds. have very rudimentary epipds. 3rd mxp. 2-branched, but only incompletely segmented. Cheliped larger than following legs, chela very robust. All other features virtually unchanged.

Megalopa. Carapace nearly quadrate. Its frontal margin resembles that of zoea. Rostrum shorter than at zoeal stage. 1st ant. 2-branched. Basal part 3-jointed, 1st joint almost spherical, but other

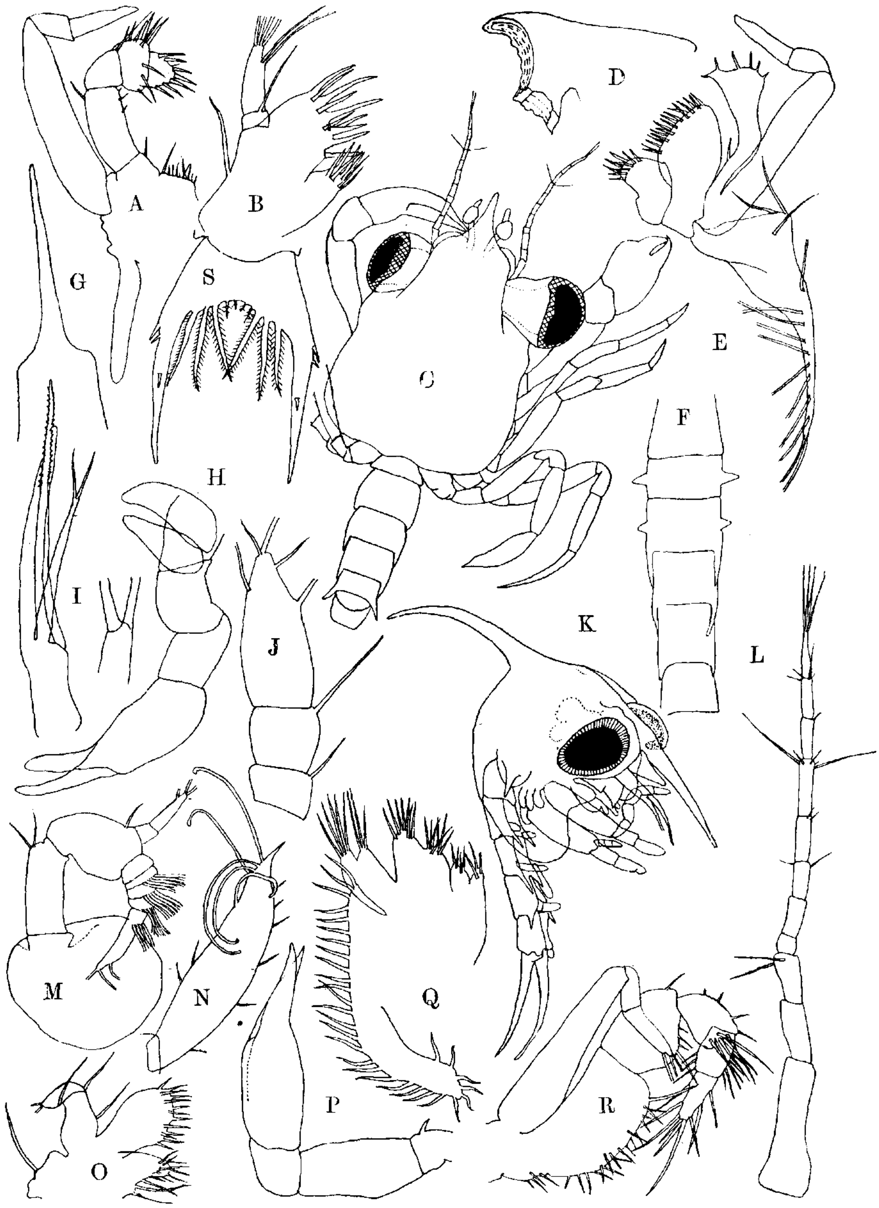


Fig. 29. *Grapsizoca rutila*. Last zoea and megalopa.
(A) 2nd mxp. (megalopa) ×48. (B) 1st mx. (III zoea) ×87. (C) megalopa ×13. (D) mandible (V zoea) ×61. (E) 1st mxp. (megal.) ×48. (F) abdomen (III zoea) ×26. (G) rostrum (V zoea) ×26. (H) cheliped (V zoea) ×39. (I) 2nd ant. (V zoea) ×61. (J) enp. of 2nd mxp. (III zoea) ×180. (K) V zoea ×21. (L) 2nd ant. (megal.) ×48. (M) 1st ant. (megal.) ×48. (N) dactylus of last leg (megal.) ×48. (O) 1st mx. (megal.) ×48. (P) cheliped (megal.) ×21. (Q) 2nd mx. (III zoea) ×87. (R) 3rd mxp. (megal.) ×48. (S) telson (III zoea) ×43.

2 elongated. Enp. 2-jointed, tapering, distal joint tipped with 3 hairs. Exp. has 5 joints; last joint with 2 terminal, 1 lateral hairs. 2nd ant. single, tapering, divisible into 3 portions. Basal portion has 3 joints, 3rd joint with 2 long stiff hairs on its distal edge. Middle portion 5 jointed. 4th joint smallest among antennal joints, 8th joint with 2 long and 2 short stiff hairs on its edge. Terminal portion is last 3 joints, each joint with 4 stiff hairs. Mandible with palp of single joint. Enpds. of both mxls. much reduced; that of 1st mx. with 3 long hairs on its lateral side, 2 short ones on its tip. 3rd mxp. usual form. Epip. of 1st mxp. has 2 terminal hairs besides long hairs around it. Basi-ischiopodite has small hook. Dactylus of last leg rather paddle-shaped, pointed at end, bears 5 curly feelers. Abdomen composed of 6 somites and small telson. Lateral ends of 3rd to 5th somites prominent as also observed in zoea.

Zoea and megalopa have many features in common with those of Portunidae. The hair formula differs from the latter group and the spinous projection is absent on the coxa of the last leg. In view of these characteristics, these larva may belong either to the family Atelecyclidae or to one of its allied families (for example Canceridae).

26. *Actumnus setifer* (DE HAAN) 1st zoea. Fig. 30.

Characters: All kinds of carapacial spines present, 2nd ant. A_2-type, telson A_3-type, hair formula 6–1, 3–5 (8), 5–1–1.

Dorsum 0.40 mm, rostrum 0.19 mm, perpendicular distance between their tips 1.15 mm, lateral spine 0.12 mm; carapace 0.66 mm long, 0.44 mm wide; abdomen 1.20 mm long, 0.17 mm wide, telson 0.44 mm.

Dorsum thick, hooked at its end. Rostrum and lateral spines rather short. 2nd ant. A_2-type. Peduncle and exp. nearly of same length, armed with fine teeth on both sides at their distal halves. In addition, exp. bears stout spinule on its middle part. Enp. of 1st mx. has 2 joints, mode of serration here expressed by 6–1. All podites of 2nd mx. well bifurcated. Enp. bears 5 hairs on inner lobe, 3 on outer. Expds. of mxpds. slightly segmented. Enp. of 2nd mxp. has 3 joints. Both 1st and 2nd joints with 1 hair each, 3rd with 5. Small buds of 3rd mxp. and 5 pairs of pereiopods already noticeable at this 1st zoeal stage. Abdomen composed of 5 somites and telson. Lateral knobs on 2nd and 3rd somites, lateral ends of 3rd to 5th somites more or less prominent. Telson A_3-type, with denticle and one hair laterally near base of telson-fork, one denticle on its dorsal side. Telson-fork long,

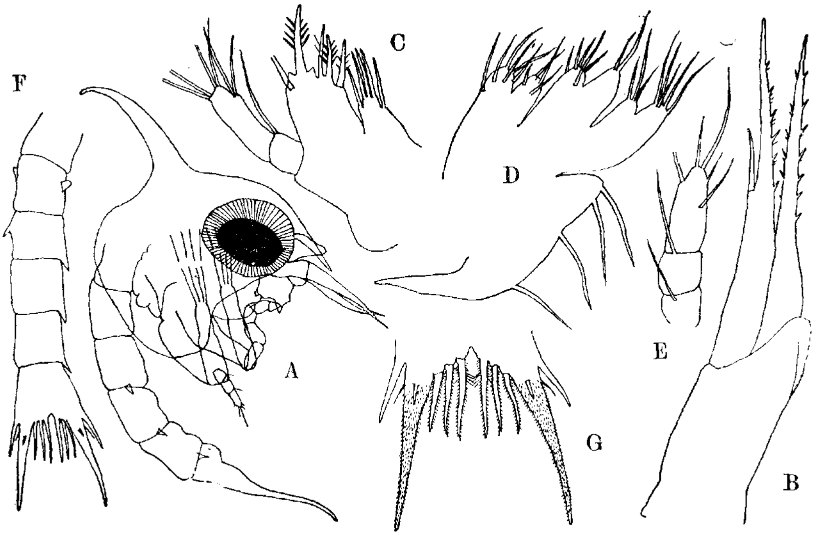


Fig. 30. *Actumnus setifer* (DE HAAN). 1st zoea.
(A) lateral view ×43. (B) 2nd ant. ×87. (C) 1st mx. ×180. (D) 2nd mx. ×270. (E) enp. of 2nd mxp. ×180. (F) abdomen ×43. (G) telson ×87.

pointed, covered all over with fine hairs. 3 pairs of inner spines of like length. Middle depression narrow, but fairly deep. Longest 3rd pair with 4 long hairs among short ones on its inner side, 1 long hair on outer side.

Zoea of *Actumnus setifer* (D. H.) resembles those of the genus *Pilumnus* and is included with the latter in the primitive zoeal group of the family Menippidae.

27. *Grapsus grapsus* LINNÉ. 1st zoea. Fig. 31.

Characters: Only lateral spines absent but dorsum and rostrum present, 2nd ant. B_1-type, secondary chrom. in 1st mxp., abdominal ones in each somite except telson, telson B-type, hair formula 5–1, 2–3 (5), 5–1–0.

Dorsum 0.30 mm, rostrum 0.25 mm, perpendicular distance between their tips 1.05 mm, carapace 0.61 mm; abdomen 0.73 mm long, 0.13 mm wide, telson 0.25 mm.

Larva fairly large. Dorsum and rostrum rather short. Rostrum straight, but dorsum slightly curved. 1st ant. bears 3 aesthetes, 2 short hairs on tip. 2nd ant. B_4-type. Peduncle thick, toothed coarsely at its distal half. Exp. ⅓ of length of peduncle, with 1 long hair and 3 short stiff hairs. Enp. of 1st mx. has 2 joints, mode of serration here

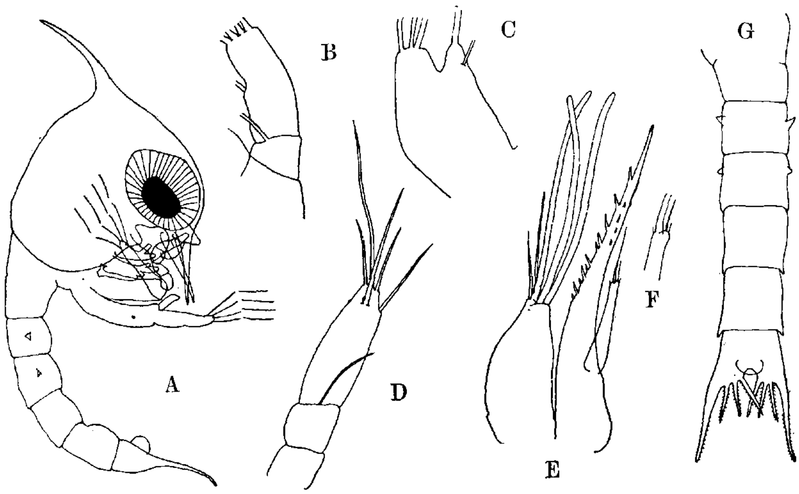


Fig. 31. *Grapsus grapsus* L. 1st zoea.
(A) lateral view ×40. (B) enp. of 1st mx. ×377. (C) enp. of 2nd mx. ×467.
(D) enp. of 2nd mxp. ×377. (E) 1st and 2nd ant. ×233.
(F) enp. of 2nd ant. ×467. (G) abdomen ×72.

expressed by 5–1. Enp. of 2nd mx. deeply bifurcated, bears 2 hairs on its outer lobe, 3 on its inner. Enp. of 2nd mxp. has 3 joints. 1st joint hairless, but 2nd 1 hair, 3rd 5 on tip. Secondary chrom. in 1st mxp. Lateral knobs on 2nd and 3rd somites. Abdominal chroms. in all somites except telson. Telson-fork pointed, covered with fine hairs. 3 pairs of inner spines of same length, middle depression fairly deep.

