Aikawa, H. 1929

On Larval Forms of Some Brachyura.

By H. Aikawa.

Reprinted from Records of Oceanographic Works in Japan, Vol. II, No. 1, September 1929.

On Larval Forms of Some Brachyura.

With Plates II—V and 1 Textfigure.

By Hiroaki AIKAWA.

CONTENTS

INTRODUCTION.

Every one who has had some experience of plankton study knows that larval forms of Brachyura are often found in tow-net collections. However, it is difficult to determine the species, genera, or even families to which they belong. The present paper proposes to furnish some aid for the identification of the larval forms, especially zoeas, of some Brachyura which are met with in the plankton.

The larvae here treated were obtained from berried crabs by keeping them alive in captivity until the larvae hatched out. These were all in the first zoea stage and did not develop further in the culture vessels;

but a comparative study of them revealed some interesting features for my purpose.

It is needless to say that there are four stages in the life history of Brachyura, namely protozoea or prezoea, zoea, megalopa and adult, which are distinguishable from each other by the number of functional appendages on the thorax besides other characters. The zoea-stage is again divided into either two or five substages according to the metamorphosis gone through by the larva, and recognizable by the number of two-jointed plumose setae on the exopodites of the maxillipedes.

The zoeas which occur in plankton collections are generally in the first stage. I will therefore mainly deal with the first zoea in this paper and try to bring out its characters according to family, genus, and if possible, species. The classification of zoeas will then be attempted.

SECTION I.

Characters of the First Larval Stage or First Zoea.

The characteristic features of the zoea, unlike those of the adult, are unstable and transitory. Even the zoeas of one and the same species differ in some respects from each other according to their developmental stages. It seems, therefore, very difficult at first sight to compare zoeas with one another and classify them. But, in reality, there is not much fear of confusion, so long as we confine ourselves to the consideration of the first zoea or even sometimes those of the later stages, because the important features are relatively stable and subject to changes in a certain definite direction.

From the results of many investigators, such as Claus (1876), Korschelt and Heider (1890), Williamson (1915), Hyman (1920, 1924), Gurney (1926) and Lebour (1927, 1928), it is quite clear that we can identify and classify the zoeas by their characteristic features, and these features I will proceed to examine.

The zoea is provided with compound eyes, the first and the second antennae, mouth parts, maxillipedes, rudimentary pereiopods, abdomen and spines on the carapace and, in addition, chromatophores distributed over the body. Of these organs, comparatively stable ones which have systematic and phylogenetic significance must be adopted.

(a) Williamson (1915) gives the following features as impotrant:

1. Size of the larva just after hatching.
2. Spines on carapace.
3. Structure of antennule and antenna.
4. Armature of the abdominal segments.

5. Form and armature of telson.
6. Pigmentation.

(b) Lebour (1928):

1. Number of zoea-stages.
2. Presence or absence of spines on carapace.
3. Character of antennae.
4. Character of telson and its armature.
5. Armature of abdominal segments.

The present author however proposes to attach most importance to the following:

1. The groupings of the chromatophores (mainly in the abdomen and maxillipedes).
2. Character of telson and its armature.
3. Character of the second antenna.
4. Absence or presence of spines on carapace.

1. Groupings of Chromatophores.

It is a prevalent opinion that, as the chromatophores are sporadic cells filled with pigment and the colour displayed by them merely protective, they are valueless for systematic purposes. On the contrary, Keeble and Gamble (1904) studied the physiology of the chromatophores of Crustacea and proved that the chromatophores are among the most important and constant characters of the zoea, inheritable and phylogenetically identical with those found in Macrura and Mysidae and may be used as a taxonomic guide. Gerbe and Williamson (1915) also recognized its value. Hyman (1920) concluded from the study of the genus *Gelasimus* that the pigmentations of all the zoeas are so remarkably constant that they serve as a ready means of establishing the identity of forms.

Chromatophores filled with brown pigment do not disappear or fade for a long time after death or preservation, and are important for the present purpose. The chromatophores of zoeas are classified into the following categories:

1. Primary system of chromatophores.
   A. Neural group.
      1. Supra-cerebral chromatophores (br. c.).
      2. Antennal c. (ant. c.).
      3. Labral c. (l. c.).
      4. Mandibular c. (md. c.).
      5. Maxillar c. (mx. c.).
      6. Maxillipedal c. (mxp. c.).
      7. Abdominal c. (abd. c.).

B. Visceral group.

8. Median gastric c. (g. c.).
9. Precardiac c. (pr. c.).
10. Subcardiac c. (sub. c.).
11. Postcardiac c. (post. c.).

II. Secondary system of chromatophores.

12. Carapacial center (ca. c.).
13. Maxillipedal chrom. (2. mxp. c.).
14. Optic center (opt. c.).
15. Median ocular center (oc. c.).

The chromatophores of the primary system are few, profusely branched and segmentally arranged, and are available to some extent for the determination of genera and species. We must keep in mind that the primary system persists with little alteration to the end of or even beyond the megalopa stage, and agrees in several points with those found in Macrura and Mysidae. By the aid of this system, animals in early as well as advanced stages of development may be diagnosed. The chromatophores of the secondary system are numerous, sparsely branched, irregularly arranged and decentralized, and have no systematic significance. (Keeble and Gamble, 1904.)

All the chromatophores seldom occur simultaneously in the same zoea but their groupings are characteristic for several species (see Table I, III a, and III b).

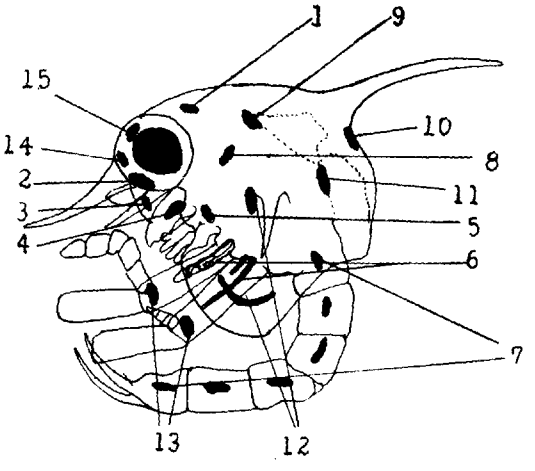


Diagram showing positions of chromatophores.

TABLE I. Distribution of chromatophores mainly in the cephalothorax of several species.

	Species	Primary system											Secondary system					
		1	2	3	4	5	6	6′	7	8	9	10	11	12	12′	13	13′	14	15
1.	*Philyra pisum*	o	/	/	o	o	o	o	o	o	/	o	o	o	/	/	/	/	o
2.	*Ebalia* sp.	/	o	/	o	o	o	o	o	o	/	/	o	o	o	/	/	/	o
3.	*Rhynchoplax messor*	/	/	/	o	o	o	o	o	o	o	/	/	o	/	/	/	o	/
4.	*Trigonoplax unguif.*	/	/	/	o	o	o	o	o	o	o	/	/	o	/	/	/	o	/
5.	*Halicarcinus sept.*	/	/	/	o	o	o	o	o	o	o	/	/	o	/	/	/	o	/
6.	*Pugettia quadridens*	o	o	o	o	/	o	o	o	o	/	/	o	o	o	/	/	o	o
7.	*Inachidae* incertae sedis	/	o	o	o	o	o	o	o	o	/	o	o	o	o	/	/	o	o
8.	*Neptunus*	/	/	o	o	o	/	/	o	/	/	/	o	o	/	/	o	/	/
9.	*Heteropanope*	/	o	o	o	o	o	o	o	o	/	o	/	o	o	/	/	o	/
10.	*Pilumnus vespertilio*	/	o	o	o	o	/	o	o	o	/	/	o	o	o	/	/	/	o
11.	*P. minutus*	/	o	o	o	o	/	o	o	o	/	/	o	o	/	/	/	/	o
12.	*Xantho exaratus*	o	o	o	o	o	/	/	o	/	/	o	/	o	o	o	o	o	o
13.	*X.* sp.	o	o	o	o	o	/	/	o	/	/	o	/	o	o	o	o	o	o
14.	*Heterograpsus sanguin.*	/	o	o	o	o	/	/	o	o	/	o	o	o	/	o	o	/	o
15.	*H. penicillatus*	/	o	o	o	o	/	/	o	o	/	o	o	o	/	o	o	/	o
16.	*Hemigrapsus longitar.*	/	o	o	o	o	/	/	o	o	/	o	o	o	/	o	/	/	o
17.	*Eriocheir japonicus*	/	o	o	o	o	/	/	o	o	/	o	o	o	o	o	/	o	o
18.	*Platygrapsus depress.*	o	o	o	o	o	/	/	o	o	/	o	o	o	/	o	/	o	o
19.	*Sesarma* sp.	/	o	o	o	o	/	/	o	o	/	o	o	o	/	o	/	/	o
20.	*Macrophthalmus dil.*	/	o	o	o	o	/	/	o	/	/	o	o	o	/	o	o	/	o
21.	*M. japonicus*	/	o	o	o	o	/	/	o	/	/	o	o	o	/	o	o	/	o
22.	*M. depressus*	/	o	o	o	o	/	/	o	/	/	o	o	o	/	o	o	/	o
23.	*Scopimera globosa*	/	o	/	o	o	/	/	o	/	o	/	/	o	/	/	/	o	o
24.	*Tympanomerus pusil.*	/	o	/	o	o	/	/	o	/	o	o	/	o	/	/	/	o	o

Note: o means presence, / absence.

The materials here presented are not sufficient to form definite conclusions, but it is easy to see that the groupings of the chromatophores of zoea are nearly similar within the same genus, though there are some exceptions. We can therefore rely upon the chromatophores for identification, and in this case it is very convenient to consider simply the presence or absence of chromatophores in the abdominal segments and two pairs of maxillipedes, because all the primary chromatophores are equivalent (Table III a and b). The maxillipedal chromatophores of the primary system differ from those

of the secondary system in their position and appearance. The former are large (O_1 in Tables), present on the protopodite or basipodite, and show complicated meshwork of pigment, while those of the latter (O_2 in Tables) occur near the junction of the exopodite and endopodite in the distal part of the protopodite, and are merely single masses of pigment. The carapacial chromatophores are two pairs, one over the mandible or at the base of the lateral spine and the other at the lower part of the carapace; the former is often absent.

The colour pattern of the body, on the contrary, is not so important, as it is affected by blue, yellow, red or other chromatophores which are very unstable and easily disappear after death or preservation. The colour of the zoeas of closely allied species are however very similar in many cases.

2. Character of Telson and its Armature.

The telson is very important as being constant throughout the zoea-stage. Its form at a certain period enables us to infer its condition in the preceding or succeeding stages. Paul Mayer (1877) attached the greatest importance to the structure of the embryonic or larval telson, and arrived at some conclusions on the classification of Brachyura. Crampton (1921) proved that the telson of adult Crustacea has a systematic significance in general, and this is true to some extent of the larval telson. The telson of the first zoea is triangular, quadrate or semicircular and united with the sixth abdominal segment. The sublateral processes are telson-forks. At the first zoea-stage there are three pairs of long spines along the emargination between the telson-forks (the *inner spines*). The general form of the telson is attained at the prezoea-stage, in which the telson-forks, inner spines, and outer denticulations or teeth, if present, are short and equal in length. The fully developed telson of the first zoea-stage remains unchanged until the end of the zoea-stage, except the inner spines which generally increase in number, and the outer teeth which become fewer.

The telson of the zoea may be grouped into six types, A, B, C, D, E and F.

A-type (Pl. IV, Figs. 37, 38, 40, 45). The telson-fork is well developed, one to two thirds as long as the telson, and the pointed ends are extended straight outwards. The telson as a whole appears trian-

gular in form, and bears on either side one or three short outer denticulations on the lateral and dorsal surfaces, varying in number according to species and developmental stages but persisting throughout the zoea-stage.

B-type (Pl. IV, Figs. 41, 43, 46). This type differs from the above by the absence of the outer teeth. The telson-fork is a little shorter and the lower emargination shallower than in A. It is unnatural to separate A from B by the absence of the outer teeth, and I would not do so, were it not for the fact that, the telson of the B-type is generally accompanied by the antenna of the B-type and seldom by that of the A-type. A- and B-type telsons are prevalent among brachyuran zoeas.

C-type (Pl. IV, Fig. 44). Slender in form, lateral margins symmetrically uneven, with a long spine on the antero-lateral swelling on each side. The telson-fork is very slender and more than half as long as the whole telson, curving first inwards then outwards. There are three inner spines, viz. a pair of long spines and an unpaired short one between them. This type is very peculiar and occurs only in the zoea of the genera *Ethusa* and *Dorippe*.

