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INVERTEBRATE
ZOOLOGY
Crustacea

1882.

W. K. Brooks + E. B. Wilson

The first Zoa of Porcellana

(Studies from the Biological Laboratory of
Johns Hopkins University, ii

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THE FIRST ZOEAL STAGE OF PORCELLANA. By W. K.
BROOKS and E. B. WILSON. With Plates VI and VII.

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THE FIRST ZOEAL STAGES OF PORCELLANA. By W. K. BROOKS and E. B. WILSON. With Plates VI and VII.

Since 1835, when Thompson obtained the larva of a British species of *Porcellana* from the egg, this very remarkable zoea has frequently attracted the attention of naturalists, and we now have quite an extensive list of papers, giving a satisfactory account of the structure of the advanced zoea, and of its transformation into the adult crab. The bibliography of the subject is given, at length, in a recent paper by Faxon, (On some young stages in the development of *Hippa*, *Porcellana* and *Pinnixa*. Bulletin of the Museum of Comparative Zoölogy, at Harvard College, Vol. V, No. 11,) and it seems unnecessary to duplicate it here.

Most of the observers who have studied it started with the advanced zoea, which is frequently captured with the hand net at the surface of the ocean, and the few papers which notice the early stages of the larva were published so long ago, that a minute account of the young, as it leaves the egg, is still lacking.

During the latter part of June, 1880, we obtained, at the marine laboratory of the Johns Hopkins University, at Beaufort, N. C., a female specimen of *Porcellana ocellata*, Gibbes, with eggs, which we succeeded in keeping alive, and in good condition until the eggs hatched, and we were thus supplied with an abundance of material for studying the early stages.

As all the members of the party were at the time fully occupied with other work, we undertook to study the larva together, and to make as many notes and drawings of the early stages as possible.

This paper is therefore the result of our combined observations, but the work of copying the original drawings, and of preparing the description has been done by W. K. Brooks. In the explanation of the figures the author of the drawing which was copied is named in each case, although in nearly every case, the accuracy of the observation was verified by a independent drawing by the other observer.

The larva immediately after its escape from the egg, is shown in Plate VI, Figure 1. It is able to rise from the bottom and to swim a little by flapping its abdomen, but until the next moult it spends most of its time lying nearly motionless upon the bottom.

The carapace makes a little more than two-fifths of the total length of the body, and is folded upon itself in such a way as to form a well defined transverse band running across its dorsal surface near the posterior edge. The posterior spines of the carapace do not seem to be at all invaginated, but they are very much convoluted and wrinkled, and their free extremities are bent forwards under the posterior edge of the carapace. Between the eyes the anterior end of the carapace forms a protuberant rounded front, and the convoluted and wrinkled rostrum is bent down towards the ventral surface. The eyes lie in deep notches on the anterior edge of the carapace, and they appear to be movable, although the stalks are very short.

The third pair of maxillipeds are small and rudimentary, while the first, *Mp*, and second, *Mp'*, pairs are well developed, although their locomotor setæ are not yet protruded, and the limbs are not moved but remain constantly in the position which is shown in the figure. The abdomen has five free movable somites, besides the sixth which is not separated from the telson, *T*.

The pigment is more conspicuous at this time than during the stages which follow, and consists of a number of pretty constant bright red spots. One of them is on the basal portion, and one on the flagellum of the second antenna, one on the mandible, *M*, one on the basal joint of the first maxilliped, two on the basal joint of the second and one on the third, as well as one about half way between the base and tip of the second; there is a long dendritic spot on the posterior edge of the first, the second, the third, and the fourth abdominal somite, and a pair of spots on the telson.

The whole surface of the body is covered by a delicate embryonic cuticle, which is too transparent to be visible with the magnifying power under which Figure 1 was drawn. This cuticle conforms to the outline of the body except on the two pairs of antennæ and the telson. It will be described, in detail, later, in the account of the appendages.

Some of the larvæ free themselves from it within a couple of hours, and assume the form shown in Plate VI, Figure 5, while others do not escape from it until nearly or quite twenty-four hours

after they leave the egg. After this first moult the stalks of the eyes, (see Figure 5), elongate, the fold at the posterior edge of the carapace is stretched out so that the latter is now about half as long as the whole body; the rounded front disappears, and the convolutions and wrinkles of the rostrum and spine are no longer seen, although these processes are still rolled up, as shown in the figure. Figure 5 shows them as they appeared in the zoea which was drawn, but the form of the bends is not at all constant.