28. *Gaetice depressus* (DE HAAN). Last zoea and megalopa. Figs. 32, 33.

=*Platygrapsus depressus* DE HAAN. AIKAWA, 1929, p. 47.

At last zoeal stage, dorsum 0.94 mm, rostrum 1.02 mm, perpendicular distance between their tips 2.41 mm, carapace 1.24 mm; abdomen 2.94 mm long, 0.10 mm wide, telson 0.62 mm.

Dorsum and rostrum medium size, pointed. Lateral spine absent. Carapace fairly large. 2nd ant. B_2-type. Peduncle slender, armed with fine teeth along outer side at its distal two-thirds. Exp. long, with 1 spinule on middle part, slendering abruptly from this spinule to end. Enp. only 1/4 of peduncle at this last stage. Enp. of 1st mx. shows 5–1 as mode of serration. All podites of 2nd mx. slightly bifurcated, 2 hairs on each lobe. Expds. of mxpds. have 12 swimming hairs. Enp.

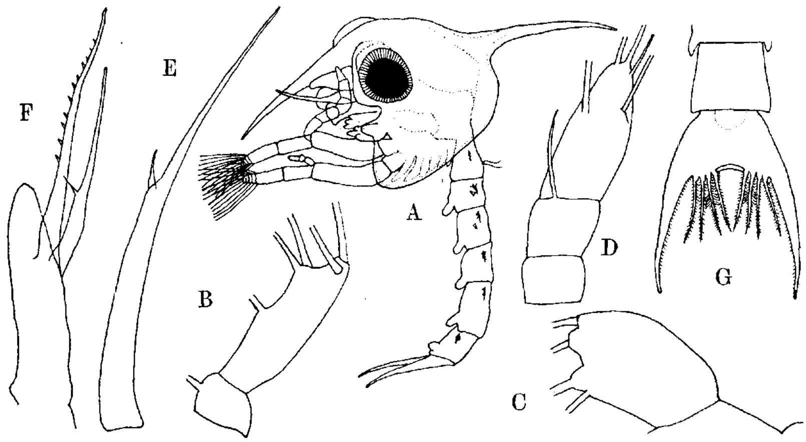


Fig. 32. *Gaetice depressus* (DE HAAN). Last zoea.
(A) lateral view ×21. (B) enp. of 1st mx. ×180. (C) enp. of 2nd mx. ×180.
(D) enp. of 2nd mxp. ×180. (E) enp. of 2nd ant. ×180.
(F) 2nd ant. ×87. (G) abdomen ×43.

of 2nd mxp. has 3 joints. Distal 3rd joint with 3 terminal, 2 lateral hairs, 2nd with 1, but 1st with none. 3rd mxp. and 5 pairs of pereiopods very small. Abdomen composed of 6 somites and telson. Lateral knobs on 2nd and 3rd somites, lateral end of 5th somite slightly prominent. Telson B-type. 4 pairs of inner spines of same length. 3rd pair with 4 or 5 long hairs among short ones on outer side, 5 or 6 long hairs on inner side. Telson-fork slender, pointed at end, finely serrated along its inner side.

Megalopa (Fig. 33). Carapace nearly quadrate. Rostral spine absent.

Middle depression on frontal margin of carapace wide. Neither dorsal nor lateral spines present. 1st ant. 2-branched. Basal part 3-jointed. 1st joint large, spherical, but 2nd and 3rd elongated. Enp. 3-articulate, tipped with 3 hairs. Exp. only 3-jointed, some sensory hairs on each joint. 2nd joint with 1 lateral hair, 3rd with 3 terminal hairs. 2nd ant. composed of 10 joints, very thick. Basal part 3-articulate, no serration on joints. 4th to 8th joints very small, closely jointed. 6th joint has ring of fine hairs around its distal edge. Last joint very small, tipped with a stiff hair. Sensory hairs present on 7th to 9th joints. Epip. of 1st mxp. has 1 terminal hair. Enp. of 1st mxp. flattened, 2 small teeth on its inner corner. Exp. 2-jointed, its

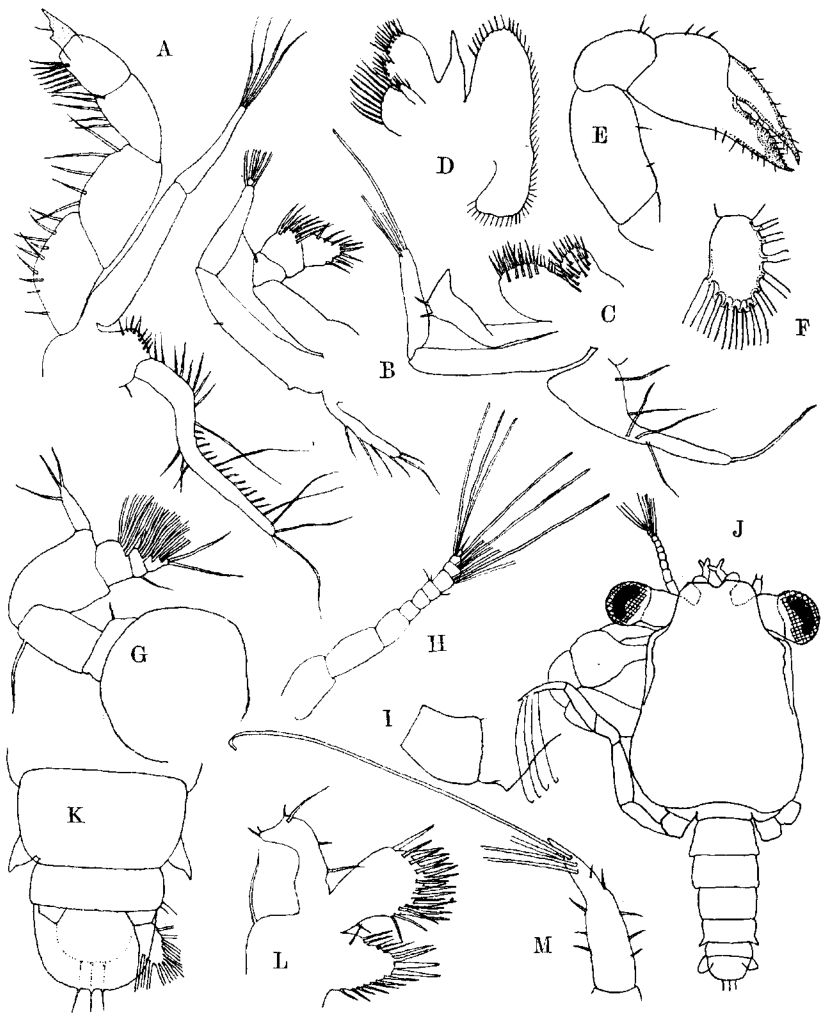


Fig. 33. *Gaetice depressus* (DE HAAN). Megalopa.
(A) 3rd mxp. ×40. (B) 2nd mxp. ×40. (C) 1st mxp. ×40. (D) 2nd mx. ×40. (E) cheliped ×43. (F) uropod of last somites ×87. (G) 1st ant. ×61. (H) 2nd ant. ×39. (I) coxa of last leg ×33. (J) dorsal view ×13. (K) abdomen ×43. (L) 1st mx. ×61.

distal joint has 4 hairs. Enp. of 2nd mxp. has 4 joints, 3rd and 4th joints thickly serrated. 2nd joint has only 1 hair, but 1st none. 1st joint of exp. has small tubercle, 2nd joint 4 terminal hairs. Epip. small, ending in 1 terminal hair. 3rd mxp. has 5-jointed enp. 1st to 4th joints rather cylindrical with stiff hairs along their inner sides.

Terminal joint becomes small stout hook, thickly chitinized, with a fine hair. Epip. large, densely serrated, with a terminal hair. Abdomen composed of 6 somites and telson. No lateral knob observed, but lateral end of 5th somite somewhat projected as noticed in zoea. Uropod of last somite bears 3 terminal hairs. Telson semicircular, 3 fine hairs on middle part of lower margin. No hook present on basi-ischipodite of cheliped, but knife-blade of chela (propodus and dactylus) densely chitinized, furnished with many short stiff hairs. Dactylus of last leg bears 4 feelers.

Enp. of 1st mx. of single joint, with 3 hairs on its inner side, 2 on outer. Enp. of 2nd mx. becomes completely rudimentary.

29. *Sesarma picta* DE HAAN. 1st zoea. Fig. 34.

Characters: Only lateral spines absent, 2nd ant. B_4-type, telson B-type, secondary chrom. only in 1st mxp. abdominal ones in all somites except telson, hair formula 5–1, 2–3 (5) 6–1–0.

Dorsum 0.17 mm, rostrum 0.15 mm, perpendicular distance between tips 0.63 mm, carapace 0.35 mm; abdomen 0.84 mm long, 0.20 mm wide, telson 0.25 mm.

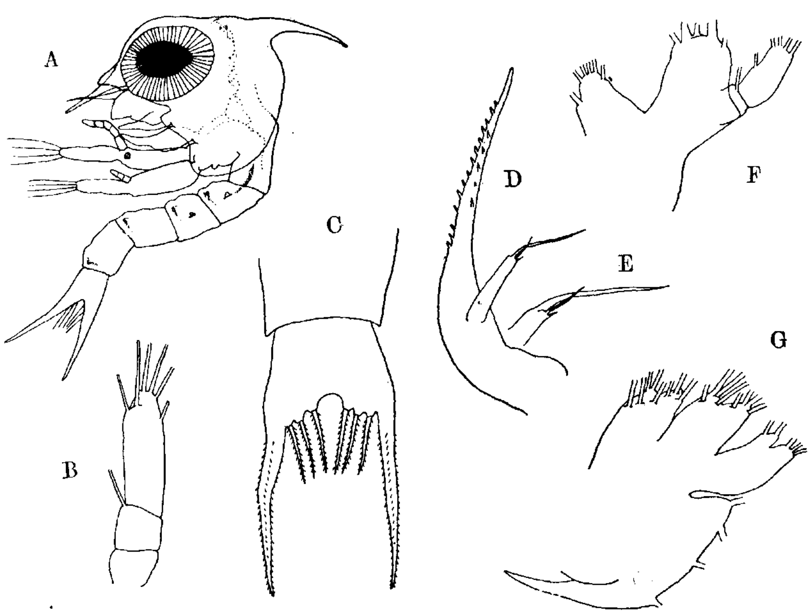


Fig. 34. *Sesarma picta* DE HAAN. 1st zoea.
(A) lateral view ×61. (B) enp. of 2nd mxp. ×377. (C) telson ×121. (D) 2nd ant. ×233. (E) enp. of 2nd ant. ×467. (F) 1st mx. ×233. (G) 2nd mx. ×233.