D-type (Pl. VI, Fig. 39). Trapezoidal in shape, wider anteriorly, and thus notably different from the preceding types. The telson-fork is very short, straight and less than one fourth as long as the whole telson. The emargination is shallow and there are three pairs of very short, rather stout and closely arranged inner spines. This type occurs only in the family Hymenosomidae.

In *Halicarcinus*, there are two outer teeth on the dorsal side near the base of the telson-fork, but there are none in other genera. For the same reason that we separated A-type from B-type, the telson of *Halicarcinus* may be separated from those of the other genera of this family; but they are here grouped together, because they agree in their main structure and are only few.

E-type (Pl. IV, Fig. 42). This form is very different from all those above described, and is a semicircular plate, articulating with the fifth abdominal segment. Its free margin is slightly concave and armed with three pairs of inner spines. The rounded sublateral corner has three very slight swellings, each with a fine short hair at the apex. This type

occurs only in the family Leucosiidae, i. e. in *Ebalia*, *Leucosia* and *Philyra*, so far as known.

F-type (Pl. IV, Fig. 35, 36). This is a very characteristic form. The principal part is similar to E-type, but the free margin is three-lobed, i.e. there is a median lobe and a telson-fork, all of them spear-shaped and flattened. The inner spines are present on each side on the inner margin of the telson-fork. The outer tooth may be present or absent. This type has been observed only in the family Pinnotheridae.

The above six types of telson have characteristics of their own and are easy to distinguish, though there are some exceptional forms, e. g. in *Pinnixa sayana* (Pl. IV, Fig. 46), whose telson is characteristically bilobed at the lower margin and have four spines on each lobe. The outermost spines, which are nothing else but the telson-fork of other types, are a little longer and stouter than the rest. This telson may be referred to the B-type.

These telsons have their representatives among macruran larvae. For example, A-type is similar to that which is seen in the Penaeidae and Sergestidae; B-type to that occurring in the Penaeidae; D-type to that of the Palaemonidae; E-type to that of Thalassinidae (Axiidae, Laomediidae), Anomura and Dromiacea; F-type to that of the family Callianassidae. C-type is a very peculiar one. The form of the telson is not to be considered as larval adaptation but has rather some phylogenetic significance.

3. Character of the Second Antenna.

The first antenna is of the same type in all the zoeas and undergoes certain definite changes during the zoea-stage. The second antenna is relatively stable and in the first zoea-stage it is typically composed of a basipodite with a long spinous process (peduncle or protopodite), the exopodite and sometimes in addition the endopodite (flagellum). The ratio of the length of the peduncle to that of the exopodite is nearly constant throughout the zoea-stage and only the endopodite, which generally appears in the second or later zoea-stage, changes in form and size with development. The main part of the antenna shows, therefore, some constant and permanent features in contrast to its variable endopodite.

The second antenna may be classified into the following four types according to the ratio of the length of the peduncle to that of the

exopodite, although this classification does not seem to be generally applicable.

A-type (Pl. II, Fig. 8; Pl. IV, Fig. 29, 33). In this type the peduncle and the exopodite are nearly equal in length, similarly modified or smooth, and longer than the rostrum or the first antenna. Cano (1892) regards the long exopodite to be a primitive feature, as it is homologous with the antennal scale of Caridea, and according to this view A-type seems to be primitive.

B-type (Pl. IV, Fig. 34; Pl. V, Fig. 56). This type is of medium size, in many cases longer than the first antenna, but shorter than the rostrum. This is a typical antenna, with an exopodite about half or a little more than half as long as the peduncle. This type of antenna occurs most widely among the zoeas.

C-type (Pl. IV, Fig. 31, 32). This type is large as in A-type, longer and stouter than the rostrum or the first antenna. It consists of a long peduncle and a very short spine; the latter occurs on the proximal part of the former and may be identical with the exopodite of the above two types. This spiny exopodite is sometimes reduced to a slender hair.

D-type (Pl. IV, Fig. 30). In this type the antenna is merely a simple and inconspicuous spiny process shorter than the rostrum or the first antenna. Its distal end is very sharply pointed and often finely serrated.

These four types of the second antenna are easily seen to differ merely in the grade of development, that is, A-type is probably the most primitive, C-type highly developed and B-type the intermediate; the three can be arranged in a series. D-type may be a deviation. The zoeas with this last type of antenna are provided with several kinds of telsons. These four types of the second antenna express some phylogenetic relations.

4. Presence or Absence of Spines on Carapace.

The spines on the carapace are rostral, dorsal and paired lateral ones. These three kinds of spines do not always occur at the same time; in some zoeas only one or two of them may occur and in some all of them may be absent.

These spines may be useful for protection and may assist in floating.

Weldon (1895) thought that the spines are useful for rapid and straight movements. Whatever the function may be, the spines show a definite structure according to genera and even families. They show important features from the systematic point of view and have been utilized by many authors (Gerbe, Claus, Cano, Thoulet, Lebour, etc.). However, we cannot help admitting that they may be reduced in length in accordance with the change in habits of the larvae during development. As the spines are more or less rudimentary, we cannot rely too much upon them and yet cannot reject them, for the closely related species of Brachyura generally agree in the number and structure of the spines. Exceptionally some zoeas, e.g. that of *Chionecetes phalangium* Fabr. have two modes of groupings of the carapace spines.

In Table II and III, the aforementioned types of the groupings of chromatophores of the abdomen and maxillipedes, the telson, the second antenna and the spines on carapace are shown.

TABLE II. Types of telson and second antenna and absence or presence of spines on carapace.

Species	2. Ant.	Telson.	Ros. sp.	Dor. sp.	Lat. sp.
Ethusa macerone Roux	A(?)	C	o	o	o
Ebalia sp.	D	E	o	/	/
Corystes cassivelanus Pen.	B	A_1	o	o	o
Inachus areneus (L)	B	A_2	o	o	o
I. coarctatus (Leach)	B	A_2	o	o	o
I. dorhynchus (Leach)	A	A_1	/	o	/
I. rostratus (L)	A	A_1	/	o	/
I. dorsettensis (Pennant)	A	A_1	/	o	/
I. dorsettensis (Pennant)	A	A(?)	o	o	/
Maia verrucosa M.-E.	B	A_3	o	o	o
M. squinado (Herbst)	B	A_3	o	o	o
Eurynome sp.	B	A_2	o	o	/
Portumus puber Leach.	B	A_2	o	o	o
P. holsatus Fabr.	B	A_3	o	o	o
P. depulator (L)	B	A_3	o	o	o
P. marmoreus Leach	B	A_1	o	o	o
P. pusillus Leach	B	A_1	o	o	o
P. plicatus	B	A_3	o	o	/
P. meanus (L)	B	A_3	o	o	/
Macropodia longirostris	A	A_1	/	o	/
Thia residua Herbst	B	A_2	o	o	o
Pilumnus hirtellus	A	A_3	o	o	o
P. sp.	A	A_3	o	o	o
Xantho hydrophilus	C	A_3	o	o	o
X. sp.	C	A_3	o	o	o
Rithropanopaeus Harrisi Gould	C	A_1	o	o	o
Pinnotheres pisum (L)	D	F	o	o	o
P. veterum	D	F	o	o	o
Perimela denticulata	A(?)	A_1	o	o	o
Pachygrapsus marmoratus Fabr.	C	B	o	o	/

TABLE III a. Types of second antenna and telson, spines on carapace and groupings of chromatophores of maxillipedes and abdomen in the zoeas cultured by the author.

Species	2. Ant.	Telson	Spines			Chromatophores							
						Mxp.		Abdomen					
			Ros.	Dor.	Lat.	1	2	1	2	3	4	5	T
1. Leucosiinae	D	E	o	/	/	o_1	o_1	o	o	o	o	o	o
2. „	D	E	o	/	/	o_1	o_1	o	o	o	o	o	/
3. Hymenosomidae	D	D	o	/	/	o_1	o_1	/	o	/	/	/	/
4. „	D	D	o	/	/	o_1	o_1	o	o	o	/	/	/
5. „	D	D	o	/	/	o_1	o_1	/	o	/	o	/	/
6. Inachidae	A	A_2	o	o	/	o_1	o_1	o		o	o	o	o
7. „	A	A_1	o	o	o	o_1	o_1	o	o	o	o	o	/
8. Portunidae	B	A_2	o	o	/	/	o_2	o	/	o	o	o	/
9. Myomenippinae	A	A_1	/	o	/	o_1	o_1	o		o	o	o	o
10. Pilumninae	A	A_3	o	o	o	o_1	o_1	/	/	o	o	/	/
11. „	A	A_2	o	o	o	/	o_1	o	/	o	o	o	o
12. Xanthinae	C	A_2	o	o	o	o_2	o_2	o	o	o	o	o	o
13. „	C	A_2	o	o	o	o_2	o_2	o	o	o	o	o	o
14. Grapsidae	B	B	o	o	o	o_2	/	o		o	o	o	o
15. „	B	B	o	o	o	o_2	o_2	o	/	o	o	o	o
16. „	B	B	o	o	o	o_2	o_2	o	/	o	o	o	o
17. „	B	A_2	o	o	o	o_2	o_2	o	o	o	o	o	o
18. „	B	B	o	o	/	o_2	/	o	o	o	o	o	o
19. „	B	B	o	o	o	/	o_2	o	o	o	/	o	o
20. Macrophthalminae	B	B	o	o	/	o_2	o_2	o	o	o	o	o	o
21. „	B	B	o	o	/	o_2	o_2	o	o	o	o	o	o
22. „	B	B	o	o	/	o_2	o_2	o	o	o	o	o	o
23. Myctirinae	C	A_1	o	o	o	/	/	o	o	o	o	o	o
24. „	C	A_1	o	o	o	/	/	o	o	o	o	o	o

TABLE III b. Characters of some zoeas (from O. W. Hyman 1920 and 1924, a, b, etc.); columns as in Tab. III a.

Neopanope texana sayi	C	A_3	o	o	o	o_b	o_b	o	o	o	o	o	o
Eurypanope depressus	C	A_1	o	o	o	o_b	o_b	o	o	o	o	o	o
Panopeus herbstii	C	A_3	o	o	o	o_2	o_2	o	o	o	o	o	o
Genus *Xantho*	B	A_3	o	o	o								
G. *Eriphia*	B	A_2	o	o	o								
G. *Trapezia*	B	?	o	o	o								
Menippe mercenaria	B	A_2	o	o	o	o_2	o_2						
G. *Pilumnus*	A	A_3	o	o	o	o_1	o_1						
Pinnotheres osterum	D	F		/	/	o_1	o_1	o	o	o	o	o	o
P. holothuriae	D	F		/	/	/	/	o	o	o	o	o	o
P. veterum	D	F	o	o	o	/	/	/	/	o	o	o	/
Pinnixa chaetopterana	D	F	o	o	o	o_2	/	o	o	o	o	o	/
P. sayana	D	B	o	o	o	/	/	/	/	/	o	o	/
Dissodactylus mellitae	D	B	o	o	o	o_2	/	o	o	o	o	o	o
Pinnotheres maculatus	D	B	o	o	o	o_2	/	o	o	o	o	o	/
P. pisum	D	F	o	/	o	/	/	/	/	/	/	/	o
Sesarma cinerea	B	B	o	o	/	o_2	o_2	o	o	o	o	o	/
S. reticulata	B	B	o	o	/	/	o_2	/	o	o	o	o	/
Planes minutus	C	A_1	o	o	/	o_1	o_1	o	o	o	o	o	o
G. *Gelasimus*	B	B	o	o	/	o_2	/	o		o	o	o	?

Note: A means A-type telson and the affixed numeral shows the number of outer teeth; o_1 primary mxp. chrom., o_2 secondary one, and o_b, both of them; o presence; / absence.

5. Some other Features.

There are some more points to be considered, viz. labrum, bilobed mandible, maxillae, maxillipedes, rudimentary pereiopods, abdomen and the number of larval stages.

Both the labrum and the mandible of the zoeas are too variable in form to be used for identification, though they have been used by some authors. The maxillae are characterized throughout the zoea-stage by the number of setae on their podites, which are at first notched or bilobed and carry some plumose setae, the number of which seems to be definite for each genus, at least at the first zoea-stage and regularly increase with the advance of development. Some examples are shown in Table IV.

TABLE IV. Number of setae on podites of both maxillae in first zoea.

