

Larval Development of *Epixanthus dentatus* (WHITE) (Brachyura, Xanthidae)

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Epixanthus dentatus (WHITE, 1847) [Kanoko-sebiro-gani] is a large xanthid crab with about 55 mm in carapace width, which inhabits crevices of rocks or under stones at estuaries of the tropical and subtropical regions. It was first reported from Japanese waters by MIYAKE and TAKEDA (1967) and subsequently by SAKAI (1976), its known geographical range being from Ishigaki-jima in the southern Ryukyu Islands through Taiwan, the Philippines and Java to the Fiji Islands, and through northern Australia, the Mergui, Nicobar and Andaman Islands to Dar-es-Salaam on the east coast of Africa.

In August of 1976, an egg-bearing female was collected from the estuary of the Oura River, Okinawa Island, and the authors reared the larvae from hatching to the megalopa stage in the laboratory. The aim of this report is to describe the features of the larval stages of *E. dentatus* on a brief comparison with the known larvae of xanthid crabs.

Material and Methods

The egg-bearing female was maintained in a compartment filled with 80% sea water until hatching occurred. After hatching, 20 zoea larvae were kept in a plastic aquarium of 14–20 cm in size, filled with 1,000 cc of 80% sea water. The first zoeae were fed with the *Artemia* nauplii and the rotifer, *Brachionus plicatilis*, and the subsequent larvae were fed only with *Artemia*. The water temperature ranged from 23.2 to 31.5°C. Some larvae of each stage were preserved in 50% ethylen glycol, and dissected under a low power binocular microscope. Drawings were made using a high power binocular microscope with help of ocular scale.

The carapace was measured from the anterior margin of eye to the posterior margin of dorsum.

Results

First zoea (Number of material examined: 8)

Carapace 1.3 mm and rostrum 1.2 mm in average length. Rostrum twice the length of spinous process of antennal protopod and equal to dorsal spine. Dorsal spine long and bent backward. Each lateral spine with its tip much pointed (Fig. 1, A). Eyes not stalked.

Antennule with 2 long and 1 short aesthetes distally (Fig. 1, B). Antennal exopod two-thirds as long as process (B type after AIKAWA, 1929), bearing 3 unequal, non-plumose apical setae (B 5 type after AIKAWA, 1933); one of the setae long and reaching tip of process; process with two rows of fine short spinules on its distal half; endopod like a simple rod, reaching a half of process (Fig. 1, C). Mandible with 3 strong teeth on its incisor process. Two-segmented endopod of maxillule with 1 long plumose seta on proximal segment, and with 4 terminal and 2 subterminal long plumose setae on distal segment (setation 1-6); basal endite with 7 short plumose setae and coxal endite with 8; a long plumose seta projecting from protopod just below endopod (Fig. 1, D). Endopod of maxilla with 3 long plumose setae on its proximal lobe and 5 on its distal lobe (setation 3-5); basal and coxal endites bilobed, and setation of the former being 5-5 and that of the latter 6-4; scaphognathite with 17-18 short soft plumose setae; its apical tip pointed and fringed with short fine hairs (Fig. 1, E).

Endopod of first maxilliped five-segmented, with setation 3-2-1-2-6 (plumose setae), and protopod with 10 short plumose setae ventrally (setation 2-2-3-3) (Fig. 1, F). Endopod of second maxilliped three-segmented, with its setation 1-1-6 (plumose setae); protopod with 4 short plumose setae ventrally (setation 1-1-1-1) (Fig. 1, G). Exopods of both maxillipeds two-segmented, bearing 4 natatory plumose hairs, respectively. Third maxilliped and pereopods rudimentary.

Abdomen consists of 5 segments and telson. Segments 2 to 5 with a lateral tubercle on either lateral side, those of second segment being directed anteriorly and the others posteriorly. Segments 3 to 5 with a spine on each lateral posterior margin, and that of fifth segment long and reaching a half of telson. A pair of pleopods present as tiny buds on each ventro-posterior margin of segments 2 to 5. Telson with a long slender fork (A type after AIKAWA, 1929); each telson fork with a fine spine on its lateral side and a long spine on its dorsal surface (A 2 type after AIKAWA, 1937); three pairs of plumose setae and a pair of short ones on inner surface of telson (Fig. 1, H).

Chromatophores recognized on whole surface of carapace, on each abdominal segment and protopods of both maxillipeds.