The swimming hairs on the first and second maxillipeds, *Mp*, *Mp'*, are extended, and these appendages, as well as the telson, are now used as locomotor organs. Spines have now made their appearance upon the posterior edges of the third, fourth and fifth abdominal somites, and the rostrum and processes of the carapace are covered with short hairs.

In, from one to two days after hatching the rostrum and processes become extended, as in Plate VII, Figure 8, and the zoea assumes the familiar form which has been described and figured by many observers.

The Appendages:

The first antenna of the newly hatched larva is shown in Plate VI, Figure 2, and that of the fully developed zoea in Plate VII, Figure 3.

In the first stage it is covered by the delicate embryonic skin, which follows the outline of the appendage very closely, except at the tip where it is produced into two long, broad, flattened, pointed setæ, which are fringed with smaller hairs. These structures, which seems to be swimming hairs, are not present in the zoea after the moult, but in the first stage the antenna carries a single stout sensory hair which, as shown in Plate VI, Figure 2, extends into one of the swimming hairs, more than half way to the tip. After the moult, Plate VII, Figure 3, the appendage ends in a number of long blunt sensory hairs, from the bases of which fine fibres run downwards to a large club-shaped granular mass, which appears to be ganglionic in nature.

The second antenna is shown before the moult, in Plate VII, Figure 1, and after the moult in Plate VII, Figure 2. It is essentially alike in both stages, but before the moult is loosely invested by the embryonic skin, which is loose and much larger than the true appendage. It consists of a swollen basal portion *d*, which carries a short pointed external branch, and a longer internal branch.

The mandibles and maxillæ are shown before the moult in Plate VII, Figure 7, and after the moult, in Plate VI, Figures 3, 4, and Plate VII, Figure 5.

In the first stage, Figure 7, Plate VII, these three appendages are folded together, and covered by the embryonic skin which is nearly conformable to their surface, although, as shown by the light outer line in the figure, it does not follow all the folds. No trace of a palpus could be discovered on the mandible, and the hairs at the tip of the maxillæ were almost completely invaginated into the appendages.

After the moult these three pairs of appendages become functional, and have nearly the adult character. The mandibles, Plate VII, Figure 5, and Plate VI, Figure 6, *M*, are not exactly alike, but exhibit that slight departure from bilateral symmetry so frequently found in these appendages. No trace of a mandibular palpus could be found, although there was a small area where the integument had been broken in each of the two specimens which were dissected; and as this area, shown in the figure, was at the same place in both cases, the fracture may have been produced by the removal of a palpus.

The first maxilla, Plate VI, Figure 3, and Figure 6, *Mx*, consists of a two-jointed basal portion, *a*, *b*, with stout cutting hairs, and a slender endopodite *c*, which in one specimen ended in two, and in another specimen in three long, slender, irregularly plumose hairs. The distal joint, *b*, of the basal portion carries upon its cutting edge, one row of five stout spines and a second row of four slender spines parallel to the larger ones. In the specimen figured, the proximal joint, *a*, was twisted so that its inner surface was shown, and the posterior edge is therefore the one at the left of the figure. It carries five long, stout, plumose spines, and at the posterior angle of its cutting edge a single spine without secondary hairs. No trace of an exopodite or scaphognathite could be detected in this appendage.

The second maxilla, Plate VI, Figure 4 and Figure 6, *Mx'*, consists of a three-jointed basal portion with short stout hairs; a two-jointed endopodite, *b*, with longer hairs; and a long flat exopodite, *c*, with five long hairs at its distal, and a long plumose flagellum, *d*, at its proximal end.

In the first stage, the first and second maxillipeds, Plate VI, Figure 1, *Mp*, *Mp'*, are fully developed, although the presence of

the embryonic skin prevents the extension of the locomotor hairs.

In Figure 1, the rudimentary third maxilliped is shown behind the base of the second.

In Plate VII, Figure 4, the third maxilliped, *c*, is shown, more highly magnified, lying in the same series with the bases, *a* and *b*, of the first and second. A fourth appendage, no doubt the first pereopod, is also represented at this stage by a bud or rudiment, *d*, and the appendages, *b*, *c*, and *d*, are furnished with little buds, which would seem to be rudimentary gills. After the moult we were not able to detect either the appendage, *d*, or the gill-like processes.