Species	First			Second			
	Coxop.	Basip.	Endop.	Coxop.	Basip.	Endop.	Scaphogn.
Philyra pisum	6	4	1–4	5	8	3	3
Rhynchoplax messor	5	5	1–5	1	8	5	3
Trigonoplax unguiformis	5	5	1–5	1	8	5	3
Halicarcinus septentrio.	4(?)	5	1–5	1	8	5	3
Pugettia quadridens	5	6	1–4	6	9	4	10
Inachidae incertae sedis	7	6	1–4	8	9	4	8
Xantho exaratus	6	5	0–4	5	8	3	4
X. sp.	6	5	1–6	9	9	8	4
Heterograpsus sanguineus	5	5	1–5	6	9	4	4
H. penicillatus	5	5	1–5	6	9	4	4
Hemigrapsus longitarsis	5	5	1–5	6	8	4	4
Eriocheir japonicus	5	5	1–6	10	9	8	3
Platygrapsus depressus	5	5	1–6	6	9	4	4
Macrophthalmus dilatatus	4	5	1–5	7	10	4	4
Macroph. japonicus	6	5	1–5	6	7	4	4
Scopimera globosa	4	5	0–5	5	7	5	4
Tympanomerus pusillus	4	5	0–4	5	9	5	4

In the first zoea, the number of setae on the basipodite of the first maxilla is constant in all the larvae except those of Inachidae, but their number on the coxopodite and endopodite varies at least according to genera. In the second maxilla, the number of setae on the endopodite and scaphognathite is constant for each genus or family, but their number on the coxopodite and basipodite varies. In such special families as Leucosiinae and Hymenosomidae, the number of setae on each podite of both maxillae is nearly constant for all the species. In short, the number of setae on the coxopodite and the endopodite of the first maxilla and on the coxopodite, basipodite and endopodite of the second maxilla seems to be of some use for the identification of the genus or species to which the first zoea belongs. The next question to be settled in this connection is how the number of setae on each podite increases at each larval stage.

The swimming hairs on the exopodite of each maxillipede is four in the first zoea in all the species, but vary afterward characteristically in different species or genera according to the number of moults gone through. They increase namely by two at each larval moult, so that the four at the first zoea would be increased to twelve at the last or fifth zoea-stage. However, the zoea-stage does not always consist of five substages but sometimes there may be only two or four of them. According to Lebour (1928) no crabs with three larval stages have been observed. Accordingly, the number of substages as well as the number of swimming hairs at each substage are characteristic for species or genera. Lebour (1928) wrote, "The number of the larval stages is important to a certain extent in distinguishing the various forms, as it is easy to see that, if a zoea be far advanced in development but has few setae on maxillipedes, it must have a few larval stages, and in this way certain genera must be eliminated."

Here I will give a table (Table V).

TABLE V a. Number of swimming hairs on maxillipedes at each larval stage; general formula.

Larval stage	1	2	3	4	5
1. maxillipede	4	6	8	10	12
2. maxillipede	4	6	8	10	12

TABLE V b. Number of swimming hairs on maxillipedes at each larval stage.

Larval stage	1. zoea		2. zoea		3. zoea		4. zoea		5. zoea	
Maxillipedes	1.	2.	1.	2.	1.	2.	1.	2.	1.	2.
1. *Inachus, Macropodia, Maia squinado*	4	4	6	6	—		—		—	
2. *Pilumnus, Thia, Carcinus, Pirimela, Gonoplax, Portunus plicatus*	4	4	6	6	8	8	10	10	—	
Ebalia sp.	4	4	6	6	6	6	8	8	—	
Maia verrucosa	4	4	6	6	8	8	11	11	—	
Xantho	4	4	6	6	9	10	11	12	—	
Neopanopeus texana	4	4	6	7	8	9	12	12	—	
Rithropanopaeus Harrisi	4	4	6	7	8	9	10	11	—	
3. *Portunus, Atelecyclus, Cancer*	4	4	6	6	8	8	10	10	12	12
Corystes sp.	4	4	6	6	10	10	12	12	14	14

Portunus plicatus was described by Williamson (1925) as having exceptionally four larval stages, but Lebour (1928) gives five for the same genus, and *Macropodia verrucosa* has five according Williamson (1915) but Lebour (1927) gives only two for *Macropodia squinado*. In this state of our knowledge, the number of hairs at different larval stages can not be used to establish the identity of genera or species. Moreover, it is rather hard to decide to which larval stage a zoea belongs. It seems, therefore, reasonable to me to disregard this character for my purpose.

The number of hairs on the inner lateral margin of the protopodite of the first and second maxillipedes is definite for the first zoea-stage of each species (Table VI).

The adbomen of the first zoea consists of five segments and the telson, with which the sixth abdominal segment is united. The number of segments increases in later larval stages or megalopa. The form of the abdomen is nearly the same throughout the whole zoea-stage in all the species. The hook-shaped processes or lateral knobs are present on the second, third and fourth segments. These stout knobs are nearly constant throughout the zoea-stage, but in certain genera or sometimes in certain families, some of them are absent. In addition to these knobs the lower lateral and lower dorsal teeth or hairs are constantly present on the abdominal segments at least in the first zoea. The lateral knobs and the hairs just mentioned are definite, but cannot be depended on, as they undergo changes with development (Hyman 1924). There is, however, some characteristic abdomen, by which the species is easily determined at first sight (Pl. VI, Fig. 46, *Pinnixa sayana*).

The size of the larva is scarcely reliable, as it is subject to too much individual variation even at the same larval stage. The ratio of the length (Huxley, 1924) of the rostral to that of the dorsal spine may be sometimes useful.

6. Conclusion.

In this paper, the following four characters have been adopted for the identification of zoeas: 1) grouping of chromatophores, 2) character of the telson and its armature, 3) character of the second antenna, 4) spines on carapace. Other characters are taken into consideration simply to confirm the results.

Families or subfamilies can be determined by 2), 3) and 4) only, but for genera the groupings of chromatophores in the abdominal somites and maxillipedes are also to be taken into account.

TABLE VI. Number of hairs on protopodite and on endopodite of first and second maxillipedes.

No.	Species	Protopodite		Endopodite								
		I. mxp.	II. mxp.	I. mxp.					II. mxp.		
1.	*Philyra pisum*	3-3-2-2	2-2	4	2	1	2	2	4	0	0
2.	*Ebalia* sp.	2-2-2-2	1-1-1-1	4	2	1	2	2	2	0	/
3.	*Rhynchoplax messor*	3-3-2-2	1-1-1-1	4	2	1	2	2	5	1	1
4.	*Trigonoplax unguiformis*		equal								
5.	*Halicarcinus septentrionalis*		equal								
6.	*Pugettia quadridens*	2-2-1-2	1-1	5	2	1	3	3	3	1	/
7.	*Inachidae* incertae sedis	2-2-1-2	1-1	6	2	1	2	2	4	1	/
8.	*Heteropanope glabra*	2-2-2-2	1-1-1	6	2	1	2	3	6	1	1
9.	*Pilumnus minutus*	3-3-2-2	1-1-1-1	5	2	1	2	3	6	1	1
10.	*Xantho exaratus*	2-2-1-1	1-1-1	4	2	1	2	2	4	1	1
11.	*Xantho* sp.	equal		5	2	1	2	2	5	1	1
12.	*Hemigrapsus longitarsis*	3-3-2-2	1-1-1-1	5	2	1	2	2			
13.	*Heterograpsus sanguineus*	equal		equal					5	1	0
14.	*Heterog. penicillatus*		equal								
15.	*Eriocheir japonicus*	3-3-1-2	1-1	equal							
16.	*Platygrapsus depressus*	3-3-2-2	1-1-1-1	5	2	1	2	2	5	1	0
17.	*Macrophthalmus japonicus*	2-2-2-2	1-1-1	6	3	1	2	2	6	1	1
18.	*Macroph. dilatatus*		equal								
19.	*Macroph. depressus*		equal								
20.	*Scopimera globosa*	3-3-2-2	1-1-1	5	2	1	2	2	6	1	0
21.	*Tympanomerus pusillus*		equal								

Note: / means absence of the segment; 0 absence of hair.

The difference between zoeas of different species of the same genus is generally so slight that we are never sure of their specific identity. The specific characters are mainly found in the labrum and mandible and in the number of setae on the maxillae and maxillipedes, though some of these characters are very unstable.

I am convinced that the classification of the larval forms based on these four characters does not bring about confusion but rather elucidates in some cases the relationships of adult forms.

SECTION II.

Key to the Identification of some Zoeas of Brachyura occurring near Misaki.

A 1. Second antenna A-type.
  B 1. Telson A-type.
    C 1. Three kinds of spines present . . . . . (*Pirimela*, *Inachus*, *Pilumnus*)
      D 1. Primary chromatophores present in both maxillipedes
        E 1. Abdominal chrom. present in 3rd. and 4th. segments . . . . . *Pilumnus* (*resper.*) (10)
        E 2. Abd. chrom. present in all somites and telson . . . . . Inachidae (7)

D 2. Prim. chrom. present in 2nd. mxp.
E 1. Abd. chrom. present in 1st. and 2nd. somites in common, and in 4th. 5th. and telson . . . . . *Pilumnus* (*minutus*) (11)

C 2. Lateral spine absent (*Inachus*)
D 1. Prim. chrom. in both mxps.
E 1. Abd. chrom. present in 1st. and 2nd. somites in common, and in 3rd. to 5th. somites and telson . . . . . *Pugettia* (6)

C 3. Dorsal spine only present (*Inachus, Macropodia, Heteropanope*)
D 1. Prim. chrom. present in both mxps.
E. 1. Abd. chrom. present in all somites and telson . . . . . *Heteropanope* (9)

B 2. Telson C-type . . . . . *Ethusa, Dorippe*

A 2. Second antenna B-type
B 1. Telson A-type
C 1. Three kinds of spines present (*Portunus, Maia, Corystes, Thia*)
D 1. Second. chrom. present in both mxps.
E 1. Abd. chrom. present in all somites and telson . . . . . *Eriocheir* (9)
E 2. Abd. chrom. present in all somites but absent in telson . . . . . *Sphaerozius*

D 2. Mxp. chrom. absent
E 1. Abd. chrom. present in all somites . *Portunus* (according to Lebour)

C 2. Lateral spine absent (*Eurynome*)
D 1. Second. chrom. in 2nd. mxp.
E 1. Abd. chrom. absent only in 2nd. somite *Hemigrapsus* (14)
E 2. Abd. chrom. absent only in 4th. somite *Sesarma* (19)
E 3. Abd. chrom. absent only in 1st. somite and telson . . . . . *Sesarma reticulata* (according to Hyman)

D 2. Second. chrom. present in 1st. mxp.
E 1. Abd. chrom. in all somites . . . . . *Platygrapsus* (18)
E 2. Abd. chrom. present in 1st. and 2nd. somites in common, and in 4th. and 5th. somites . . . . . *Gelasimus* (according to Hyman)

D 3. Second. chrom. present in both mxps.
E 1. Abd. chrom. in all somites . . . . . *Macrophthalmus* (20, 21, 22)
E 2. Abd. chrom. absent only in telson . . . . . *Sesarma cinerea* (according to Hyman)

C 3. Lateral spine absent (*Eurynome*)
E 1. Abd. chrom. absent only in 2nd. somite . . . *Heterograpsus* (15, 16)

A 3. Second antenna C-type.
B 1. Telson A-type.
C 1. Three kinds of spines present
D 1. Second. chrom. present in both mxps.
E 1. Abd. chrom. in all somites . . . . . *Xantho* (12, 13)

D 2. Mxp. chrom. absent
E 1. Abd. chrom. in all somites . . . . . Subfamily Myctirinae.
F 1. Subcardiac chrom. absent, postocardiac present . . . . . *Scopimera* (23)
F 2. Subcardiac chrom. present, postocardiac absent . . . . . *Typanomerus* (24)
C 2. Lateral spine absent
D 1. Prim. chrom. present in both mxps.
E 1. Abd. chrom. in all somites . . . . . *Planes* (according to Hyman)
B 2. Telson B-type
C 1. Lateral spine absent . . . . . *Pachygrapsus* (according to Hyman)
A 4. Second antenna D-type
B 1. Telson B-type . . . . . Family Pinnotheridae
B 2. Telson D-type
C 1. Only rostral spine present
D. 1. Prim. chrom. in both mxps. . . . . Family Hymenosomidae
E 1. Abd. chrom. present only in 2nd. somite *Rhynchoplax* (3)
E 2. Abd. chrom. present in 1st., 2nd and 3rd. somites . . . . . *Trigonoplax* (4)
E 3. Abd. chrom. in 2nd. and 4th. somites . *Halicarcinus* (5)
B 3. Telson E-type
C 1. Only rostral spine present
D 1. Prim. chrom. present in both mxps.
E 1. Abd. chrom. in all the somites . . . . . *Philyra* (1)
E 2. Abd. chrom. absent only in telson . . . *Ebalia* (2)
B 4. Telson F-type . . . . . Family Pinnotheridae (according to Hyman)

SECTION III.