Larva medium size. Both carapacial spines thick at base, pointed at end. 2nd ant. longer than rostrum, B_4-type. Peduncle slightly curved, armed with teeth on distal part. Exp. only ¼ of length of peduncle, ends in a long hair and a short one. Enp. of 1st mx. 2-articulate, mode of serration here expressed by 5–1. All podites of 2nd mx. deeply bifurcated, mode of serration here 2–3 (5). Enp. of 2nd. mxp. has 3 joints. 1st joint hairless, but 2nd 1 hair on its distal edge, 3rd 6 on tip. Secondary chrom. only in 1st mxp. Lateral knobs on 2nd and 3rd somites. All abdominal somites have chromatophores. Telson-forks long, slender, parallel to each other, covered over with fine hairs. 3 pairs of inner spines present, middle depression fairly deep.

30. *Plagusia dentipes* DE HAAN. 1st zoea and megalopa. Figs. 35, 36.

Characters: All kinds of carapacial spines present, 2nd ant. B_4-type, telson B-type, primary chrom. in both mxpds., abdominal ones in all somites and in telson, hair formula 5–1, 2–3 (5), 5–1–1.

Dorsum 0.42 mm, rostrum 0.45 mm, perpendicular distance between their tips 1.25 mm, lateral spine 0.21 mm, carapace 0.42 mm, abdomen 1.15 mm, telson 0.37 mm.

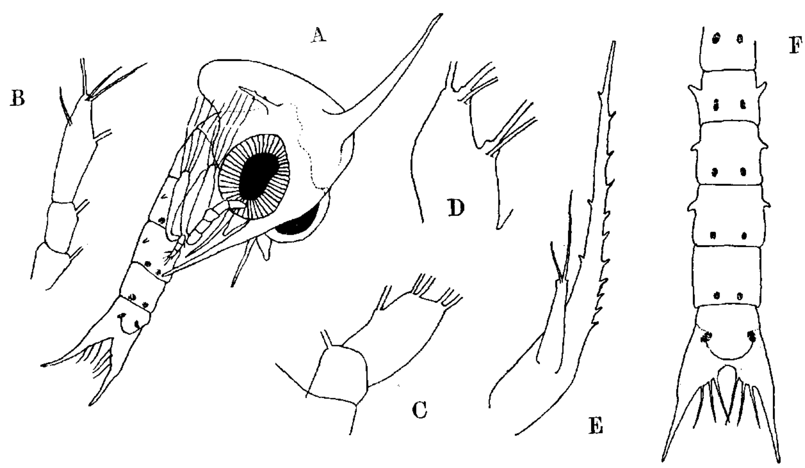


Fig. 35. *Plagusia dentipes* DE HAAN. 1st zoea.
(A) lateral view ×40. (B) enp. of 2nd mxp. ×213. (C) enp. of 1st mx. ×320. (D) enp. of 2nd mx. ×320. (E) 2nd ant. ×213. (F) abdomen ×61.

Dorsum thick at base, pointed at end. Rostrum nearly straight. Lateral spine straight, coarsely toothed. 1st ant. usual form, 2nd ant.

B_4-type. Peduncle curved, armed with teeth. Exp. short, only ¼ of peduncle, tipped with long spinule and a short hair. Enp. of 1st mx. 2-articulate, mode of serration here expressed by 5–1. Enp. of 2nd mx. biramous, 2 hairs on its small outer lobe, 3 on large inner lobe. Primary chroms. in both mxpds. Enp. of 2nd mxp. has 3 joints. 1st and 2nd joints with 1 hair on each distal edge, 3rd with 3 on tip and with 1 on each lateral side.

Lateral knobs present on 2nd to 4th somites. Abdominal chroms. present in all somites and in telson. Telson B-type. 3 pairs of inner spines of same length. Middle depression wide, but shallow. Telson-fork thick at base, pointed at end.

Megalopa (Fig. 36). The megalops of I stage usually form swarms in the open seas from late winter to spring. Those of II stage live in great abundance on floating weeds and timbers from spring to early summer. Megalops are carried to the coast with weeds and timbers and dammed up there. I megalops are almost transparent, pale greenish, but II megalops become rather brownish, of colour similar to floating weeds. Megalops change to young crab through 2 stages, although they show 3 modes in their body lengths. II megalop,

Megalopa Stage	Carapace		Abdomen	
	length mm	width mm	length mm	width mm
Stage I	5.1	3.5	2.7	1.2
„ IIa	7.5	7.1	4.3	2.6
„ IIb	9.0	6.2	5.0	3.0
Young crab	10.1	9.0	—	—

which is of remarkable size, are called "Saba-gani". Fishermen expect a good catch wherever these Saba-gami are found in great numbers. At the megalopa stage, both mxls. and 1st to 3rd mxpds. have already acquired their adult forms. Carapace nearly quadrate and slightly narrows towards its anterior end. Rostrum present at I megalopa stage, but disappears at II stage. 2nd ant. composed of terminal, middle, and basal parts. Terminal part 3-articulate, slender. Basal part also 3-articulate, 3rd joint has ring of short hairs around its distal edge. Middle part 5-articulate at I stage, 8 at II stage and in young crab. Last joint bears 3 sensory hairs on its tip at 1 stage, 5 at II stage and in young crab. All joints of cheliped smooth at I stage, but at II stage its merus and propodus become thick where the beaded ridge develops in the young crab. Ischium of cheliped has large hooked spine at I stage. Spine becomes smaller and straight at II stage, finally in young crab hardly distinguishable from the hairs around it. Abdominal somites wider than long, ridged along median line at each somite. Short tooth on middle end of 5th somite. Lateral ends of 1st to 5th somites more or less projected.

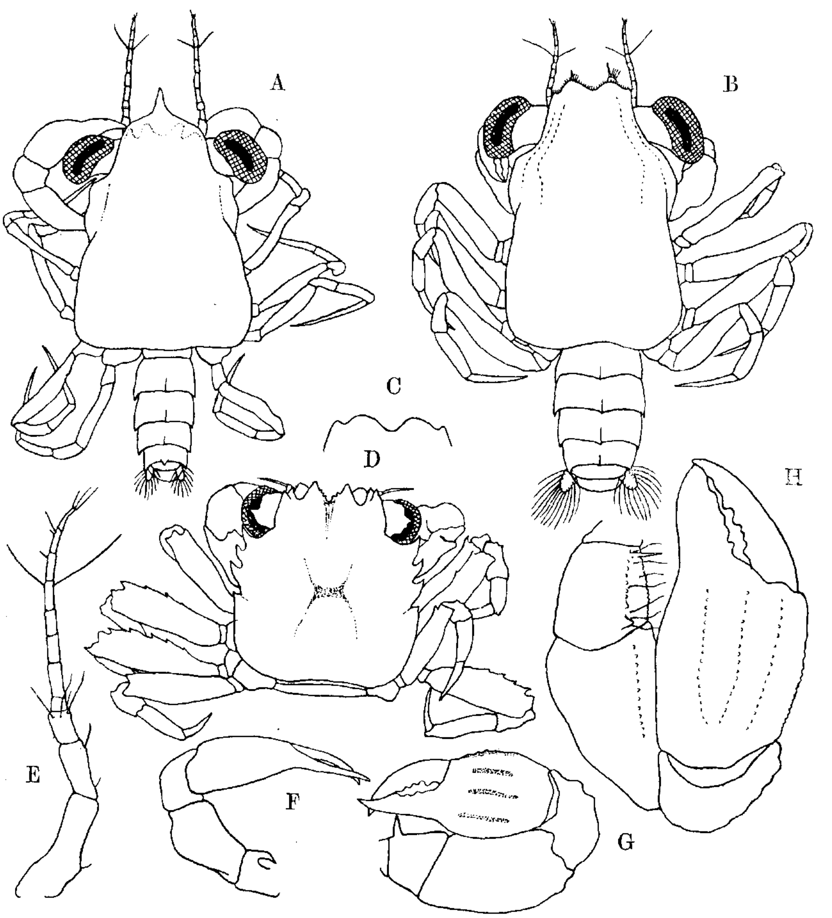


Fig. 36. *Plagusia dentipes* DE HAAN. Megalopa and young crab.
(A) dorsal view (I megalopa) ×7. (B) dorsal view (II megal.) ×5. (C) frontal margin of carapace (II megal.) ×5. (D) dorsal view (young crab) ×3. (E) 2nd ant. (I megal.) ×24. (F) cheliped (I megal.) ×9. (G) cheliped (II megal.) ×9. (H) cheliped (young crab) ×9.

Part III. Larval characteristics of some important families

The writer attempts here to describe the larval characters of some important families, refering to zoeas described in Japan and abroad. As listed in Table I–IV, they total about 70 genera and 150 species.

(1) Family Dromiidae (Table I, 1).

Zoea of *Dromia vulgaris* has no stable brown chromatophores, the colour pattern of its body being very similar to those of both Macrura and Anomura. 2nd antenna F-type, telson G-type. Excepting the fairly large spinous process on the basal part of the 2nd antenna it is almost impossible to separate dromiid zoea from those of Macrura and Anomura. Endopodite of 2nd maxilla single, but endopodite of 1st maxilla 2-articulate. In these points, dromiid larva can be distinguished from homolid zoea.

Table I. List of larval characters

No.	Species	Reference	Carapacial spines		
			Ros.	Dor.	Lat.
1.	*Dromia vulgaris* M.-EDWS.	LEBOUR(5), p. 241, pls. 1–5	0	×	×
2.	*Latreillia phlangium* D. H.	Fig. 3.	0	×	×
3.	*Parahomola japonica* PAR.	Fig. 4.	0	×	×
4.	*Homola* sp.	WILLIAMSON(2), p. 543.	0	×	×
5.	*Homola* sp.	Fig. 5.	0	×	×
6.	*Ethusa macerone* ROUX	WILLIAMSON(2), p. 561.	0	0	0
7.	*Dorippe* sp.	GURNEY(1), p. 194.	0	0	0
8.	*Dorippe granulata* D. H.	Fig. 6.	0	0	×
9.	*Dorippe* sp. A.	Fig. 7.	0	0	×
10.	*Dorippe* sp. B.	Fig. 8.	0	0	×
11.	*Calappa lophos* (HERBST)	Fig. 9.	0	0	0
12.	*Ebalia tuberosa* (PEN.)	WILLIAMSON(2), p. 557. LEBOUR(3), p. 539.	0	×	0
13.	*E. longipedata* ORT.	Fig. 10.	0	×	0
14.	*E. cranchii* LEACH	LEBOUR(3), p. 540.	0	×	×
15.	*E.* sp.	JÖRGENSEN(1), p. 157.	×	×	0
16.	*Leucosia signata* LEACH	GURNEY(3), p. 284.	0	×	0
17.	*Ilia* sp.	CANO(2), p. 527.	—	—	—
18.	*Philyra pisum* D. H.	AIKAWA(1), p. 34.	0	×	×
19.	*P. tuberculata* STIMPSON	ibid. p. 35.	0	×	×

(2) Family Homolidae (Table I, 2–5).