After the embryonic skin is moulted, the locomotor hairs of the first and second maxillipeds lengthen and these appendages become functional, while the third pair remain rudimentary. Figure 6, Plate VII, shows the first and second maxillipeds soon after the moult, and hardly calls for explanation.

The embryonic skin conforms closely to the surface of the abdomen and telson, although it appears to have no trace of a division into somites.

Figure 7 of Plate VI shows one-half of the telson of Figure 1 before the embryonic skin is shed. A comparison with Figure 6, *T*, will show that the great difference which has been pointed out by Faxon and others between the telson of the embryonic skin and that of the zoea in the ordinary crab, does not occur in *Porcellana*, but that the two are here nearly alike.

The five pairs of long swimming hairs of the zoea are, before the moult, about half invaginated, and the extended portion, Plate VI, Figure 8, is finely plumose. The hairs of the embryonic cuticle are much stouter, and their edges are not plumose, but they agree with those of the zoea, in number and arrangement.

The outer hair, or marginal spine of the telson, has the same appearance before the moult that it has afterwards.

EXPLANATION OF THE FIGURES.

PLATE VI.

FIGURE 1.—Zoea immediately after its escape from the egg, seen from the left side. From a drawing by W. K. Brooks.

FIGURE 1.—*Continued.*

A, first antenna; *An*, second antenna; *M*, mandible; *Mp*, first maxilliped; *Mp'*, second maxilliped; *R*, rostrum; *T*, telson.

FIGURE 2.—First antenna of the same larva, more highly magnified. From a drawing by W. K. Brooks.

FIGURE 3.—First maxilla of the larva shown in Figure 5. From a drawing by W. K. Brooks.

a, proximal joint of basal portion; *b*, distal joint of basal portion; *c*, endopodite.

FIGURE 4.—Second maxilla of the larva shown in Figure 5. From a drawing by W. K. Brooks.

a, three-jointed basal portion; *b*, two-jointed endopodite; *c*, scaphognathite; *d*, flagellum.

FIGURE 5.—Zoea, seen from the right side, immediately after moulting the embryonic skin. From a drawing by E. B. Wilson.

A, first antenna; *An*, second antenna; *Mp*, first maxilliped; *Mp'*, second maxilliped; *R*, rostrum.

FIGURE 6.—Ventral view of the same zoea, one day after moulting the embryonic skin. From a drawing by E. B. Wilson.

A, first antenna; *An*, second antenna; *L*, labrum, *M*, mandible; *Mp*, first maxilliped; *Mp'*, second maxilliped; *Mx*, first maxilla; *Mx'*, second maxilla; *R*, rostrum; *T*, telson.

FIGURE 7.—Dorsal view of right half of telson of the larva shown in Figure 1. From a drawing by E. B. Wilson.

FIGURE 8.—One of the setæ of Figure 7, more highly magnified. From a drawing by E. B. Wilson.

PLATE VII.

FIGURE 1.—Second antenna of the larva shown in Plate VI, Figure 1. From a drawing by W. K. Brooks.

a, embryonic skin; *b*, external branch; *c*, internal branch; *d*, enlarged basal joint.

FIGURE 2.—Second antenna of the zoea shown in Plate VI, Figure 5. From a drawing by W. K. Brooks. Letters of reference as in Figure 1.

FIGURE 3.—First antenna of the zoea shown in Plate VI, Figure 5. From a drawing by W. K. Brooks.

FIGURE 4.—Basal joints of the maxillipeds of the larva shown in Plate VI, Figure 1. From a drawing by W. Brooks.

a, base of first maxilliped; *b*, base of second maxilliped; *c*, third maxilliped; *d*, first pereopod; *e*, edge of carapace.

FIGURE 5.—Mandible of the zoea shown in Plate VI, Figure 5. From a drawing by E. B. Wilson.

FIGURE 6.—First and second maxillipeds of the zoea shown in Plate VI, Figure 5. From a drawing by W. K. Brooks.

FIGURE 7.—Mandible and maxilla of the larva shown in Plate VI, Figure 1. From a drawing by W. K. Brooks.

M, mandible; *Mx*, first maxilla; *Mx'*, second maxilla.

FIGURE 8.—Side view of the zoea, one day after moulting the embryonic skin. From a drawing by E. B. Wilson.

ERRATA.

Page 60, bottom line,
for "external," read "internal,"
for "internal," read "external."