Description of Zoeas of Twenty-four Species.

Family Leucosiidae Dana
Subfamily Leucosiinae Miers
Genus *Philyra* Leach (1)
Subfamily Ebaliinae Stimpson
Genus *Ebalia* Leach (2)
Family Hymenosomidae Milne-Edwards
Genus *Rhynchoplax* Stimpson (3)
Trigonoplax M.-E. (4)
Halicarcinus White (5)
Family Inachidae Miers
Subfamily Acanthonychinae Miers
Genus *Pugettia* Dana (6)
Inachidae incertae sedis (7)
Family Portunidae Ortmann
Genus *Neptunus* de Haan (8)

Family MENIPPIDAE Ortmann
Subfamily MYOMENIPPINAE Ortmann
Genus *Heteropanope* Stimpson (9)
Subfamily PILUMNINAE Ortmann
Genus *Pilumnus* Leach (10, 11)
Family XANTHINAE Ortmann
Subfamily XANTHINAE Ortmann
Genus *Xantho* Leach (12, 13)
Family GRAPSIDAE Dana
Subfamily VARUNIINAE Alcock
Genus *Hemigrapsus* Miers (14)
Heterograpsus d. H. (15, 16)
Eriocheir d. H. (17)
Platygrapsus Stimpson (18)
Subfamily SESARMINAE Dana
Genus *Sesarma* Say (19)
Family OCYPODIDAE Ortmann
Subfamily MACROPHTHALMINAE Dana
Genus *Macrophthalmus* Latreille (20, 21, 22)
Subfamily MYCTIRINAE Miers
Genus *Scopimera* d. H. (23)
Tympanomerus Rathbun (24)

Family LEUCOSIIDAE Dana.

Subfamily LEUCOSIINAE Miers.

1. Genus *Philyra* Leach.

1. *Philyra pisum* de Haan (Pl. II, Fig. 1; Pl. IV, Fig. 26, 30, 42).

FIRST LARVAL STAGE.

Characters. Rostral spine only present; second antenna D-type; telson E-type; primary chromatophores in both maxillipedes; abdominal chromatophores in all somites and telson.

The breeding season is June. Berried crabs are found on sandy bottoms of shallow littoral regions. Egg-mass is fresh yellow when young, greyish green afterward.

The rostral spine measures 0.08 mm. from frontal border of eye to tip; interorbital distance 0.22 mm.; length of carapace (measured from the frontal border of eye through center of retina to dorso-posterior margin of carapace) 0.42 mm.; abdomen (from first to fifth somites) 0.42 mm.; telson 0.10 mm.

The larva has a greenish appearance; gastric region pale yellowish orange; basal part of maxillipedes pale greenish yellow; rest of the body, except the chromatophores, colourless. The dark brownish chromatophores are large, complicatedly branched, and the chromatophores of the labrum and mandible show intricate meshwork of pigments (Table I and III a).

The carapace is round; rostral spine short, hook-shaped, curving posteriorly along the ventral side; first antenna of usual type, with two aesthetes and two hairs at the tip; second antenna (Pl. VI, fig 30) D-type; labrum circular, deeply pigmented, with hairs on sublateral margin of each side; mandible bilobed, outer lobe unevenly toothed at the chewing surface and thickly haired, the inner one triangular and small; maxillae of usual type (Pl. V, 26; Table IV); lateral margin of scaphognathite distinctly emarginated just behind the lowest setae; maxillipedes of usual type (Table VI). Abdomen with five segments; second and third somites with small semicircular knobs at middle of lateral margin; telson (Pl. VI, fig. 42) E-type, with linear chromatophores along each lateral margin.

Subfamily EBALIINAE Stimpson.

2. Genus *Ebalia* Leach.

2. *Ebalia* sp. (Pl. III, Fig. 12).

FIRST ZOEA STAGE.

Characters. All the characters same as in *Philyra* except the groupings of chromatophores in the thoracic region; *br. c.* and *sub. c.* absent, but *ant. c.* present and *ca. c.* two in number, one over the mandible and the other on the lower part of carapace. No chromatophore in the telson. A pair of chromatophores, common to the first and second somites, cross with each other on the dorsal side of the first somite.

The chief breeding season is July. Berried crabs are found in rock pools with bottom of small gravel.

The larva has a greenish appearance, deeper in tone than in *Philyra*. Mandible, maxillae, digestive tracts of the thorax, and the environs of the abdominal chromatophores all green. Gastric region pale yellowish orange. Chromatophores large and dark brown (Table I, III a).

Rostral spine 0.14 mm. long; length of carapace 0.46 mm.; interorbital distance 0.52 mm.; abdomen 0.42 mm.; telson 0.24 mm.

Carapace round. The first and second antennae and the labrum respectively similar to those of *Philyra*. Mandible with large triangular

inner lobe; outer lobe slightly uneven at the chewing surface. Maxillipedes of usual type (Table VI).

Abdominal knob present only in the third somite. Abdominal chromatophores clearly paired.

Note on larvae of the family Leucosiidae.

The above two species have the main characters, such as those of the second antenna, the telson, spine on the carapace and the chromatophores on the maxillipedes, similar to each other. Williamson (1915) and Lebour (1928) give the same characters for the larvae of *Ebalia*. The larvae of Leucosiidae may therefore be characterised as follows: (1) second antenna D-type, (2) telson E-type, (3) rostral spine only present, (4) primary chromatophores present on both maxillipedes.

Family Hymenosomidae Milne-Edwards.

3. Genus *Rhynchoplax* Stimpson.

3. *Rhynchoplax messor* Stimpson (Pl. IV, Fig. 28, 39).

FIRST ZOEA STAGE.

Characters. Rostral spine only present; second antenna D-type; telson D-type; primary chromatophores in both maxillipedes; abdominal chromatophores present only in the second somite and extending into the preceding and next following somites.

The chief breeding season is April to June. Berried crabs live among sea-weeds below low water mark. Egg-mass dark purple when young, greyish green afterward.

Rostral spine 0.22 mm. long; length of carapace 0.58 mm.; interorbital distance 0.30 mm.; abdomen 0.58 mm.; mean width of abdominal segments 0.10 mm.; telson 0.30 mm.

Eyes dark brown, with splashes of emerald green. Greater part of mandible, lower gastric parts, and rostral spine all pale pinkish crimson. Upper gastric parts, digestive tracts, and basal parts of maxillae and maxillipedes all pale yellowish green; the place occupied in other zoeas by the subcardiac chromatophore pale orange. Greater part of carapace, antennae, labrum and abdomen without colour. Chromatophores dark brown (Table I and III a).

The carapace is round, with almost circular lateral border and smooth surface. First antenna of usual type, with two aesthetes and two hairs. Second antenna D-type. Mandible bilobed, inner lobe triangular, outer lobe toothed at the upper corner and smooth at the chewing surface. Maxillae of usual type (Table IV). The characteristic

coxopodite of the second maxilla only with a sparsely plumose spine. Maxillipedes of usual type (Table VI). Abdomen with five segments, lateral knobs absent. Telson D-type, finely serrated at the lateral margin on each side, outer denticulations absent.

4. Genus *Trigonoplax* White.

4. *Trigonoplax unguiformis* de Haan (Pl. III, Fig. 9; Pl. V, Fig. 50).

FIRST ZOEA STAGE.

Characters. Abdominal chromatophores present in first, second and third somites; other characters similar to those of *Rhynchoplax*.

The breeding season lasts from May to July. Berried crabs live among sea-weeds below low water mark. Egg-mass dark purple when young, grey afterward.

Rostral spine 0.28 mm. long; length of carapace 0.64 mm.; interorbital distance 0.34 mm.; abdomen 0.62 mm. long, 0.10 mm. wide; telson 0.34 mm.

Colour pattern of body and distribution of chromatophores, except in abdomen, as in *Rhynchoplax* (Table I and III a).

Labrum elliptical; mandible bilobed, inner lobe triangular, outer one uneven at the chewing surface; other characters remarkably similar to those of *Rhynchoplax messor* Stimpson.

5. Genus *Halicarcinus* White.

5. *Halicarcinus septentrionalis* Yokoya (Pl. II, Fig. 3; Pl. V, Fig. 49).

FIRST ZOEA STAGE.

Characters. Abdominal chromatophores in second and fourth somites, on dorsal side in the former, on ventral in the latter, both chromatophores extending into preceding and next following segments, so that the third somite is pigmented both dorsally and ventrally; other characters as in *Rhynchoplax* and *Trigonoplax*.

The chief breeding season is July. Berried crabs live among sea-weeds below low water mark; colour of egg-mass similar to that of the two preceding species.

Rostral spine 0.10 mm. long; second antenna 0.08 mm.; carapace 0.44 mm. long and 0.34 mm. wide; interorbital distance 0.16 mm.; abdomen 0.46 mm. long and 0.10 mm. wide; telson 0.22 mm.

Colour pattern of body same as in the foregoing species or a little deeper in tint, but the pale orange which prevails in the subcardiac region in the preceding species is absent.

Distribution of chromatophores as shown in Table I and III a; median gastric chromatophore runs transversely along the posterior border of eye; maxillipedal chromatophores slender, branched and extending into endopodite and exopodite. These characters distinguish it from *Rhynchoplax* and *Trigonoplax*.

Carapace round, with sharply projected lower margin. Rostral spine more like that of Leucosiidae than of the two preceding species. It is very interesting that the larva of *Halicarcinus* has the rostrum of Leucosiidae and the telson of Hymenosomidae. The telson has two outer denticulations on either side at the base of the fork, thus differing from the two preceding species. Other characters similar to those of *Rhynchoplax* and *Trigonoplax*.

A note on the larvae of Hymenosomidae.

From a comparison of the larvae of these three species, we may give the larval characteristics of the family Hymenosomidae as follows: (1) the rostral spine alone present, (2) second antenna D-type, (3) telson D-type, (4) primary chromatophores in both maxillipedes.

So far as the larval forms and the four important characters are concerned, Hymenosomidae seems to be more closely related to Leucosiidae rather than to the cancroid crabs. The larvae of Brachyura described by Gurney (1924, p. 196) as incertae sedis, belong no doubt to the present family.

Family Inachidae Miers.

Subfamily Acanthonychinae Miers.

6. Genus *Pugettia* Dana.

6. *Pugettia quadridens* (de Haan) (Pl. III, Fig. 19; Pl. IV, Fig. 25, 33).

First Zoea Stage.

Characters. Rostral and dorsal spines present; second antenna A-type; telson A-type, with two outer teeth; primary chromatophores in both maxillipedes; abdominal chromatophores present in first and second somites in common, in third to fifth somites and in telson.

The breeding season lasts from May to June. Berried crabs are found among sea-weeds below low water mark. Egg-mass dark purple when young, greyish green afterward.

Larva relatively large. Rostral spine 0.24 mm. long; dorsal spine (measured from tip to posterior angle formed with the carapace) 0.59 mm.; distance between ends of the two spines 1.14 mm.; carapace

0.94 mm. long; interorbital distance 0.44 mm.; abdomen 0.80 mm.; telson 0.36 mm.

Colour pattern greenish as a whole. Chromatophores large and easily noticeable (Table I and III a). Carapacial chromatophores two, one at base of lateral spine, the other at lower margin of carapace. Supra-cerebral chromatophore just behind the rostrum.

Lower margin of carapace coarsely haired. First antenna of usual type, with two aesthetes and three hairs. Second antenna A-type, very much longer than rostrum; peduncle and exopodite similarly toothed on either side in the distal half, peduncle with two short spines at middle; endopodite already present as an elliptical plate. Labrum elliptical, slightly swollen, smooth at lower free margin, coarsely haired at sublateral corners. Mandible bilobed, irregular in shape. Maxillae of usual type (Table IV). Setae on the lateral margin of scaphognathite much more numerous than in larvae of other families. Maxillipedes of usual type (Table VI). Abdomen with five segments and telson; a hair on the lower lateral margin in second to fifth somites; telson A-type, with a dorsal median tooth and a lateral one near base; distal part of telson-fork finely serrated all over.