Zoeas of *Latreillia phalangium*, *Parahomola japonica*, and 2 unknown species of G. *Homola* described. These zoeas possess the F-type of 2nd antenna and G-type of telson. The spinous process on the basal part of 2nd antenna is fairly large. It is also noteworthy that in this family the endopodite of the 2nd maxilla is 2-articulate, and its terminal joint furnished with more hairs than its basal joint. In addition, the endopodite of the 2nd maxilliped has 4 or 5 joints. In these respects, zoeas of the Homolidae can be determined, although they can be grouped into *Lithozoea* together with dromiid larva. The cephalothorax of G. *Homola* bears many spinous processes large or small. Carapace is 2-lapped, each lap being finely toothed along its lower margin in the Homolidae.

(3) Family Dorippidae (Table I, 6–10).

Zoeas of *Ethusa macerone*, *Dorippe granulata*, and 3 unknown

of the Dromiidea and the Oxystomata.

	2nd antenna	Telson	mxp.-chrom.		Hair Formula		
			1st mxp.	2nd mxp.	1st mx.	2nd mx.	2nd mxp.
1	E	G	×	×	4–2	7	?
2	E	G	×	×	5–1	3–4(7)	5–2–0–0
3	E	G	×	×	5–1	2–6(8)	5–2–1–1
4	E	G	×	×			
5	E	G	×	×	5–1	2–4(6)	5–3–1–3–0
6	A	C	—	—			
7	A_3	C	—	—			
8	A_3	C	×	×	4–0	4	3–1–0
9	A_3	C	×	×	4–0	4	3–1–0
10	A_3	C	×	×	4–0	4	4–1–0
11	B_2	A_2	×	×	4–0	2–5(7)	4–1–1
12	D	E	×	×			
13	D	E	—	—	4	3	3
14	D	E	×	×			
15	D	E	—	—			
16	D	E	0_1	0_1			
17	D	E	—	—			
18	D	E	0_1	0_1	4–0	3	1–0
19	D	E	0_1	0_1	4 0	3	2–0

species of *Dorippe* are described. In the remarkable length of both dorsum and rostrum, these zoeas resemble Porcellana larva. Stable brown chromatophores are also absent. Here, 2nd antenna is also F-type, but its spinous process on the basal portion also well developed. Telson is a peculiar C-type. These larvae, which are grouped into *Ethusozoea,* are easily distinguished from other Brachyura larvae. The species can be determined only by the presence or absence of carapacial spines and other detailed structures, of which it is difficult to be sure in the previous papers. All kinds of carapacial spines are present in the larva of *Ethusa,* while the lateral spines alone are absent in *Dorippe.* The endopodite of 1st maxilla is 2-articulate, but its basal joint is hairless. The endopodite of 2nd maxilla is usually single. Endopodite of 2nd maxilliped has 3 joints, its basal joint hairless. Ethusozoeas resemble the usual Brachyura larvae rather than those of the Dromiidae and the Homolidae.

(4) Family Calappidae (Table I, 11).

The calappid zoea has already attained typical brachyuran form, differing from any zoeas of the Oxystomata. 2nd antenna is B-type, telson A-type, hence grouped into *Grapsizoea.* It is easily distinguished from other members of *Grapsizoea* merely by absence of the stable brown chromatophores in both maxillipedes and in abdomen. Endopodite of 1st maxilla has 2 joints, its basal joint hairless. Endopodite of 2nd maxilla bifurcated. Endopodite of 2nd maxilliped has 3 joints, all with hair each. Colour pattern of body almost same as those of both Dromiidae and Homolidae.

(5) Family Leucosiidae (Table I, 12–19).

Zoeas of only a few genera are known from this large family. The presence and absence of carapacial spines is irregular, while all have the D-type of 2nd antenna, which is regarded as a deviation. Telson of E-type resembles the *Pasiphaë*-telson and retains the primitive features. Endopodite of 2nd maxilla generally single, endopodite of 2nd maxilliped only 1 or 2 articulate, never 3. Maxillipedal chromatophores are of primary character. The zoeas of this family, which are always called *Leucozoea,* are easily distinguishable from other brachyuran larvae. The species may be determined by the grouping of chromatophores in maxillipedes and in abdomen, and by the presence or absence of carapacial spines. The *Leucozoea* is at all events a deviated group of brachyuran zoeas.

ORTMANN assumed that the Raninidae and the Leucosiidae together form a particular group, and the Matutidae, the Calappidae, and the Orythyidae another group. The Dorippidae differs from either, although it is closer to the latter group than the former. Considering the relationship between these groups based on their larval characters, the zoeas of the Calappidae and the Dorippidae differ greatly from the Leucosiidae, showing besides close affinity with the usual brachyuran group. In this way, the zoeas of the Oxystomata can be separated into 3 groups, namely, *Leucozoea*, *Ethusozoea*, and *Grapsizoea*. *Leucozoea* may be related to the *Lithozoea* of the Homolidae and the Dromiidae on one hand, and to the *Grapsizoea* of the Calappidae with the usual brachyuran zoea on the other.

(6) Family Corystidae (Table II, 1).

The larva of *Corystes cassivelanus* is well known among this family. All kinds of carapacial spines are present. 2nd antenna B_4-type, telson also A_1-type. Secondary chromatophores present in both maxillipedes. Endopodite of 2nd maxilla probably single (WILLIAMSON, 2, p. 545, fig. 468), the lateral knobs occuring only on 2nd abdominal somite (LEBOUR, 3, p. 525). In addition, the zoea is rather more advanced in development than in most like stage of the Brachyrhyncha group (LEBOUR, 3, p. 527). The rudiments of the 3rd maxilliped and 5 pairs of pereiopods may therefore be present already at the 1st larval stage. In these respects, the zoea of *Corystes cassiv.* greatly resembles the larvae of Majidae, especially the group represented by G. *Maia* and certain others, ORTMANN placed this family with the Inachidae and the Majidae in the Majoidea. The zoea of the Corystidae clearly differ from the larvae of Cancroidea.

(7) Family Hymenosomidae (Table II, 2–4).

The zoea of this family is the *Hymenozoea*, being characterized by the D-type of 2nd antenna and telson. Rostrum alone is present, its shape being very peculiar. Primary chromatophores are present in both maxillipedes. Endopodite of 1st maxilla has 2 joints, its basal joint with a hair. Endopodite of 2nd maxilla is single. Endopodite of 2nd maxilliped has 3 joints. Lateral knobs absent on abdomen. The Hymenosomidae, which may be a deviated group, seems to be related to the Leucosiidae rather than to the Cancroidea.

(8) Family Inachidae (Table II, 5–22).

Zoeas of the Inachidae generally have the A_3-type of 2nd antenna. Telson generally A_1-type, but less frequently A_2 or A_3-type. The zoeas are separable into 2 groups, the one with only a rostrum, the

Table II. List of larval

No.	Species	Reference	Carapacial spines		
			Ros.	Dor.	Lat.
1.	*Corystes cassivelanus* (PENN.)	WILLIAMSON (2), p. 544. LEBOUR (3), p. 526.	0	×	0
2.	*Rhynchoplax messor* STIMPSON	AIKAWA (1), p. 36.	0	×	×
3.	*Trigonoplax unguiformis* D. H.	ibid., p. 37.	0	×	×
4.	*Halicarcinus septentrionalis* Y.	ibid., p. 37.	0	×	×
5.	*Stenorhynchus unguif.* M.-EDWS.	CANO (2), p. 527.	×	0	×
6.	*Paratymolus pubescens* D. H.	Fig. 12.	0	0	×
7.	*Achaeus* sp. A	Fig. 13.	×	0	×
8.	*Achaeus* sp. B	Fig. 14.	×	0	×
9.	*Inachus dorsettensis* (PENN.)	WILLIAMSON (2), p. 530. LEBOUR (3), p. 546.	×	0	×
10.	*I. rostratus* (L.)	WILLIAMSON (2), p. 532.	×	0	×
11.	*I. cranchii* (LEACH)	ibid., p. 530.	×	0	×
12.	*I. dorhynchus* (LEACH)	LEBOUR (3), p. 547.	×	0	×
13.	*I. leptocheirus* LEACH	ibid., p. 548.	×	0	×
14.	*I. scorpio*	CANO (2), p. 527.	×	0	×
15.	*Macropodia egyptia* M.-E.	LEBOUR (3), p. 550.	×	0	×
16.	*M. rostratus* (L.)	ibid., p. 550.	×	0	×
17.	*M. longirostris* (FABR.)	ibid., p. 549. .	×	0	×
18.	*Inachus* sp.	CANO (2), p. 527.	×	0	×
19.	*Pleistacantha san.-joh.* MIERS	Fig. 11.	0	0	×
20.	*Huenia proteus* D. H.	Fig. 15.	0	0	×
21.	*Pugettia quadridens* D. H.	AIKAWA (1), p. 38.	0	0	×
22.	*Acanthonyx* sp.	CANO (2), p. 527.	0	0	×
23.	*Hyas araneus* (L.)	WILLIAMSON (2), p. 521. LEBOUR (4), p. 93.	0	0	0
24.	*H. coarctatus* LEACH	WILLIAMSON (2), p. 526.	0	0	0
25.	*Maia squinado* HERBST	LEBOUR (3), p. 542.	0	0	0
26.	*M. verrucosa* M.-EDWS.	WILLIAMSON (2), p. 538.	0	0	0
27.	*M.* sp.	ibid., p. 539.	0	0	0
28.	*Chionecetes opilio* FABR.	Fig. 17.	0	0	0
29.	*Herbstia* sp.	CANO (2), p. 527.	0	0	×
30.	*Pisa biaculeata* MONTAGU	LEBOUR (3), p. 544, (4), p. 94.	0	0	×
31.	*Naxia hystrix* MIERS	Fig. 16.	0	0	0
32.	*Eurynome aspera* (PENNANT)	LEBOUR (3), p. 543.	0	0	0
33.	*Eurynome* sp.	CANO (2), p. 527, WILLIAMSON (2), p. 534.	0	0	×
34.	*Tiarinia cornigera* LATR.	Fig. 18.	0	0	×
35.	*Lissa* sp.	CANO (2), p. 527.	×	0	×

Note: 0 = presence, × = absence,

characters of the Majoidea.

No.	2nd antenna	Telson	Mxp.-chrom.		Hair Formula		
			1st mxp.	2nd mxp.	1st mx.	2nd mx.	2nd mxp.
1	B_4	A_1	0_2	0_2		Single	4-1-1
2	D	D	0_1	0_1	4-1	5	5-1-1
3	D	D	0_1	0_1	4-1	5	5-1-1
4	D	D	0_1	0_1	4-1	5	5-1-1
5	A_3	A_1	—	—			
6	B_2	B	×	×	6-1	3-5(8)	2-0-0
7	A_3	A_1	—	—	3-0	4	4-0-0
8	A_3	A_1	—	—	3-0	4	4-0-0
9	A_3	A_1	×	0_1			
10	A_3	A_1	—	—			
11	A_3	A_1	—	—			
12	A_3	A_1	0_1	0_1			
13	A_3	A_1	×	0_1			
14	A_3	A_3	—	—			
15	A_3	A_1	0_1	0_1			
16	A_3	A_1	×	0_1			
17	A_3	A_1	0_1	0_1			
18	A_3	A_1	—	—			
19	A_3	A_3	—	—	6-1	5	4-1-0
20	A_3	A_1	×	0_1	5-0	4	4-1-0
21	A_3	A_2	0_1	0_1	4-1	4	3-1-0
22	A_3	A	—	—			
23	B_5	A_2	—	—			
24	B_5	A_2	0_1	0_1			
25	B_6	A_3	0_1	0_1			
26	B_6	A_3	—	—			
27	B	A_1	—	—			
28	B_5	A_2	—	—	5-1	2-3(5)	5-×-×
29	A_3	A_1	—	—			
30	A_3	A_1	0_2	0_2			
31	A_3	A_1	—	—	6-1	5	4-1-0
32	B_4	A_3	0_1	0_1			
33	B_4	A_3	—	—			
34	A_3	A_3	—	—	6-1	3-5(8)	6-1-1
35	A_3	A_1	—	—			

— = not ascertained.

other with both rostrum and dorsum. Endopodite of 2nd maxilla is always single. Primary chromatophores are present in both maxillipedes or in one of them. Lateral knobs are present on 2nd somite alone. A characteristic of this group is that the rudiments of the 3rd maxilliped and 5 pairs of pereiopods are present already at 1st larval stage. The zoeas of *Stenorhynchus*, *Achaeus*, *Inachus*, and *Macropodia* belong to the 1st group. The 2nd group comprises the larvae of *Pugettia*, *Huenia*, *Pleistacantha*, and *Acanthonyx*. The zoea of *Acanthonyx* has both dorsum and rostrum, although the latter is minute and rudimentary. The zoea of *Acanthonyx* is therefore a transition form between these 2 groups. The division based on the larval characters is not in entire agreement with the classification of the adult form, but the 1st group undoubtedly corresponds to the subfamily Inachinae and the 2nd group to the Acanthonychinae.