7. Inachidae incertae sedis (Pl. III, Fig. 16).

Characters. Three kinds of spines present; second antenna A-type; telson A-type, with two outer teeth; primary chromatophores in both maxillipedes; abdominal chromatophores in all the somites except telson.

The chief breeding season is early April. Berried crabs live on rocks below low water mark. Egg-mass dark purple when young.

Rostral spine 0.24 mm. long; dorsal 0.54 mm.; distance between their tips 1.18 mm.; lateral spine 0.16 mm. long; carapace 0.62 mm.; interorbital distance 0.30 mm.; abdomen 0.80 mm.; telson 0.28 mm.

The body is nearly colourless and transparent, only the brown pigment in the retinal portion and the small dark brown chromatophores of other parts being distinct (Table I and III a).

Lateral spine very short; rostral spine shorter than the first or second antenna. First antenna of usual type, with two aesthetes and three hairs at tip. Second antenna A-type; peduncle and exopodite finely toothed from tip to middle, the former with two spines at middle. Labrum elliptical, coarsely haired all over. Mandible bilobed; inner lobe triangular, outer irregularly toothed on chewing surface. Maxillae of usual type (Table IV). Maxillipedes of usual type (Table VI).

Abdomen with five segments and telson, with stout, upwardly directed lateral knobs on second somite; lower lateral margin of each somite pointed; telson A-type, with a comparatively large, dorsal outer tooth at base of fork, which is finely serrated all over.

Family PORTUNIDAE Ortmann.

7. Genus *Neptunus* Miers.

8. *Neptunus trituberculatus* (Miers).

Characters. Rostral and dorsal spines present; second antenna B-type; telson A-type, with two outer teeth; secondary chromatophore present in first maxillipede; abdominal chromatophores present in all the somites except the second and telson.

Family MENIPPIDAE Ortmann.

Subfamily MYOMENIPPIDAE Ortmann.

8. Genus *Heteropanope* Stimpson.

9. *Heteropanope glabra* de Haan (Pl. III, Fig. 13; Pl. IV, Fig. 29, 47, 48).

FIRST ZOEA STAGE.

Characters. Dorsal spine only present; second antenna A-type; telson A-type, with an outer tooth; primary chromatophores in both maxillipedes; abdominal chromatophores in all the somites and telson.

The chief breeding season is August. Berried crabs live among seaweeds, especially calcareous algae, below low water mark. Egg-mass dark purple when young, greyish green afterward.

The larva has a greenish appearance. Chromatophores complicatedly branched and notably extended (Table I and III a).

Larva large. Dorsal spine 0.36 mm. long; carapace 0.56 mm.; interorbital distance 0.36 mm.; abdomen 1.26 mm.; telson 0.44 mm.

Dorsal spine bending posteriorly like a hook at end, and into it a branch of subcardiac chromatophores extends. First antenna of usual type, with two aesthetes and four hairs at tip. Second antenna A-type, with linear chromatophore running through its length; penduncle and exopodite finely toothed on inner side. Labrum oval, haired on either side along lateral and sublateral border. Mandible bilobed; inner lobe triangular, outer uneven at the chewing surface; mandibular chromatophore a fine meshwork of pigment. Maxillae of usual type (Table IV).

Maxillipedes of usual type (Table VI). Abdomen with five segments and telson; abdominal chromatophores in all the somites, namely, a dorsal one common to first and second somites, ventral one in each segment and telson; second somite with a lateral knob; third to fifth somites with a tooth on lower lateral margin; telson A-type, with a medium, dorsal outer tooth on fork.

Subfamily PILUMNINAE Ortmann.

9. Genus *Pilumnus* Leach.

10. *Pilumnus vespertilio* Fabricius (?) (Pl. III, Fig. 14).

FIRST ZOEA STAGE.

Characters. Three kinds of spines present; second antenna A-type; telson A-type, with three outer teeth; primary chromatophores in both maxillipedes; abdominal chromatophores present only in third and fourth somites.

The chief breeding season is July. Berried crabs are found below low water mark. Egg-mass dark purple when young, afterwards greyish green, semitransparent and dotted with dark brown pigment. Egg relatively large.

Rostral spine 0.67 mm. long; dorsal spine 0.67 mm.; distance between their tips 1.78 mm.; lateral spine 0.14 mm.; carapace 0.54 mm. interorbital distance 0.31 mm.; second antenna 0.52 mm.; abdomen with the telson 1.44 mm.

The colour pattern could not be observed as the material was in formalin. Chromatophores dark brown (Table I and III a).

Dorsal and rostral spines very long, lateral ones short, all straight. First antenna of usual type, with two aesthetes and two hairs. Second antenna A-type; peduncle and exopodite with a row of fine teeth on each side; endopodite with a bud at junction of peduncle and exopodite. Labrum oval, with smooth lower free margin. Mandible convex at middle of the chewing surface and rounded at upper and lower corners. Maxillae of usual type; setae on each podite and hairs on protopodites of maxillipedes could not be counted, as the larva seemed to be just after moulting from the protozoea. Abdomen with five segments and telson; second somite with lateral knobs; inner side of telson-fork finely serrated on either side from tip to base; an outer tooth and a hair present on the side of the telson-fork.

11. *Pilumnus minutus* de Haan (Pl. III, Fig. 15).

FIRST ZOEA STAGE.

Characters. Three kinds of spines present; second antenna A-

type; telson A-type, with two outer teeth; primary chromatophores in both maxillipedes; abdominal chromatophores in all the somites and telson

The chief breeding season is May. Berried crabs are found among sea-weeds below low water mark. Egg-mass dark purple when young, greyish green afterward.

Rostral spine 0.12 mm. long; dorsal spine 0.42 mm.;distance between their tips 0.84 mm.; lateral spine 0.10 mm.; carapace 0.56 mm.; interorbital distance 0.34 mm.; abdomen 0.64 mm.; telson 0.36 mm.; second antenna 0.32 mm.

The body appears almost colourless, but the gastric region is pale orange, the buds of the pleopods and the protopodites of the maxillipedes all pale pinkish crimson, and the environs of the chromatophores pale green. The dark brown chromatophores are complicatedly branched and contain a red reflecting substance (Table I and III).

Dorsal spine very long, rostral and lateral very short. Lower margin of carapace finely haired. First antenna of usual type, with two aesthetes and three hairs at tip. Second antenna A-type; peduncle and exopodite finely serrated on each side. Labrum hexagonal, with a bundle of short hairs on each side at the sublateral corner. Mandible semicircular in outline and simple in structure; rounded upper corner with two short hairs; lower corner forming a dull tooth. Maxillae of usual type (Table IV). Maxillipedes of usual type (Table VI). Abdomen with five segments and telson; third and fourth somites with lateral knobs; third to fifth somites each with a tooth on lower lateral margin; telson A-type, with two outer teeth, as in *P. vespertilio.*

Family XANTHIDAE Ortmann.

Subfamily XANTHINAE Ortmann.

10. Genus *Xantho* Leach.

12. *Xantho exaratus* (Milne-Edwards) (Pl. III, Fig. 18; Pl. IV Fig. 37).

FIRST ZOEA STAGE.

Characters. Three kinds of spines present; second antenna C-type; telson A-type, with two outer teeth; secondary chromatophores in both maxillipedes; abdominal chromatophores in all the somites and telson.

The chief breeding season is July. Berried crabs live in crevices of rocks near low water mark. Egg-mass dark grey when young, green afterward.

Larva large. Rostral spine 0.38 mm. long; dorsal spine 0.24 mm.; distance between their tips 1.26 mm.; lateral spine 0.12 mm.; carapace 0.52 mm.; interorbital distance 0.41 mm.; abdomen 0.62 mm.; telson 0.43 mm.; second antenna 0.40 mm.

Colour pattern very brilliant; rostral spine pale pinkish crimson dorsal and lateral spines and labrum all pale green; upper part of mandible clear reddish orange, lower part pale green, central region dark purple. Red, pale yellow, orange, pale green diffused and mingled in several parts of body; they quickly disappear after death or preservation leaving only the dark brown chromatophores (Table I and III a).

The dorsal and rostral spines are the most striking characters of this larva. The rostral spine is longer and more slender than the dorsal, which bends backward at the end like a hook. Lateral spine very short and slender. First antenna of usual type, with two aesthetes and one (?) hair. Second antenna C-type, much longer than the rostral spine and with three rows of fine teeth on its distal one-third; exopodite reduced to a spiny process. Labrum oval and toothed on the sublateral corner on each side. Mandible bilobed. Maxillae of usual type (Table IV). Maxillipedes as in Table VI. Abdomen with five segments, second to fifth each with a short, pointed tooth at lower lateral margin; second somite with a lateral knob; telson A-type, with an outer tooth and a hair.

13. *Xantho* sp. (Pl. II, Fig. 7; Pl. IV, Fig. 31, 38).

FIRST ZOEA STAGE.

Characters. All the characters same as in the above species.

The breeding season lasts from June to July. Berried crabs are found under stones near low water mark. Egg-mass dark red when young, pale grey afterward.

Rostral spine 0.36 mm. long; dorsal spine 0.38 mm.; distance between their tips 0.90 mm.; lateral spine 0.10 mm.; carapace 0.48 mm.; interorbital distance 0.30 mm.; abdomen 0.56 mm.; telson 0.27 mm.; second antenna 0.38 mm.

The body is of light tint and nearly transparent, but in some parts such as the mandible, pale green and pale red are mingled, with branched dark brown pigment between. The frontal region, the base of the second antenna and the gastric region all pale yellowish green. A branch of the subcardiac chromatophore extends into the dorsal spine. The chromatophores branched and mingled with a red reflecting substance in all parts. Environs of chromatophores pale green (Table I and III a).

Dorsal and rostral spines very long, lateral short. Carapace like a depressed box, rectangular when seen from front; lateral spine projecting horizontally; carapacial chromatophores two in number, one at base of lateral spine, the other on lower part of carapace. First antenna of usual type, with two aesthetes and three hairs at tip. Second antenna C-type, as in *Xantho exaratus*, but movable and smooth on each side. Labrum pear-shaped; sublateral corner fairly swollen and with fine hairs; lower free margin fairly concave and toothed at middle. Mandible bilobed; inner lobe with two teeth, outer one smooth. Maxillipedes of usual type (Table VI). Abdomen with five segments and telson; lower lateral margin of second to fifth somites pointed; lateral knobs present on second somite; telson-fork with an outer tooth.

A note on Xanthini larvae.

The above described larvae of *Pilumnus* and *Xantho* well agree in their characters with those described by other authors.

The first zoea stage of the Xanthidae are characterized by the presence of rostral, dorsal and lateral spines and by the usually long and robust antennae. The known zoeas of the family are separated into two groups. In those of *Panopaeus*, *Neopanope*, *Eurypanopeus* and *Xantho*, the exopodite of the second antenna is extremely minute, while in those of *Pilumnus*, *Trapezia*, *Eriphia* and *Menippe* it is well developed. The zoea of *Panopaeus* is usually considered to be most highly specialized, while that of *Pilumnus* is least so (Hyman).

But I cannot follow this opinion in detail. Xanthini larvae, I suppose, have long slender rostral and dorsal spines and very short lateral ones. The telson is generally of the A-type. These characters strike one at first sight. According to the type of the second antenna and the grouping of chromatophores in the maxillipedes, the larvae are diagnosed as follows.

Xanthini. Three kinds of spines present, telson A-type.

Family Menippidae Ortmann.

Subfamily Pilumninae. Second antenna A-type, primary chromatophores in both maxillipedes.

Family Xanthidae Ortmann.

Second antenna C-type, secondary chromatophores in both maxillipedes.

Family Oziidae Ortmann.

Subfamily Panopaeinae. Second antenna C-type, primary and secondary chromatophores in both maxillipedes.

Subfamily Eriphiinae. Second antenna B-type, maxillipedal chromatophores not yet ascertained.

Family GRAPSIDAE Dana.

Subfamily VARUNINAE Alcock.

11. Genus *Hemigrapsus* Miers.

14. *Hemigrapsus longitarsis* (Miers) (Pl. III, Fig. 20).

FIRST ZOEA STAGE.

Characters. Three kinds of spines present; second antenna B-type; telson B-type; secondary chromatophores in first maxillipedes; abdominal chromatophores in all the somites, namely, one pair common to first and second somites, third to fifth somites and telson each with one pair.

The breeding season is May to June. Berried crabs are found at a fair depth below low water mark. Egg-mass reddish brown when young, grey afterward.

Rostral spine 0.22 mm. long; dorsal spine 0.26 mm.; distance between their tips 0.76 mm.; lateral spine 0.14 mm.; carapace 0.44 mm.; interorbital distance 0.30 mm.; abdomen 0.50 mm.; telson 0.28 mm.

Body pale brown. Mandible, frontal region, basal part of maxillipedes and environs of chromatophores all pale yellowish green. Chromatophores dark brown (Table I and III a).

Lower margin of carapace haired. First antenna of usual type, with two aesthetes and a hair. Second antenna B-type; peduncle armed with a row of fine teeth; exopodite with a relatively long spine at middle. Labrum circular, lower free margin smooth. Mandible bilobd; inner lobe pointed; outer one with two teeth at upper corner, lower corner rounded. Maxillae of usual type (Table IV). Maxillipedes of usual type (Table VI). Abdomen with five segments and telson; lateral knobs on second and third somites, projecting upward in former and downwards in latter; telson typical B-type, with three pairs of inner spines of equal length.

12. Genus *Heterograpsus* (Lucas).

15. *Heterograpsus sanguineus* de Haan (Pl. IV, Fig. 34).

FIRST ZOEA STAGE.

Characters. Abdominal chromatophores absent only in the second somite; secondary chromatophores present in both maxillipedes. Other characters same as in the above species.

Breeding season lasts from June to July. Berried crabs are found in crevices of rocks or under stones near low water mark, on more or less muddy beaches. Egg-mass dark purple when young, greyish green afterward.

Rostral spine 0.22 mm. long; dorsal spine 0.26 mm.; distance between their tips 0.88 mm.; lateral spine 0.14 mm.; carapace 0.48 mm.; interorbital distance 0.28 mm.; abdomen 0.50 mm.; telson 0.30 mm.

Body dirty brownish green, the dark brown chromatophores large and complicatedly branched. Environs of chromatophores all pale yellowish green, gastric region pale reddish orange, rostral spine pinkish crimson. Chromatophores dark brown (Table I and III a).

Lower margin of carapace coarsely haired. Rostral spine nearly straight, dorsal curved posteriorly like a hook. First antenna with two aesthetes and two hairs. Second antenna B-type; peduncle a little shorter than rostral spine, toothed on each side from tip to about middle; exopodite with a medium denticle at middle. Labrum oval, with straight lower free margin, haired at sublateral corner. Mandible bilobed; inner lobe with three teeth; outer smooth at chewing surface. Maxillae of usual type (Table IV). Maxillipedes as in Table IV. Abdomen with five segments and telson; lateral knob of scond somite directed upwards, that of third somite downwards; a hair on the lower dorsal margin of each somite; telson B-type, finely serrated on each side along inner side of fork.

16. *Heterograpsus penicillatus* de Haan (Pl. III, Fig. 17; Pl. IV Fig. 43).

FIRST ZOEA STAGE.

Characters. Entirely identical with those of the above species.

The breeding season begins earlier and ends later than in the above species. Berried crabs are found crawling on muddy beaches near low water mark. Egg-mass dark purple at first, greyish green afterward.

Rostral spine 0.26 mm. long; dorsal spine 0.30 mm.; distance between their tips 0.90 mm.; lateral spine 0.12 mm.; carapace 0.44 mm.; interorbital distance 0.26 mm.; abdomen 0.50 mm.; telson 0.30 mm.; second antenna 0.18 mm.

Colour pattern and groupings of chromatophores as in preceding species. We can hardly distinguish these two larvae by their features.

13. Genus *Eriocheir* de Haan.

17. *Eriocheir japonicus* de Haan (Pl. II, Fig. 8; Pl. III, Fig. 22; Pl. IV, Fig. 45).

First Zoea Stage.

Characters. Three kinds of spines present; second antenna B-type; telson A-type; secondary chromatophores in both maxillipedes; abdominal chromatophores in all the somites and telson.

The breeding season lasts from May to July. Berried crabs live deep in the crevices of rocks or on the sea-bottom. Egg-mass dark purple when young, grey afterward.

Rostral spine 0.28 mm. long; dorsal spine 0.48 mm.; distance between their tips 1.34 mm.; lateral spine 0.22 mm.; carapace 0.57 mm.; interorbital distance 0.38 mm.; second antenna 0.20 mm.; abdomen 0.72 mm.; telson 0.38 mm.

Colour pattern pale in tone, very like that of *Platygrapsus depressus* de Haan. Rostral spine clear pinkish crimson; gastric region and basal part of maxillipedes yellowish orange; abdomen and environs of chromatophores pale yellowish green. Chromatophores dark brown (Table I and III a).

Lower margin of carapace coarsely haired. Carapacial chromatophores two, one at base of lateral spine, the other at lower part of carapace. First antenna with two aesthetes and a hair at tip. Second antenna B-type, very like that of *Platygrapsus* and *Heterograpsus*. Labrum oval, closely haired at sublateral corner on each side. Mandible bilobed; inner lobe rectangular, outer unevenly toothed at the chewing surface and pointed at upper corner. Maxillae and maxillipedes of usual types (Table IV and VI respectively). Abdomen with five segments and telson; second to fourth somites with lateral knobs, directed upwards in second and downwards in third and fourth; telson A-type, with a dorsal tooth at middle of fork and a lateral one near base.

14. Genus *Platygrapsus* Stimpson.

18. *Platygrapsus depressus* (de Haan) (Pl. III, Fig. 21, Pl. IV, Fig. 24.)

First Zoea Stage.

Characters. Dorsal and rostral spines present; second antenna B-type; telson B-type; secondary chromatophores in first maxillipedes; abdominal chromatophores dorsal in first somite and ventral in the others.

The breeding season lasts from May to July or sometimes to August. Berried crabs are found under stones near low water mark on more or less sandy beaches. Egg-mass dark purple when young, greyish green afterward.

Rostral spines 0.20 mm. long; dorsal spine 0.24 mm; distance between their tips 0.88 mm.; carapace 0.50 mm.; interorbital distance 0.30 mm.; abdomen 0.66 mm.; telson 0.30 mm.

Colour pattern same as in *Hemigrapsus* and *Heterograpsus*. Chromatophores dark brown (Table I and III a).

Lower margin of carapace coarsely haired. Lateral spine absent, an exception among grapsid larvae. First antenna with two aesthetes and two hairs at tip. Second antenna B-type, as long as rostral spine; peduncle longer than exopodite, both similarly toothed on each side in distal half. Labrum and mandible as in *Heterograpsus*. Maxillae and maxillipedes of usual type (Table IV and VI). Abdomen with five segments and telson; second and third somites with lateral knobs; second to fifth somites with a hair on lower lateral margin; all the somites with a small tooth on lower lateral margin; telson B-type, innermost pair of inner spines is shortest.

Subfamily Sesarminae Kingsley.

15. Genus *Sesarma* Say.

19. *Sesarma* sp.

First Zoea Stage.

Characters. Three kinds of spines present; second antenna B-type; telson B-type; secondary chromatophores only in the second maxillipede; abdominal chromatophores in all the somites except fourth and in telson.

The larva being a protozoea has not yet taken on all the definitive features. Still the chromatophores are well recognizable (Table I and III a).

A note on grapsid larvae.

O. W. Hyman (1924) described as follows: "The only zoeas of this family, which have been described as far, are remarkably uniform in structure, and these (*Sesarma*, *Planes* and *Pachygrapsus*) are characterized by the absence of the lateral spine on carapace and the equal length of the antennae and the frontal spine. They are very similar to the zoeas of the family Ocypodidae, from which they may be distinguished by the comparative length of the antenna, which is only two thirds as long as the rostral spine in Ocypodidae."

But it is clear from my observations as well as from a comparison with the larvae described by Hyman, that there is almost no common feature between the zoeas of the present family, and that the distinction between the larvae of Grapsidae and Ocypodidae is far more remarkable than Hyman supposes. The larvae of the present family is fairly heterogeneous in their forms, like those of Pinnotheridae.

From a study of the larvae alone, therefore, the family Grapsidae may be subdivided into several groups quite different from those usually adopted, such as Grapsinae, Sesarminae, Varuiinae and Plagusiinae. My studies have led me to subdivide the Grapsidae into the following four groups:

1. Second antenna B-type, telson A-type. *Eriocheir.*
2. Second antenna B-type, telson B-type.
   A. Three kinds of spines present
      . . . . . *Heterograpsus*, *Hemigrapsus*, *Sesarma.*
   B. Lateral spine absent
      . . . . . *Platygrapsus*, *Sesarma* (according to Hyman).
3. Second antenna C-type, telson A-type . . . . . *Planes.*
4. Second antenna C-type, telson B-type . *Pachygrapsus* (Hyman).

Hemigrapsus longitarsis (Miers) is usually grouped with *Heterograpsus*, but it seems to me better to separate them, as they differ in pigmentation.

Family Ocypodidae Ortmann.

Subfamily Macrophthalminae Dana.

16. Genus *Macrophthalmus* Latreille.

20. *Macrophthalmus dilatatus* de Haan (Pl. II, Fig. 4).

First Zoea Stage.

Characters. Rostral and dorsal spines present, lateral absent or sometimes represented by a fine hair; second antenna B-type; telson B-type; secondary chromatophores present in both maxillipedes; abdominal chromatophores in all the somites and telson.

The breeding season lasts from June to July. Berried crabs are found in oblique holes in mud near low water mark. Egg-mass dark purple when young, pale brown afterward.

Larva fairly small. Rostral spine 0.16 mm. long; dorsal spine 0.12 mm.; distance between their tips 0.58 mm.; carapace 0.38 mm.; interorbital distance 0.18 mm.; abdomen 0.34 mm.; telson 0.18 mm.

Colour pattern generally pale. Rostral spine clear pinkish crimson, gastric region, digestive tract and environs of chromatophores all pale

yellowish green. Orange reflecting substance in gastric region in early stage. Chromatophores dark brown (Table I and III a).

Dorsal and rostral spines very short and nearly straight. A short hair present a little below dorsal spine on each side of carapace. First antenna with two aesthetes and two hairs at tip. Second antenna B-type, shorter than rostral spine but longer than first antenna; peduncle and exopodite nearly equal in length, the former with a row of fine teeth on each side along its whole length. Labrum hexagonal and finely serrated on sublateral corner on each side. Mandible bilobed, outer lobe irregular at chewing surface, inner three-toothed. Maxillae and maxillipedes of usual type (Table IV and VI). Abdomen with five segments and telson; second and third somites with lateral knobs; fifth somite with a tooth on lower lateral margin; telson B-type, fork short, arms parallel, inner and dorsal sides finely serrated.

21. *Macrophthalmus japonicus* de Haan (Pl. II, Fig. 6; Pl. IV, Fig. 41; Pl. V, Fig. 56).

22. *Macrophthalmus depressus* Rüppell (Pl. II, Fig. 2).

Characters. All the features same as in *Macrophthalmus dilatatus* de Haan.

Subfamily Myctirinae Miers.

17. Genus *Scopimera* de Haan.

23. *Scopimera globosa* de Haan (Pl. V, Fig. 52, 55, 57.)

First Zoea Stage.

Characters. Three kinds of spines present; second antenna C-type; telson A-type, with an outer tooth; maxillipedal chromatophore absent; abdominal chromatophores in all the somites and telson.

The chief breeding season is June. Berried crabs live in holes on sandy beaches from above to far below low water mark. Egg-mass dark purple when young, greyish green afterward.

Larva fairly large. Rostral spine 1.04 mm. long; dorsal spine 0.76 mm.; distance between their tips 2.16 mm.; lateral spine 0.20 mm.; carapace 0.50 mm. long, 0.32 mm. wide; interorbital distance 0.28 mm.; abdomen 0.50 mm. long; telson 0.21 mm.; second antenna 0.32 mm.

Distal parts of spines clear pinkish crimson. A linear chromatophore in rostral spine. Median gastric and mandibular chromatophores much extended, united with each other, so that almost the whole gastric region is pigmented. Posterior gastric region, basal part of maxillipedes

and environs of chromatophores all pale yellowish green. Red reflecting substance abundant between branches of brown chromatophores (Table I and III a).

Dorsal and rostral spines very long and in one line, as in *Porcellana* larva, sparsely toothed on surface. Lateral spines very short. First antenna with two aesthetes and two hairs at tip. Second antenna C-type. Labrum oval, with smooth lower free margin. Mandible bilobed; inner lobe triangular, outer toothed at upper part and pointed at lower corner. Maxillae (Table IV) and maxillipedes (Tables VI) of usual type. Abdomen with five segments and telson; second and third somites with lateral knobs, directed upwards in the former and downwards in the latter; telson about half as long as abdomen, fork slender, innermost pair of inner spines longest; a pair of linear chromatophores along the emargination.