(9) Family Majidae (Table II, 23–33).

The larvae of the Majidae are not so uniform in character as those of the Inachidae. They are as a whole separable into 3 groups. The 1st group being composed of the larvae of *Pisa*, *Naxia*, and *Herbstia*, the 2nd group of *Maia* and *Eurynome*, and the 3rd of *Hyas* and *Chionecetes*. In the 1st group, both dorsum and rostrum are present, but the laterals either absent or very rudimentary (*Herbstia*). As assumed so far from the larval characters of *Pisa*, the maxillipedal chromatophores are of secondary character, the endopodite of the 2nd maxilla being single. Rudiments of the 3rd maxilliped and pereiopods are present in the 1st stage, the lateral knobs occurring only on the 2nd somite. The larval characters of the 1st group are therefore similar to those of the 2nd group of the Inachidae, except the character of its maxillipedal chromatophores. Both 2nd and 3rd group, which have B-type 2nd antenna and A-type telson, are grouped in the *Grapsizoea*. In the 2nd group, the lateral knobs occur on the 2nd abdominal somite alone, while in the 3rd group they occur on both 2nd and 3rd somites. So far as assumed from the larval characters of *Chionecetes*, the endopodite of the 2nd maxilla is bifurcated in 3rd group, while probably single in 2nd group. In addition, the lateral spines of the 2nd group are much shorter than those of the 3rd group. Both 2nd and 3rd groups are easily distinguishable from other *Grapsizoeas* by the presence of primary chromatophores in the maxillipedes. Lebour suggested the advisability of keeping the subfamily Pisinae for *Pisa*, together with certain foreign crabs, including *Lissa*, which according to Cano, closely resembles *Pisa* in development, and of placing *Hyas* in a new subfamily (LEBOUR, 4, p. 96), with all of which the present writer agrees except his treatment of *Lissa*.

(10) Family Periceridae (Table II, 34, 35).

The larvae of *Lissa* sp. and *Tiarinia cornigera* are described. Both 2nd antenna and telson are of A-type. *Lissa* has only the dorsum, whereas *Tiarinia* has both dorsum and rostrum. The larva of *Lissa* strongly resembles those of the 2nd group of Inachidae. The writer has regarded here the larva of *Tiarinia* as representative of this family. Endopodite of 2nd maxilla biramous. Rudiments of 3rd maxilliped and pereiopods absent at 1st stage, whence the larva of the Periceridae retains to a considerable extent the primitive features, being related to the 1st group of Majidae more closely than to either the 2nd or 3rd groups.

The zoeas of the Majoidea may be related in the manner shown in the following scheme:

3rd group....*Hyas, Chionecetes*
(Hyasteninae)
↑
2nd group....*Maia, Eurynome*
(Majinae)
↑
Lissa, Tiarinia Periceridae ←—— 1st group....*Pisa, naxia, Herbstia.*
(Pisinae)
———————————— Majidae
↑
2nd group....*Huenia, Pugettia, Acanthonyx*
(Acanthonychinae)
↑
1st group....*Stenorhynchus, Achaeus, Inachus, Macropodia*
(Inachinae)
———————————— Inachidae

The 1st group of Inachidae (Inachinae) is the most primitive. The pericerid group and the 2nd group of the Majidae (Majinae) may have originated from the 1st group of the Majidae (Pisinae). The 3rd group of the Majidae (Hyasteninae) may be the most highly developed of the Majoidea. The 2nd group of the Inachidae (Acanthonychinae) and the 1st group of the Majidae (Pisinae) are very closely related.

(11) Families Polybiidae (Table III, 1), Portunidae (2–14), Thalamitidae (15, 16), Parthenopidae (17, 18), Atelecyclidae (19, 20), Carcinidae (21, 22), Canceridae (23–25) and Thiidae (26).

All zoeas of these families have the B-type of 2nd antenna and

Table III. List of larval

No.	Species	Reference	Carapacial spines Ros.	Dor.	Lat.
1.	*Polybius henslowi* LEACH	LEBOUR(3), p. 516.	0	0	0
2.	*Bathynectes longipes* RISSO	ibid., p. 515, (4), p. 94.	0	0	0
3.	*Callinectes sapidus* RATHBUN	CHURCHILL(1), p. 98.	0	0	0
4.	*Portunus puber* (L.)	WILLIAMSON(2), p. 514. LEBOUR(3), p. 506.	0	0	0
5.	*P. corrugatus* (PENN.)	LEBOUR(3), p. 509.	0	0	0
6.	*P. pusillus* LEACH	WILLIAMSON(2), p. 517. LEBOUR(3), p. 511.	0	0	0
7.	*P. arcuatus* LEACH	LEBOUR(3), p. 510.	0	0	0
8.	*P. marmoreus* LEACH	ibid., p. 512.	0	0	0
9.	*P. holsatus* FABR.	WILLIAMSON(2), p. 496. LEBOUR(3), p. 513.	0	0	0
10.	*P. depulator* L.	WILLIAMSON(2), p. 496.	0	0	0
11.	*P. trituberculatus* MIERS	Fig. 23.	0	0	0
12.	*P. pelagicus* L.	Fig. 24.	0	0	0
13.	*P. maenus* (L.)	WILLIAMSON(2), p. 503.	0	0	×
14.	*P. plicatus* COUCH.	WILLIAMSON(2), p. 511.	0	0	×
15.	*Charybdis 6-dentata* HERBST	Fig. 20.	0	0	0
16.	*C. bimaculata* MIERS	Figs. 21, 22.	0	0	0
17.	*Lambrus anguilifrons* LATR.	CANO(2), p. 527.	0	0	0
18.	*L. validus* DE HAAN	Fig. 19.	0	0	0
19.	*Atelecyclus septend.* (MONT.)	LEBOUR(3), p. 524.	0	0	0
20.	*Erimacrus eisenbeckii* (BDT.)	Fig. 27.	0	0	0
21.	*Perimela denticulata* (MONT.)	LEBOUR(3), p. 519.	0	0	0
22.	*Carcinus maenus* PENNANT	WILLIAMSON(1).	0	0	×
23.	*Cancer pagurus* L.	WILLIAMSON(2), p. 485. LEBOUR(3), p. 522.	0	0	0
24.	*C. amaenus* (HERBST)	CONNOLLY(1), p. 335.	0	0	0
25.	*C. gibbosulus* (D. H.)	Fig. 28.	0	0	0
26.	*Thia residua* HERBST	WILLIAMSON(2), p. 549.	0	0	0
27.	*Menippe mercenaria* SAY	HYMAN(4), p. 14.	0	0	0
28.	*Sphaerozius nitidus* STIMPSON	AIKAWA(2), p. 187.	0	0	0
29.	*Actumnus setifer* D. H.	Fig. 30.	0	0	0
30.	*Pilumnus hirtellus* (PENN.)	WILLIAMSON(2), p. 490. LEBOUR(3), p. 532.	0	0	0
31.	*P. spinifer* M.-EDWS.	HYMAN(4), p. 15.	0	0	0
32.	*P. villosus* HYMAN	ibid., p. 15.	0	0	0
33.	*P. minutus* D. H.	AIKAWA(1), p. 41.	0	0	0
34.	*P. vespertilio* FABR.	ibid., p. 41.	0	0	0
35.	*Heteropanope globula* D.H.	ibid., p. 40.	×	0	×
36.	*Xantho florida* (MONTAGU) = *X. incisa* LEACH	WILLIAMSON(2), p. 487. LEBOUR(3), p. 530.	0	0	0
37.	*X. hydrophilus* (HERBST)	LEBOUR(3), p. 531.	0	0	0
38.	*X. exaratus* (M.-EDWS.)	AIKAWA(1), p. 42.	0	0	0
39.	*X.* sp.	ibid., p. 43.	0	0	0
40.	*X.* sp.	WILLIAMSON(2), p. 492.	0	0	0
41.	*Panopaeus herbsti* (M.-EDWS.)	HYMAN(4), p.9.	0	0	0
42.	*Eurypanopeus depressus* (SMITH)	ibid., p. 8.	0	0	0
43.	*Neopanope texana sayi* (SMITH)	ibid., p. 3.	0	0	0
44.	*Hexapanopeus angustifrons* RATH.	ibid., p. 10.	0	0	0
45.	*Rhithropanop. harrsi* (GOULD)	CONNOLLY(2), p. 327.	0	0	0
46.	*Laphopanop. bellus* (STIMPSON)	HART(1), p. 414.	0	0	0
47.	*Eriphia spinifrons* HERBST	HYMAN(4), p. 13.	0	0	0
48.	*Trapezia* sp.	ibid., p. 15.	0	0	0

Note 0 = presence, × = absence.

characters of the Cancroidea.

No.	2nd antenna	Telson	mxp.-chrom.		Hair Formula		
			1st mxp.	2nd mxp.	1st mx.	2nd mx.	2nd mxp.
1	B_1	A_3	—	—			
2	B_3	A	—	—			
3	B	A_2	—	—			
4	B_2	A_3	—	—			
5	B_2	A_3	—	—			
6	B_2	A_3	—	—			
7	B_2	A_3	—	—			
8	B_2	A_3	—	—			
9	B_2	A_3	—	—			
10	B_2	A_3	—	—			
11	B_4	A_3	0_2	×	6-1	2-4(6)	4-1-1
12	B_4	A_3	0_2	×	6-1	2-4(6)	5-1-1
13	B_4	A_3	—	—	6-1	3-5(8)	?
14	B_2	A_3	—	—			
15	B_2	A_2	0_2	×	6-1	2-4(6)	4-1-1
16	B_2	A_2	—	—	6-1	2-4(6)	5-1-1
17	B_1	A_1	—	—			
18	B_4	A_1	—	—	6-1	2-5(7)	3-1-1
19	B_4	A_2	×	×			
20	B_4	A_3	—	—	6-1	3-5(8)	5-1-1
21	B	A_1	0_2	0_2			
22	B_5	A_3	×	×	6-1	3-5(8)	5-1-1
23	B_5	A_2	×	×			
24	B_4	A_2	×	×	6-1	3-5(8)	5-1-1
25	B_4	A_2	—	—	6-1	3-3(6)	5-1-1
26	B_4	A_2	×	×			
27	B_2	A_2	0_2	0_2			
28	B_1	A_1	0_2	0_2	4-1	3-3(6)	5-1-0
29	A_2	A_3	—	—	6-1	3-5(8)	5-1-1
30	A_2	A_3	×	0_1	5-1	2-4(6)	?
31	A_2	A_3	—	—			
32	A_2	A_3	—	—	4-1	3-5(8)	5-1-1
33	A_1	A_3	×	0	4-1	3-5(8)	6-1-1
34	A_1	A_2	0_1	0_1			
35	A	A_3	0_1	0_1	5-1	3-5(8)	?
36	C_2	A_3	0_2	0_2			
37	C_2	A_3	0_2	0_2			
38	C_2	A_3	0_2	0_2	4-0	3-5(8)	4-1-1
39	C_2	A_3	0_2	0_2	6-1	3-5(8)	5-1-1
40	C_2	A_3	—	—			
41	C_2	A_3	0_2	0_2			
42	C_2	A_1	0b	0b	6-1	3-5(8)	?
43	C_2	A_1	0b	0b	6-1	3-5(8)	5-1-1
44	C_2	A_1	0_2	0b			
45	C_1	A_1	—	—			
46	C_2	A_1	0_2	0_2	6-1	3-5(8)	5-1-1
47	B_2	A_2	—	—	4-1	3-3(6)	4-1-0
48	B_4	A	—	—			

— = not ascertained.

the A-type of telson, and are included in *Grapsizoea*. 3 kinds of carapacial spines nearly always present, the maxillipedal chromatophores being of secondary character. They are separable into 3 groups, the 1st of which comprises the Portunidae and its allied families, the mode of serration on the endopodite of the 2nd maxilla being 2–4 (6). The Atelecyclidae and its allied families are comprised in the 2nd group, the mode of serration on the endopodite of the 2nd maxilla being usually 3–5 (8). The larvae of the Parthenopidae is placed in the 3rd group, the mode of serration on the endopodite of the 2nd maxilla being 2–5 (7).