18. Genus *Tympanomerus* Rathbun.

24. *Tympanomerus pusillus* de Haan (Pl. II, Fig. 5; Pl. IV, Fig. 32; Pl. V, Fig. 53, 54).

First Zoea Stage.

Characters. All the features same as in the above species.

The breeding season lasts from May to July. Berried crabs live in holes generally of more or less muddy beach. Colour of egg-mass similar to that of the above species both when young and afterwards.

Rostral spine 0.45 mm. long; dorsal spine 0.36 mm.; distance between their tips 1.08 mm.; carapace 0.32 mm. long, 0.26 mm. wide; interorbital distance 0.22 mm.; abdomen 0.36 mm. long, 0.12 wide at the widest segment; telson 0.24 mm. long; second antenna 0.24 mm.

Lateral spine clear pinkish crimson, dorsal and rostral spines colourless. Frontal region, gastric region, intestinal tracts, and environs of chromatophores all pale yellowish green. Chromatophores complicatedly branched and the grouping as in *Scopimera*, except that the subcardiac chromatophore is present and the postocardiac is absent (Table I and III a).

Labrum elliptical, with flat and haired lower free margin. Mandible bilobed; inner lobe four-toothed, outer uneven at chewing surface. The other features are entirely similar to those of *Scopimera globosa* de Haan.

Explanation of Plates.

Plate II.

1.	Philyra pisum de Haan.	Lateral view.	× 84.
2.	Macrophthalmus depressus Rüppel.	,,	,,
3.	Halicarcinus septentrionalis Yokoya.	,,	,,
4.	Macrophthalmus dilatatus de Haan.	,,	,,
5.	Tympanomerus pusillus de Haan.	,,	,,
6.	Macrophthalmus japonicus de Haan	,,	,,
7.	Xantho sp.	,,	,,
8.	Eriocheir japonicus de Haan.	Second antenna.	,,

Plate III.

9.	Trigonoplax unguiformis de Haan.	Lateral view.	× 56.
10.	Petrolithytes japonicus de Haan.	Telson.	×187.
12.	Ebalia sp.	Lateral view.	× 56.
13.	Heteropanope glabra de Haan.	Lateral view.	,,
14.	Pilumnus vespertilio Fabricius.	,,	× 48.
15.	Pilumnus minutus de Haan.	,,	× 56.
16.	Inachidae incertae sedis.	,,	,,
17.	Heterograpsus penicillatus de Haan.	,,	,,
18.	Xantho exaratus (Milne-Edwards).	,,	× 48.
19.	Pugettia quadridens de Haan.	,,	,,
20.	Hemigrapsus longitarsis (Miers).	,,	× 56.
21.	Platygrapsus depressus de Haan.	,,	,,
22.	Eriocheir japonicus d.H.	,,	,,

Plate IV.

24.	Platygrapsus depr.	Second maxilla.	×200.
25.	Pugettia quadrid.	,,	,,
26.	Philyra pisum.	,,	,,
27.	Trigonoplax unguif.	,,	,,
28.	Rhynchoplax messor Stimpson.	Lateral view.	× 56.
29.	Heteropanope glabra.	Second antenna.	
30.	Philyra pisum.	,,	
31.	Xantho sp.	,,	
32.	Tympanomerus pus.	,,	
33.	Pugettia quadrid.	,,	
34.	Heterograpsus sangui.	,,	
35.	Pinnotheres veterum.	Telson.	
36.	Pinn. pisum.	,,	
37.	Xantho exaratus.	,,	
38.	X. sp.	,,	
39.	Rhynchoplax mes.	,,	

40.	Tympanomerus pus.	Telson	
41.	Macrophthalmus jap.	,,	
42.	Philyra pisum.	,,	
43.	Heterograpsus pen.	,,	
44.	Ethusa macerona Roux.	,,	
45.	Eriocheir jap.	,,	
46.	Pinnixa sayana.	,,	
47.	Heteropanope glabra.	First maxillipede.	
48.	,, ,,	,,	

Plate V.

49.	Halicarcinus sept.	First maxilla.	×280.
50.	Trigonoplax unguiformis.	,,	×300.
51.	Xantho sp.	Labrum.	×280.
52.	Scopimera globosa de Haan.	Lateral view.	× 84.
53.	Tympanomerus pusillus.	First maxilla.	×300.
54.	,, ,,	Mandible.	×280.
55.	Scopimera globosa.	,,	,,
56.	Macrophthalmus japonicus.	First and second antenna.	
57.	Scopimera globosa.	First maxilla.	×300.

LITERATURE CONSULTED.

1804. Herbst, J.F.W. Versuch einer Geschichte der Krabben und Krebse, nebst einer Beschreibung der verschiedenen Arten. Berlin und Stralsund.

1815. Leach, W.E. Malacostraca Podophthalmata Britanicae. Descriptions of such British species of Linnean genus Cancer. London.

1858. Bate, C. Spence. On the development of the Decapoda Crustacea. Phil. Trans. Roy. Soc. London.

1861. Claus, C. Zur Kenntnis der Malacostrakenlarven. Würzburger naturw. Zeitschr., Bd. 2.

1872. Smith, S.I. The metamorphosis of lobster and other Crustacea. Rep. U.S. Fish. Comm. 1871-72.

1876. Bate, C. Spence and Power, W.H. On the development of the crustacean embryos and variation of forms exhibited in the larvae of 38 genera of Podophthalma. Ann. Mag. Nat. Hist. (4), Vol. 8.

— Williemoes-Suhm. Preliminary remarks on the development of some pelagic Decapods. Proc. Roy. Soc. London, Vol. 24 or Ann. Mag. Nat. Hist. (4), Vol. 17.

1877. Mayer, P. Zur Entwicklungsgeschichte der Decapoden. Jena. Zeitschr. f. Naturw., Bd. 11.

1890. Weldon, W.F.R. Note on the function of spine of crustacean zoea. Jour. Mar. Biol. Assoc. Plymouth, N.S., Vol. 1.

1890. Korschelt und Heider. Lehrbuch der Entwicklungsgeschichte der wirbellosen Thiere, Bd. 2, Decapoden.

1892. Cano, G. Sviluppo postembryonale dei Dorippidei, Leucosidi, Corystoidei e Grapsidi. Memorie delle Scienze, Ser. 3 a, Vol. 8. Napoli.

— ,, Sviluppo postembryonale dei Cancroidi. Bull. Ent. Ital., Vol. 24.

— ,, Sviluppo dei Portunidi. Morphologia dei Portunidi e Corystoidi. Memorie di matematica e di fisica della Societa Italiana delle Scienze, Ser. 3 a, Vol. 8.

1896. Cunningham, J.T. On the early postlarval stages of the common crab (Cancer pagurus) and on the affinity of that species with Atelecyclus heterodon. Proc. Roy. Soc. London, Vol. 15.

1904. Keeble, F. and Gamble, F.W. The colour physiology of higher Crustacea. Phil. Trans. Roy. Soc. London, B, Vol. 196.

1913. Brueck, W. Beiträge zur Decapodenmetamorphose. II. Ueber das postlarvale Stadium von Calocaris macandreae. Archiv Zool. Vol. 8, No. 7.

1915. Williamson, H.C. Die Decapoden. I. Theil. Larven. Nordisches Plankton, Bd. 7, Lief. 18.

1916. Pesta, O. Entwicklung und Embryologie der Krebslarven. Verh. Zool. bot. Ges. Wien, Bd. 66.

1918. Joergensen, O.M. Note on the development of Carcinus maenus. Rep Dove Mar. Lab.

— Meek, A. On the Crustacea. Ibid.

1920. Hyman, O.W. The development of Gelasimus after hatching. Jour. of Morphol., Vol. 33, No. 2.

1921. Churchill, E. Life history of blue crab. Bull. Bur. Fish. Washington, Vol. 36.

— Crampton, G.C. A comparison of the terminal abdominal structures of insects and crustacea. Ent. News, Philadelphia, Vol. 32.

1922. Hyman, O.W. Adventures in life of a fiddler crab. Ann. Rep. Smithonian Inst., Vol. 120.

1923. Connolly, C.J. The larval stages and megalops of Cancer maenus (Herbst). Contributions to the Canadian Biology, N.S., Vol. 1.

1924. Gurney, R. The zoea of Eurynome aspera. Jour. Mar. Biol. Assoc. Plymouth, Vol. 13, No. 2.

— Hyman, O.W. Studies on the larvae of the family Pinnotheridae. Proc. U. S. Nat. Mus., No. 2497, Vol. 64, Art 7.

— ,, Studies on the larvae of the family Grapsidae. Ibid. No. 2575, Vol. 65, Art. 10.

— ,, Studies on larvae of crabs of the family Xanthidae. Ibid., No. 2575, Vol. 67, Art. 3.

1924. Gurney, R. Crustacea. IX. Decapod larvae. British Antarctic Expedition "Terra Nova A."

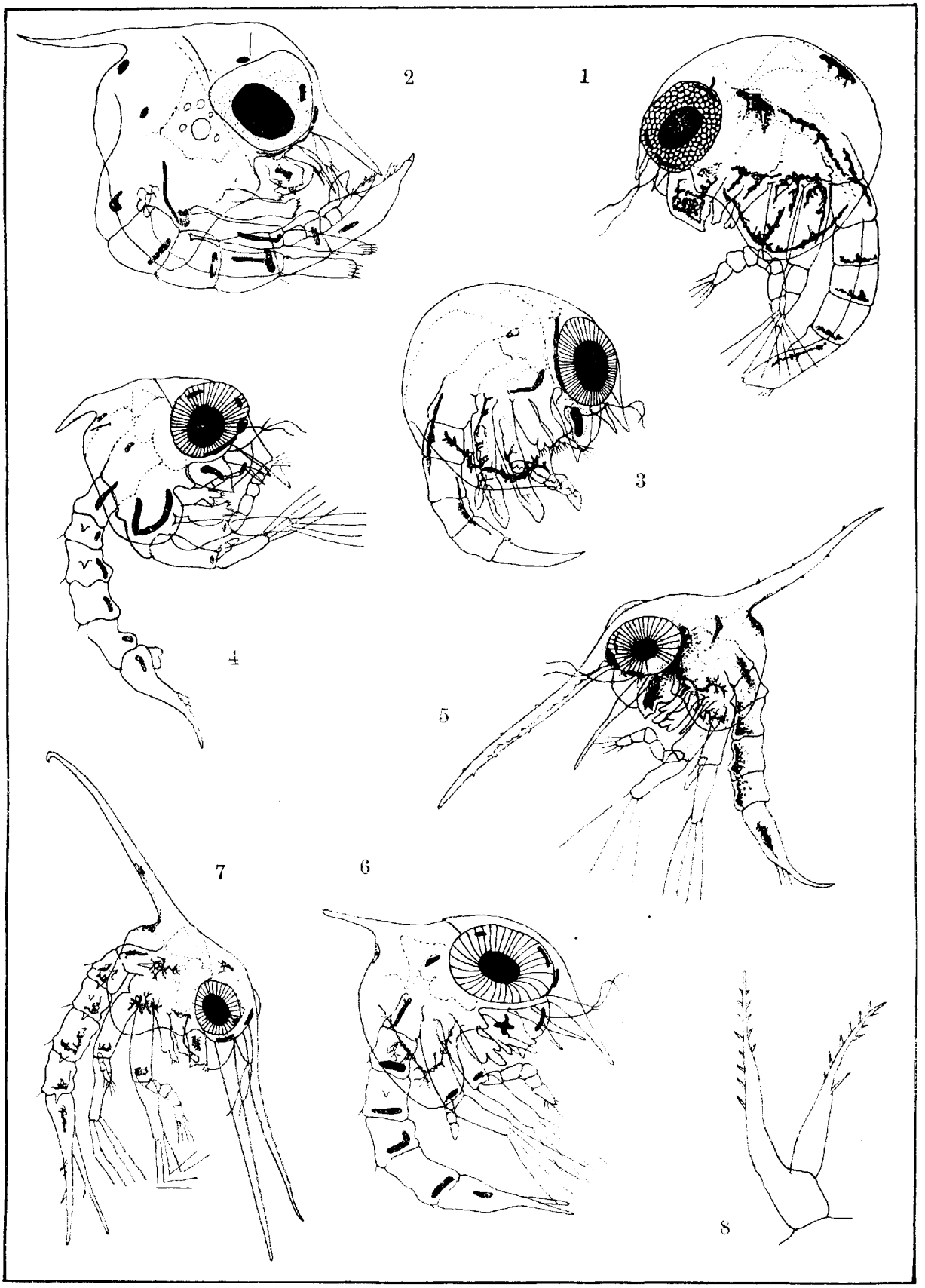
— Huxley, J.S. The variation in width of abdomen in immature fiddler crabs considered in relation to their relative growth rate. Amer. Nat., Vol. 58.