The zoeas of the portunid group. Dorsal and rostral spines usually very long, but the lateral very short. The outer lobe of endopodite of 2nd maxilla usually smaller than the inner. Lateral knobs present on both 2nd and 3rd abdominal somites.

The characters of the portunid megalopa are, (1) there is a simple pointed rostrum, but no other spines on carapace, (2) fairly long antenna, (3) chela neither particularly large nor thick, (4) eye large, (5) coxa of last leg has a very large hook-like spine, coxae of 2nd to 3rd legs a small hook-like spine, and (6) the ischia of the 1st leg also a small hook.

Characters of the atelecyclid zoeas. Lateral spines sometimes absent. Lateral knobs on 3rd somite also sometimes either absent or all on both somites wholly disappear. Endopodite of 2nd maxilla more sharply bifurcated than that of the portunid zoeas.

Characters of the parthenopid zoeas. All kinds of carapacial spines present, laterals fairly long, compared with those of the two groups just mentioned. Lateral knobs present on both 2nd and 3rd abdominal somites. According to LEBOUR, the larvae of the Parthenopidae, which does not agree with those of the Majidae, is an exception to the Oxystomata, for which reason the Parthenopidae had better be regarded as an allied group of the Portunidae, or at least as a member of the Cancroidea.

(12) Family Menippidae (Table III, 27–35).

The larvae of *Menippe mercenaria*, *Actumnus setifer*, *Heteropanope globula*, *Sphaerozius nitidus*, and 6 species of G. *Pilumnus* are described. The larval characters are not uniform in the foregoing. These zoeas are separable into 2 groups, the 1st of which comprises *Menippe* and *Sphaerozius*, have the B-type of 2nd antenna and the A-type of telson, as observed in the larvae of the atelecyclid group. The

2nd group, to which belong *Pilumnus*, *Actumnus*, and *Heteropanope*, has the A-type of 2nd antenna and telson. The maxillipedal chromatophores are of secondary character in the 1st group and primary in the 2nd. The latter, which seems to retain the primitive characters, resembles the members of the Inachidae or of the Majidae, although it is distinguished from the two by the mode of serration on the endopodite of the 2nd maxilla and by the grouping of the carapacial spines. On the other hand, it is also closely related to zoeas of the Carcinoplacidae, as ORTMANN had assumed. The 1st group of the Menippidae can also be distinguished from the atelecyclid group of zoea by the mode of serration on the endopodite of the 2nd maxilla (4–1 or 5–1, but never 6–1 in the menippid zoeas) and the absence of hair on the basal joint of the endopodite of the 2nd maxilliped.

(13) Family Xanthidae (Table III, 36–40).

6 zoeas of G. *Xantho* are described. Larval characters of this family very uniform. All kinds of carapacial spines present, all fairly long. 2nd antenna C_2-type, telson A-type. Secondary chromatophores present in both maxillipedes or only in one of them. Endopodite of 2nd maxilla bifurcated, mode of serration here expressed by 3–5 (8).

(14) Family Oziidae (Table III, 41–47).

The zoeas of subfamily Panopaeinae clearly differ from those of the subfamily Eriphiinae, resembling rather those of the Xanthidae. 2nd antenna C_2-type, telson A-type. All carapacial spines present, fairly long. *Panopaeus herbstii* and *Lophopanopeus bellus* have secondary chromatophores in both maxillipedes, but *Eurypanopeus depressus* and *Neopanope texana sayi* have both primary and secondary chromotophores simultaneously in both maxillipedes. *Hexapanopeus angustifrons* has only secondary chromatophore in the 1st maxilliped, but both primary and secondary chromatophores in the 2nd maxilliped. Mode of serration on endopodite of 2nd maxilla similar to that of the Xanthidae. Zoeas of the Panopaeinae can be distinguished from those of the Xanthidae by the former having 2 kinds of chromatophores in the maxillipedes. The 2nd group, to which belongs *Eriphia spinifrons*, resembles zoeas of the 1st group of Menippidae by having the B-type of 2nd antenna and A-type of telson. All carapacial spines are also present. The zoea of *Eriphia* are scarcely distinguishable from those of the 1st group of Menippidae.

(15) Family Trapeziidae (Table III, 48).

Trapezia sp., which alone is known for its larval form, resembles in important features those of the Menippidae (1st group) and of the Eriphiinae, all scarcely distinguishable from one another.

Upon comparing the larval features of Menippidae, Xanthidae, Oziidae, and Trapeziidae, they are separable into 3 main groups according to differences in the structure of the 2nd antenna. Telson always of A-type.

Group A. The zoeas, which have the A-type of 2nd antenna, as observed in *Pilumnus*, *Actumnus*, and *Heteropanope*, seem to retain the primitive characters. This group can be connected directly with the zoeas of Carcinoplacidae and Gonoplacidae, followed by the Grapsini.

Group B. Zoeas have the B-type of 2nd antenna. Here we have zoeas of *Sphaerozius*, *Menippe*, *Eriphia*, and *Trapezia*. This group may be related to the atelecyclid group through the zoea of the Thiidae, all being member of the large *Grapsizoea* group.

Group C. Zoeas have the C-type of antenna. Zoeas of the Xanthidae and the subfamily Panopaeinae of the Oziidae belong to this group. Group A is the most primitive and group C the most highly developed. The relationship between these groups are shown in the scheme on p. 92. HYMAN noted that, when arranged in a series, the zoea of *Panopaeus* is found to be most highly specialized, while that of *Pilumnus* is least so (HYMAN, 1925). RATHBUN and others have placed all these genera in the family Xanthidae without dividing them into subfamilies. Neverthless, considering their larval features, there are certainly 3 clearly distinct groups among them. According to LEBOUR, the larvae of the Xanthidae naturally divide themselves into 3 groups, the one which belongs *Xantho*, with a rudimentary antennal scale (C_2-type), and the other, to which belong *Pilumnus*, with a well developed exopodite (A-type). CANO, in describing *Eriphia*, showed the 3rd group with antenna like the *Portunus* (B-type). Therefore, as suggested by differences in the larval features, it may be better to keep some subfamilies or families for each of them.

(16) Families Carcinoplacidae and Gonoplacidae (Table IV, 1).

The zoeas of *Gonoplax rhomboides* and *Geryon affinis* are described, although the writer is unable to refer directly to description of the latter. Both zoeas, which have the A-type of 2nd antenna and telson, seem closely related to the Menippidae (2nd group), as ORTMANN assumed. They are yet distinguishable from the member of the Menippidae, seeing that they have secondary chromatophores in the maxillipedes. Since the endopodite of the 2nd maxilla is bifurcated, the zoeas also differ from those of members of the Inachidae.

(17) Family Pinnotheridae (Table IV, 2–11).

The zoeas of this family are separated into 2 groups, *Pinnozoea* and *Dissodactylozoea*. *Pinnixa chaetopterana* and some zoeas of G. *Pinnotheres* which belong to *Pinnozoea*, have the D-type of 2nd antenna and F-type of telson. *Dissodactylozoea*, which comprises *Dissodactylus mellitae* and *Pinnixa sayana*, have the D-type of 2nd antenna and B-type of telson. Both *Pinnozoea* and *Dissodactylozoea* belong to the Pinnotheridae. The following are additional characteristics: (1) endopodite of 2nd maxilla single, (2) endopodite of 2nd maxilliped 1- or 2-articulate, (3) maxillipedal chromatophores generally primary in character, except *Pinnixa chaetopterana*, which has secondary maxillipedal chromatophores. MIYAKE (1935) divided the F-type telson into 2 subtypes, F_1- and F_2-types. The former type is peculiar to *Pinnotheres* and the latter to *Pinnixa*, the two having different telson-forks. He noted also that the zoea may be regarded as belonging to *Pinnotheres* if it has a D-type of 2nd antenna and F_1-type of telson, in which case the mode of serration on the endopodite of the 2nd maxilla and the presence or absence of carapacial spines serve to determine species in the *Pinnotheres* (MIYAKE, 1935, p. 201).

The zoeas raised from berried crabs are mostly Pinnozoeas, whereas Dissodactylozoeas are more frequently observed among plankton than Pinnozoeas. The writer would define the D-type of telson in the Hymenosomidae as one with a telson-fork that is smaller or at least nearly equal to the inner spines in length. There are some telson intermediate between this D-type and the B-type of the Pinnotheridae. The *Hymenozoea* of the Hymenosomidae look very much like *Dissodactylozoea* of the Pinnotheridae. MIERS placed these two families in the Pinnotheridae. In other respects, *Hymenozoea* resembles the member of the Inachidae as already mentioned. The classification of these crabs must be examined again.

(18) Family Grapsidae (Table IV, 12–28).

Several larvae of this family are described. They are not uniform in larval characters, contrary to HYMAN's conclusion (HYMAN, 1924), and are separable into 3 groups, although this division is not in complete accord with the adult classification. The endopodite of the 2nd maxilla is always bifurcated, the mode of serration being here usually 2–2 (4) or in less frequent cases 2–3 (5) or 3–5 (8). The endopodite

Table IV. List of larval

No.	Species	Reference	Carapacial spines		
			Ros.	Dor.	Lat.
1.	*Gonoplax rhomboides* (L.)	LEBOUR(3), p. 534.	0	0	0
2.	*Pinnixa sayana* (STIMPSON)	HYMAN(2), p. 6.	0	0	0
3.	*Pinnotheres maculatus* SAY	ibid., p. 5.	0	0	0
4.	*Pinnix chaetpterana* (STIMP.)	ibid., p. 5.	0	0	0
5.	*Pinnotheres veterum* BOSC	ibid., p. 3, LEBOUR(3), p. 537	0	0	0
6.	*P. pisum* (PENNANT)	ibid., p. 4, ibid., p. 536.	0	×	0
7.	*P. ostrum* SAY	ibid., p. 3.	×	×	×
8.	*P. pholothurias* SEMPER	ibid., p. 4.	0	0	×
9.	*P. taylori* RATHBUN	HART(1), p. 192.	×	×	×
10.	*P. latissimus* BÜRGER	MIYAKE(1), p. 192.	0	0	×
11.	*Dissodactylus mellitae* RATHBUN	HYMAN(2), p. 5.	0	0	0
12.	*Planes minutus* L.	HYMAN(4), p. 5.	0	0	×
13.	*Pachgrapsus marmoratus* FABR.	WILLIAMSON(2), p. 518.	0	0	×
14.	*Hemigrapsus oregoniensis* (DANA)	HART(1), p. 430.	0	0	0
15.	*H. nudus* (DANA)	ibid., p. 424.	0	0	0
16.	*H. sanguineus* (D. H.)	AIKAWA(1), p. 45.	0	0	0
17.	*H. penicillatus* (D. H.)	ibid., p. 46.	0	0	0
18.	*H. longitarsis* (MIERS)	ibid., p. 45.	0	0	0
19.	*Eriocheir japonicus* D. H.	ibid., p. 47.	0	0	0
20.	*E. sinensis* M.-EDWS.	PETERS(1), p. 157.	0	0	0
21.	*Platygrapsus depressus* (D. H.)	AIKAWA(1), p. 47, Figs. 32, 33.	0	0	×
22.	*Grapsus grapsus* L.	Fig. 31.	0	0	×
23.	*Sesarma incisa* BOSC	HYMAN(4), p. 6.	0	0	×
24.	*S. reticulata* SAY	ibid., p. 6.	0	0	×
25.	*S. sinerea* (BOSC)	ibid., p. 6.	0	0	×
26.	*S. picta* D. H.	Fig. 34.	0	0	×
27.	*S.* sp.	AIKAWA(1), p. 48.	0	0	×
28.	*Plagusia dentipes* D. H.	Figs. 35, 36.	0	0	0
29.	*Cardisoma guanhumi* LATR.	MOREIRA(1), p. 155.	×	0	×
30.	*C. armatum* HERKLOTS	CANNON(1), p. 11.	0	0	0
31.	*Macrophthalmus dilatatus* D. H.	AIKAWA(1), p. 50.	0	0	×
32.	*M. depressus* RÜPPELL	ibid., p. 50.	0	0	×
33.	*M. japonicus* D. H.	ibid., p. 50.	0	0	×
34.	*Tympanomerus pusillus* RATHBUN	ibid., p. 50.	0	0	0
35.	*Scopimera globosa* D. H.	ibid., p. 50.	0	0	0
36.	*Uca pugilator* (BOSC)	HYMAN(1), p. 485.	0	0	×
37.	*U. pugnax* (SMITH)	ibid., p. 485.	0	0	×
38.	*U. minax* (LE CONTE)	ibid., p. 485.	0	0	×

Note: 0 = presence, × = absence.

characters of the Grapsini.

No.	2nd antenna	Telson	Mxp.-chrom.		Hair Formula		
			1st mxp.	2nd mxp.	1st mx.	2nd mx.	2nd mxp.
1	A_3	A_2	0_2	0_2			
2	D	B	×	×			
3	D	F_2	0_2	×	4-×	3	5
4	D	B	0_2	×	2-×	3	5-0
5	D	F_1	0_1	0_1			
6	D	F_1	—	—			
7	D	F_1	0_1	0_1			
8	D	F_1	×	×			
9	D	B	0_1	0_1	4-0	4	3-0
10	D	B	×	×	4-0	3	5
11	D	B	0_2	×			
12	C_2	A_1	0_1	0_1	4-1	2-2(4)	4-1-0
13	C_2	A_1	—	—	6-1	2-2(4)	?
14	B_2	B	—	—	5-1	2-2(4)	6-1-0
15	B_2	B	—	—	5-1	2-2(4)	5-1-0
16	B_2	B	0_2	0_2	5-1	2-2(4)	5-1-0
17	B_2	B	0_2	0_2	5-1	2-2(4)	5-1-0
18	B_2	B	0_2	×	6-1	3-5(8)	5-1-0
19	B_2	A_2	0_2	0_2	6-1	3-5(8)	5-1-0
20	B	B	0_2	×	?	?	5-0-0
21	B_2	B	0_2	×	5-1	2-2(4)	5-1-0
22	B_4	B	0_2	×	5-1	2-3(5)	5-1-0
23	B_4	B	—	—			
24	B_2	B	×	0_2			
25	B_4	B	0_2	0_2			
26	B_4	B	—	—	5-1	2-3(5)	6-1-0
27	B_2	B	×	0			
28	B_4	B	0_1	0_1	5-1	2-3(5)	5-1-1
29	B_3	B	—	—	4-×	2-3(5)	3-1-0
30	B_2	B	0_2	×			
31	B_1	B	0_2	0_2	5-1	2-2(4)	6-1-1
32	B_1	B	0_2	0_2	5-1	2-2(4)	6-1-1
33	B_1	B	0_2	0_2	5-1	2-2(4)	6-1-1
34	C_2	A_1	×	×	4-0	2-3(5)	5-1-0
35	C_2	A_1	×	×	4-0	2-3(5)	5-1-0
36	B_2	B	0_2	×	4-0	3	4-0-0
37	B_2	B	—	—	4-0	3	4-0-0
38	B_2	B	—	—	4-0	3	4-0-0

— = not ascertained.

of the 2nd maxilliped has 3 joints, its basal joint being hairless.

The 1st group, to which belongs *Plagusia dentipes*, has B-type of both 2nd antenna and telson. Maxillipedal chromatophores of primary character. 2nd group, to which belong most species of Grapsidae, has B-type of both 2nd antenna and telson. Maxillipedal chromatophores of secondary character. *Hemigrapsus*, *Platygrapsus*, *Eriocheir*, *Sesarma*, *Grapsus*, and *Hetergrapsus* belong to this group. Only *Heterograpsus longitarsis* shows the mode of serration 3–5 (8) on the endopodite of the 2nd maxilla, in this differing from its allied species. *Eriocheir japonicus* has the A-type of telson, and *E. sinensis* the usual B-type telson. It is rather unusual to find zoeas of the same genus having different types of telson. The 3rd group, which comprises *Planes minutus* and *Pachygrapsus*, has the C-type of 2nd antenna and A-type of telson. Maxillipedal chromatophores are of primary character. The 3rd group of *Planes* and *Pachygrapsus* is therefore the most highly developed group among the Grapsidae, as assumed in other cases.

(19) Family Gecarcinidae (Table IV, 29–30).

The zoeas of *Cardisoma guanhumi* and *C. armatum* are described. Both 2nd antenna and telson are B-type. *C. guanhumi* has dorsum alone, while *C. armatum* has all kinds of carapacial spines. Secondary chromatophore present in 1st maxilliped (*C. armatum*). Endopodite of 2nd maxilla bifurcated and mode of serration here is 2–3 (5) as seen in *Sesarma* and *Plagusia*. The zoeas of this family resemble those of the Grapsidae rather than those of the Ocypodidae.

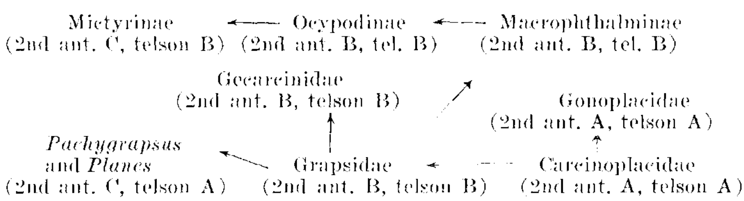
(20) Family Ocypodidae (Table IV, 31–38).

The zoeas of *Macrophthalmus*, *Tympanomerus*, *Scopimera*, and *Uca* are described. These zoeas are separable into 3 groups as in the case of their adult forms.

The 1st group, to which belongs *Macrophthalmus*, has the following characters: (1) lateral spines absent, (2) 2nd antenna B-type, (3) telson B-type, (4) secondary chromatophores in both maxillipedes, (5) endopodite of 2nd maxilla bifurcated, mode of serration 2–2 (4) as seen in the larvae of the Grapsidae, and (6) 2nd maxilliped has 3-jointed endopodite, its basal joint having a hair, differing from the joint in the Grapsidae.

The 2nd group, which comprises *Tympanomerus* and *Scopimera*, and which corresponds to the subfamily Mictyrinae, has the following characteristics: (1) all kinds of carapacial spines present, (2) 2nd antenna C_2-type, (3) telson A_1-type, (4) no chromatophores present in maxillipedes, (5) endopodite of 2nd maxilla bifurcated, mode of serration 2–3 (5), and (6) 3rd joints of endopodite of 2nd maxilliped hairless. The larvae of the subfamily Mictyrinae are thus easily distinguishable from members of the Xanthidae, Panopaeinae, and *Planes* and *Pachygrapsus* of Grapsidae.

The 3rd group, to which belong *Uca* and *Ocypoda* of the subfamily Ocypodinae, has both 2nd antenna and telson of B-type. Lateral spines absent, maxillipedal chromatophores of secondary character, endopodite of 2nd maxilla single, with 3 hairs on tip. This member of the Ocypodinae resembles that of the Macrophthalminae (1st group). The two differ in the mode of serration on the endopodite of the 2nd maxilla and in the grouping of chromatophores in the maxillipedes. Of the Ocypodidae, the Mictyrinae is most highly developed, while the 1st group (Macropthalminae) is the most primitive. The relationship between these groups, as ORTMANN had assumed, is shown in the following scheme:



Part IV. Key to families based on larval characters, and its application to undetermined zoeas

1. Key of families

A_1 2nd antenna E-type
- B_1 Telson G-type .... **Lithozoea**
  - C_1 No brown chromatophores present in body
    - D_1 Enp. of 2nd mx. single .... Dromiidae (*Dromia*)
    - D_2 Enp. of 2nd mx. 2-articulate or bifurcated
      - E_1 Enp. of 2nd mxp. 4-articulate .... Homolidae (*Latreillia*, *Parahomola*)
      - E_2 Enp. of 2nd mxp. 5-articulate ..... Homolidae (*Homola*)

A_2 2nd antenna D-type
- B_1 Telson E-type .... **Leucozoea**

C_1 Primary chroms. present or absent in mxpds. ....
................Leucosiidae (*Ebalia Illia, Leucosia, Philyra*)

B_2 Telson D-type ....**Hymenozoea**

C_1 Primary chroms. in both mxpds. ....
...Hymenosomidae (*Trigonoplax, Halicarcinus, Rhynchoplax*)

B_3 Telson B-type ....**Dissodactylozoea**

C_1 Secondary chroms. absent or present in mxpds. ....
....................Pinnotheridae (*Pinnixa, Dissodactylus*)

B_4 Telson F-type ....**Pinnozoea**

C_1 Primary or secondary chroms. present or absent in mxpds. ...
......................Pinnotheridae (*Pinnotheres, Pinnixa*)

A_3 2nd antenna A-type.

B_1 Telson C-type ....**Ethusozoea**

C_1 No brown chroms. present in mxpds.

D_1 Enp. of 2nd mx. single

E_1 Enp. of 2nd mxp. 3-articulate ....Dorippidae

F_1 all kinds of carapacial spines present...*Ethusa, Dorippe*

F_2 Lateral spines absent ....*Dorippe*

B_2 Telson A-type ....**Inachizoea**

C_1 Primary chroms. present in mxpds.

D_1 Enp. of 2nd mx. single ....Inachidae

E_1 Only dorsum present ....*Stenorhynchus, Achaeus, Acanthonyx, Macropodia, Inachus*

E_2 Only lateral spines absent........*Pleistacantha, Huenia, Pugettia*

D_2 Enp. of 2nd mx. bifurcated

E_1 2nd ant. A-type ....Menippidae

F_1 All carapacial spines present .....*Actumnus, Pilumnus*

F_2 Dorsum alone present ....*Heteropanope*

C_2 Secondary chroms. present in mxpds.