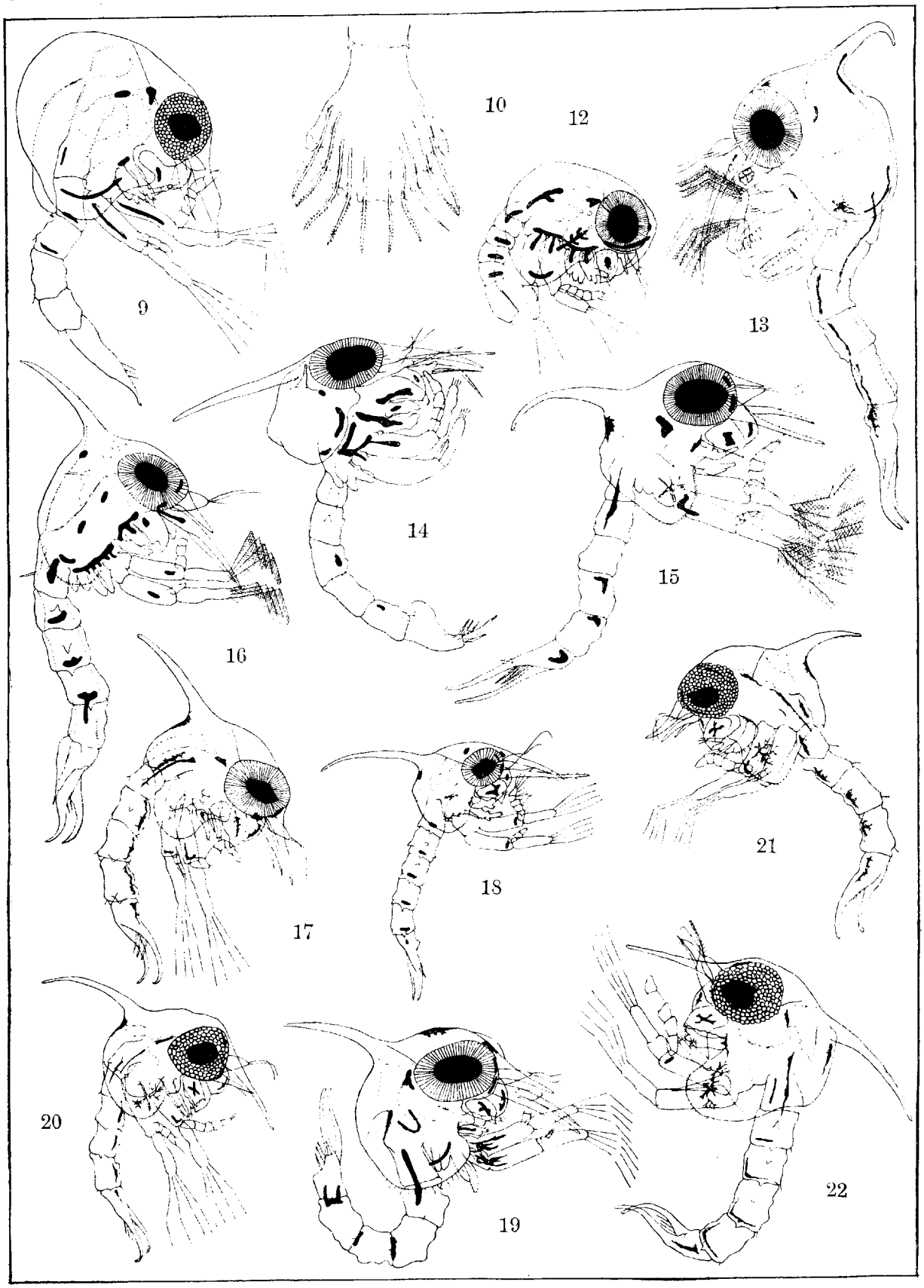
1927. Lebour, M. Studies of Plymouth Brachyura. I. Jour. Mar. Biol. Assoc. Plymouth, Vol. 14.

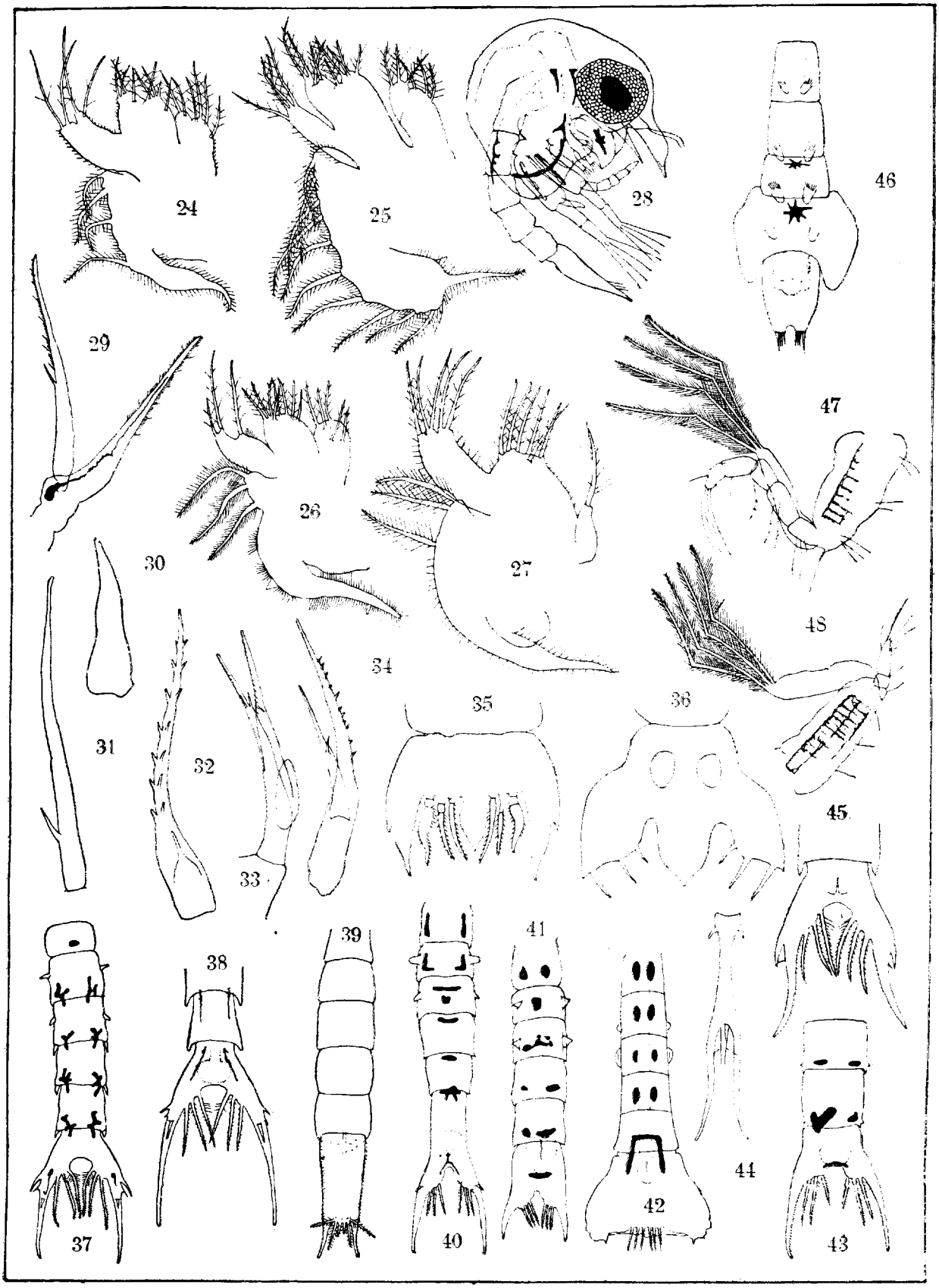
— Gurney, R. Report on the larvae of crustacea. Cambridge Suez Canal Expedition. Trans. Zool. Soc. London, Part 2.

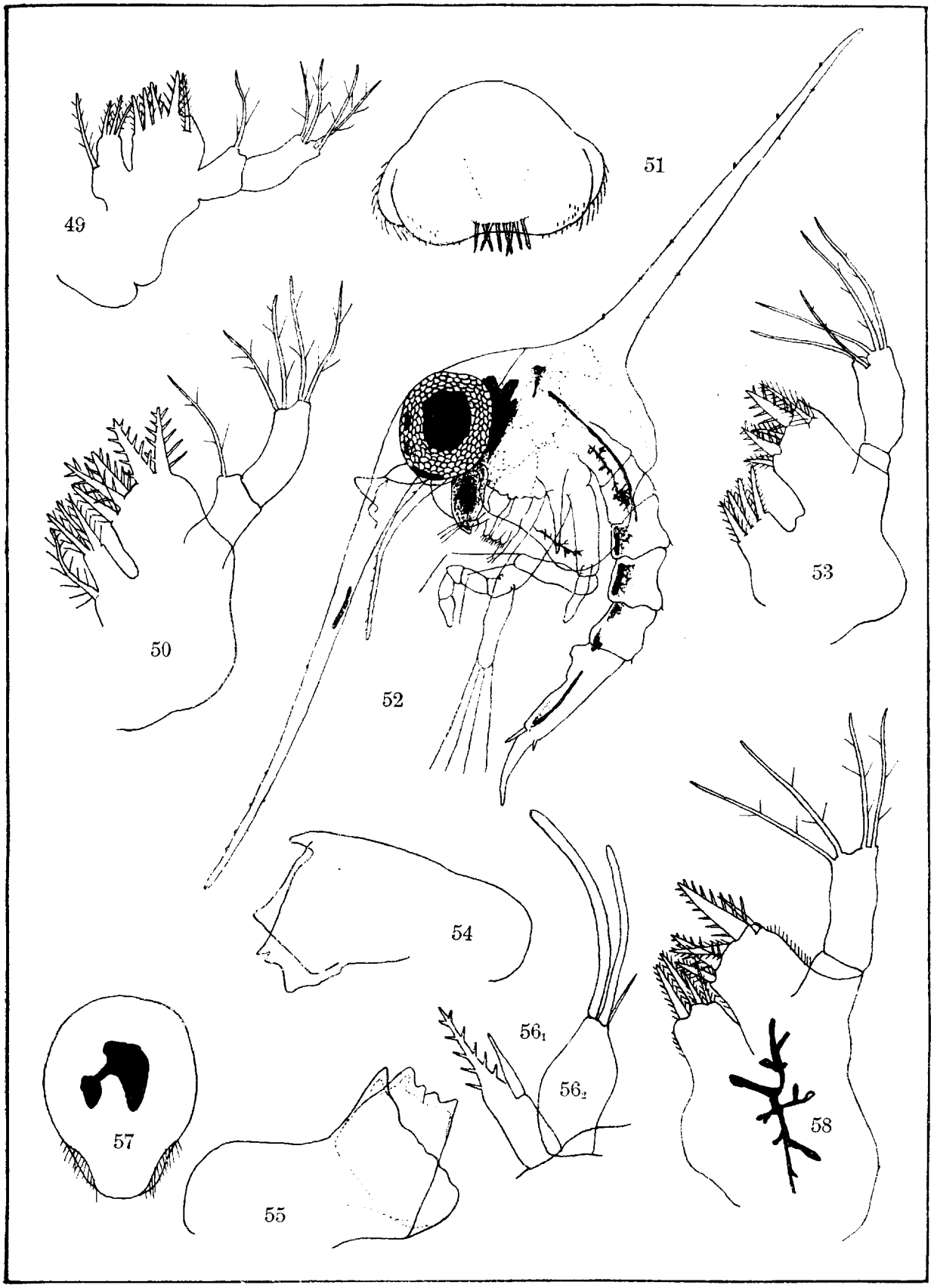
1928. Lebour, M. Studies of Plymouth Brachyura. II. Jour. Mar. Biol. Assoc. Plymouth,Vol. 15, No. 1.

— Lebour, M. The larval stages of Plymouth Brachyura. Jour. Zool. Soc. London, Part 2.


2
1
3
4
5
7
6
8


9
10
12
13
14
15
16
17
18
19
20
21
22


24
25
28
46
29
47
26
27
30
48
34
31
35
36
32
33
45
39
41
38
37
40
42
44
43


49
51
50
52
53
54
56₁
56₂
57
55
58