D_1 Enp. of 2nd mx. single ....Majidae

E_1 Only lateral spines absent ....*Pisa, Naxia*

E_2 All spines present ....*Herbstia*

D_2 Enp. of 2nd mx. bifurcated...Carcinoplacidae, Gonoplacidae

C_3 Primary or secondary chroms. present in mxpds.

D_1 Enp. of 2nd mx. bifurcated

E_1 2nd ant. A-type ....Periceridae

F_1 Lateral spines absent ....*Tiarinia*

F_2 Only dorsum present ....*Lissa*

A_4 2nd ant. B-type .... **Grapsizoea**

B_1 Telson A-type

C_1 Primary chroms. in mxpds.

D_1 All carapacial spines present ....Majidae

E_1 Lateral knobs only on 2nd abdominal somite............ ....*Maia, Eurynome*

E_2 Lateral knobs on both 2nd and 3rd somites.............. ....*Hyas, Chionecetes*

C_2 Secondary chroms. in mxpds.

D_1 Mode of serration on enp. of 2nd mx. 2–4 (6), and lateral knobs on both 2nd and 3rd somites............ ....Portunid group of zoeas

D_2 Mode of serration 3–5 (8), and lateral knobs on both somites or only on 2nd or wholly absent ....Atelecyclid group of zoeas

E_1 Mode of serration on enp. of 1st mx. 6–1................ ....Atelecyclidae, Carcinidae, Canceridae

E_2 Mode of serration 4–1 or 5–1........Oziidae, Trapeziidae

D_3 Mode of serration on enp. of 2nd mx. 3–3 (6)............ Canceridae (*Cancer*), Menippidae (*Menippe, Sphaerozius*), Oziidae (*Eriphia*).

D_4 Mode of serration on enp. of 2nd mx. 2–5 (7)........... ....Parthenopidae

C_3 No mxpdal. chrom. present, and the mode of serration on enp. of 2nd mx. 2–5 (7) and that on 1st mx. 4–0 ....Calappidae

B_2 Telson B-type.

C_1 Primary chroms. in mxpds.

D_1 Enp. of 2nd mx. single

E_1 All carapacial spines present...Gecarcinidae (*Cardisoma*)

E_2 Lateral spines absent ....Ocypodidae (*Uca*)

D_2 Enp. of 2nd mx. bifurcated

E_1 All carapacial spines present

F_1 Mode of serration on enp. of 2nd mx. 2–2 (4)........ ....Grapsidae (*Hemigrapsus, Heterograpsus*)

F_2 Mode of serration 3–5 (8)......................... ....Grapsidae (*Hemigrapsus, Eriocheir*)

E_2 Lateral spines absent

F_1 Mode of serration on enp. of 2nd mx. 2–2 (4)

G_1 1st joint of enp. of 2nd mxp. has no hair...........
........................Grapsidae (*Platygrapsus*)

G_2 1st joint bears a hair..Ocypodidae (*Macrophthalmus*)

F_2 Mode of serration 2–3 (5)..........................
.....................Grapsidae (*Sesarma*, *Grapsus*)

A_5 2nd ant. C-type .... **Xanthozoea**

B_1 Telson A-type

C_1 Mode of serration on enp. of 2nd mx. 2–2 (4)...............
........................Grapsidae (*Planes*, *Pachygrapsus*)

C_2 Mode of serration 3–5 (8)

D_1 Denticle on the telson-fork only 1 (A_1-type)..............
................Oziidae (*Rhithropanopeus*, *Eurypanopeus*, *Neopanope*, *Lophopanope*, *Hexapanope*)

D_2 Denticles on telson-fork 3 (A_3-type).....................
...............Xanthidae (*Xantho*), Oziidae (*Panopaeus*)

C_3 Mode of serration 2–3 (5)...............................
.................Ocypodidae (*Tympanomerus*, *Scopimera*)

2. Application of this key to undetermined zoeas

(1) *Zoea pelagica* Bosc (Williamson, 1915, p. 563, fig. 516). This zoea has the E-type of telson (gegabelt oder halbmondförmig und in seinen Innern sind einige kurze Stacheln) and D-type of 2nd antenna (zweite Antennen ist einfach). It is undoubtedly a *Leucozoea*, belonging to the Leucosiidae, although Lilljeborg thought it belonged to G. *Hyas*.

(2) *Zoea* sp. J. V. Thompson (Williamson, 1915, p. 564, fig. 518). This zoea has the B-type of 2nd antenna and telson, and in addition, has 3 kinds of carapacial spines. This is a typical *Grapsizoea*, probably belonging to the Grapsidae.

(3) *Zoea* sp. H. Rathke (Williamson, 1915, p. 565, fig. 519). 2nd antenna is B-type and telson A-type. Lateral spines absent. Williamson regarded it as the zoea of *Portunus maenus*. Although the zoeas of *P. plicatus* and *Carcinus maenus* are also similar to it. It is therefore impossible to determine this zoea without referring to the hair formula and the grouping of chromatophores in the maxillipedes and in the abdomen.

(4) *Zoea* sp. Dohrn (Williamson, 1915, p. 566, fig. 521) and *Zoea boscii* Guerin-Meneville (ibid., p. 564, figs. 516). It being impossible to be certain of their features from descriptions, they have

to remain undetermined.

(5) *Zoea* sp. CLAUS (WILLIAMSON, 1915, p. 566, figs. 522, 523) Lateral spines absent. 2nd antenna of D-type (einfach, auf conischen Höcker reduzierte Antennen) and telson D-type (fig. 523). This undoubtedly is a *Dissodactylozoea*, belonging to the family Pinnotheridae.

(6) Xanthid zoea (LEBOUR, 1934, p. 15, fig. 13) LEBOUR regarded it as a member of the Xanthidae, resembling greatly the latter, except the absence of the lateral spines. The telson of this zoea is clearly of B-type (fig. 13, 1). In the Xanthidae, zoeas with B-type of telson are members of the Menippidae, or Eriphiinae, or Trapeziidae, although they all have all kinds of carapacial spines. The writer therefore regards the Xanthid zoea of LEBOUR as a member of the Grapsidae, especially the allied form of G. *Pachygrapsus*, although this cannot be said with certainty as the mode of serration on the endopodites of both 1st and 2nd maxillae and of the 2nd maxilliped are not known.

(7) Brachyura, incertae sedis (GURNEY, 1924, fig. 78). This zoea has the D-type of both 2nd antenna and telson. Rostral spine alone present. Hair formula 4–1, 4, ?. This is certainly a *Hymenozoea* and belongs to the Hymenosomidae.

(8) *Inachizoea* (AIKAWA, 1933, figs. 1–4, 30). The zoea with the A-type of 2nd antenna and telson is an *Inachizoea*, and found only rather rarely among plankton. *Inachizoea genkaiensis* (fig. 1), *I. bidentata* (fig. 2), and *I. punctata* (fig. 4) are members of the 2nd group of Inachidae, which comprises *Huenia*, *Pugettia*, and *Pleistacantha*. Although *I. minuta* (fig. 3) and *I. macrosphaera* (fig. 30) have features similar to the Inachidae, both differ from the latter, since the rostral spine alone is present. These two zoeas may belong the unknown group of Inachidae.

(9) *Grapsizoea* (AIKAWA, 1933, fig. 5–38). Grapsizoeas are always provided with the B-type of 2nd antenna, of which those with the A-type of telson are very difficult to determine so far as our present knowledge goes. In the matter of hair formula and the character of maxillipedal chromatophores, the writer has determined some of them as follows:

I. Members of the Majidae.

Grapsizoea tusimaensis (fig. 6), *G. hukuiensis* (fig. 8), *G. sagamiensis* (fig. 12), *G. sphaerophthalma* (fig. 13), *G. regularis* (fig. 18), *G. otawaensis* (fig. 30) and *G. bucephalis* (fig. 30).

II. Members of the Portunid group.

G. toyamaensis (fig. 9), *G. aomoriensis* (fig. 10), *G. akitaensis* (fig. 11), *G. pelagica* (fig. 30), *G. elegans* (fig. 31), and *G. sumatraensis* (fig. 32).

III. Members of the Atelecyclid group.
G. hukuokaensis (fig. 7), *G. macrophthalma* (fig. 15), and *G. spinifera* (fig. 17).

IV. Members of the Grapsidae.
G. globosa (fig. 5), *G. longicauda* (fig. 14), *G. longifurca* (fig. 19), *G. serrata* (fig. 25), *G. latifrons* (fig. 27), *G. orbitalis* (fig. 28), and *G. tropica* (fig. 32).

V. Members of the Trapeziidae or Eriphiinae or Menippidae.
G. japonica (fig. 16).

IV. Members of the Macrophthalminae.
G. brevispinosa (fig. 26).

Grapsizoea mysis (fig. 16), *G. acutirostrata* (fig. 23), *G. manazuruensis* (fig. 24), and *G. misakiensis* (fig. 31) have not yet been determined.

(10) *Xanthozoea* (AIKAWA, 1933, figs. 33–38). The zoeas with C-type of 2nd antenna is Xanthozoea: it is determined more easily than Grapsizoea.

I. Members of the Xanthidae or Panopaeinae (Oziidae).
Xanthozoea pilumniformis (fig. 35) and *X. tropica* (fig. 38).

II. Members of the Mictyrinae (Ocypodidae).
X. hakutoensis (fig. 33), *X. ocypoda* (fig. 36), *X. elongata* (fig. 38).

III. Members of the Grapsidae (allied form to *Pachygrapsus*).
X. longiclavata (fig. 37).

Xanthozoea hyalina, yet undetermined.

(11) *Dissodactylozoea* (AIKAWA, 1933, figs. 39–44). *Dissodactylozoea* is a member of the Pinnotheridae, and has the D-type of 2nd antenna and B-type of telson. More *Pinnozoea* of the Pinnotheridae is obtained by rearing berried crabs than *Dissodatylozoea*, while in contrast to it, the former is found less among plankton than the latter. In most Dissodactylozoeas, it is impossible to determine the species or even the genera to which they belong.

(12) *Ethusozoea* (AIKAWA, 1933, figs. 45, 46) *Ethusozoea* has A-type of 2nd antenna and C-type of telson. *Ethusozoea lineata* may belong to G. *Dorippe*, the lateral spines being absent. *E. koreana* may belong to G. *Ethusa*, all kinds of carapacial spines being present.

(13) *Hymenozoea* (AIKAWA, 1933, figs. 47, 48). This group of zoea, which is a member of the family Hymenosomidae, is provided with D-type of both 2nd antenna and telson.

(14) *Leucozoea* (AIKAWA, 1933, figs. 40–56). *Leucozoea*, with D-type of 2nd antenna and E-type of telson, is a member of the family Leucosiidae.

(15) *Lithozoea* (AIKAWA, 1933, figs. 58–60). It is a question whether the Lithozoea is always a member of both Dromiidae and Homolidae or not. They can be determined with safety after the larvae of the families Albuneidae, Hippidae and their allied groups have been carefully studied. The larva of the Raninidae may be comprised in this group. *Lithozoea kagosimaensis* (fig. 58) and *L. multispinosa* (fig. 59) are not yet determined. *L. serrulata* (fig. 60) may belong to the Homolidae, especially to G. *Homola*.

(16) *Pinnozoea* (AIKAWA, 1933, fig. 57). S. MIYAKE (1935) regarded *Pinnozoea ostrea* as the zoea of *Pinnotheres latissimus* BÜRGER.

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