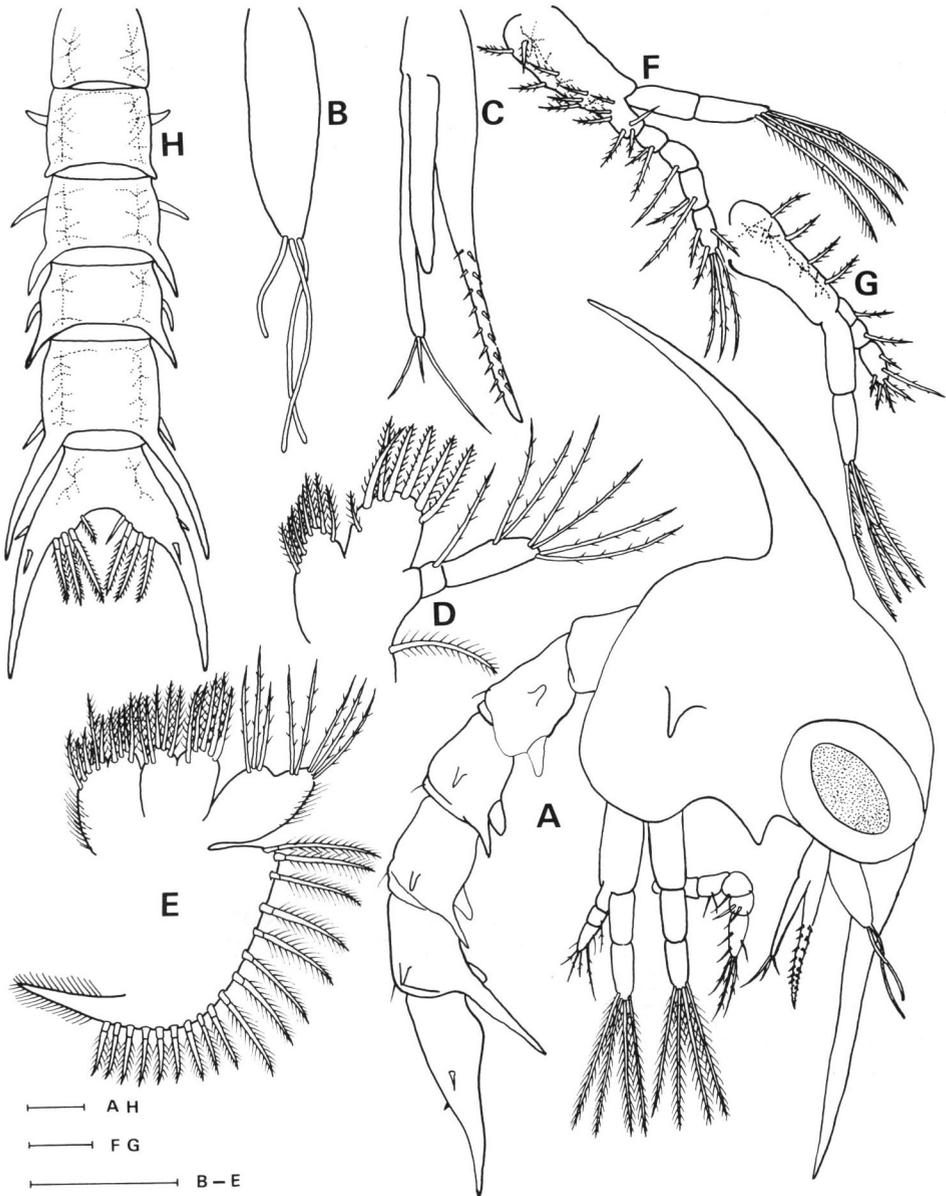


Fig. 1. First zoea. — A, Lateral view; B, antennule; C, antenna; D, maxillule; E, maxilla; F, 1st maxilliped; G, 2nd maxilliped; H, abdomen (dorsal view). Scales represent 0.1 mm.

Second zoea (Number of material examined: 5)

Carapace 1.8 mm and rostrum 1.3 mm in average length. Eyes stalked.

Antennule divided into 3 indistinct segments; second segment with a simple rod-like endopod on its distal end, and last segment with 7–10 aesthetes (Fig. 2, A). Antennal endopod partially segmented and well elongated, reaching near tip of process (Fig. 2, B). Mandible has a spatulate palp (Fig. 2, C). Endopods of maxillule and maxilla with the same setation as the preceding stage. Basal and coxal endites of maxillule with 10 short plumose setae; two long plumose setae on protopod just below endopod (Fig. 2, D). Setation of basal endite of maxilla 5–7 and that of coxal endite 4–7; scaphognathite with 41–43 soft plumose setae, its tip being rounded (Fig. 2, E).

Endopod of second maxilliped completely four-segmented (1–1–2–4) (Fig. 2, H). Exopods of first and second maxillipeds each with 12 swimming hairs distally (Fig. 2, F, G). Third maxilliped and pereopods well developed and slightly segmented, being seen under carapace.

Abdomen increased to 6 segments; last segment the shortest and about half the length of fifth segment. Pleopods become larger and their endopods appear as rudimentary buds. Setation of telson 5–5; lateral spines on forks have disappeared (Fig. 2, I).

Distribution of chromatophores similar to that in the preceding stage.

Megalopa (Number of material examined: 5)

Carapace 1.8 mm in average length and 1.6 mm in average width. Front triangular, and rostrum slightly bent downward. Dorsal and lateral spines disappeared. Gastric and cardiac regions moderately convex (Fig. 3, A).

Proximal portion of antennule consists of 3 segments, the first of which is larger than the others; unsegmented endopod with 4 short non-plumose setae; exopod divided into 4 indistinct segments, distal one of which bears 1 long and 1 short non-plumose setae and 5–6 aesthetes; segments 1 to 3 with the same aesthetes on each distal margin (Fig. 3, B). Antenna composed of 9 segments, with setation 1–0–1–0–2–0–5–3–5 (Fig. 3, C). Palp of mandible incompletely three-segmented, and last segment with 12 short plumose setae (Fig. 3, D). Endopod of maxillule incompletely two-segmented, with four plumose setae; basal and coxal endites with some 16 plumose setae, respectively (Fig. 3, E). Endopod of maxilla with 4 short plumose setae; basal endite with 7 long and 1 plumose setae on its proximal lobe, and 9 long and 1 short plumose setae on its distal lobe; coxal endite with 5 long and 3 short plumose setae on its proximal lobe, and 7 long plumose setae on its distal lobe; scaphognathite with some 50 plumose setae (Fig. 3, F).

Endopod of first maxilliped unsegmented, bearing 4 short subterminal setae; exopod divided into 3 segments; first segment with 2 subterminal plumose setae and the third with 4 terminal setae; basal and coxal endites with numerous short plumose setae; epipod with 9 non-plumose setae on its distal half and 1 non-plumose hair and

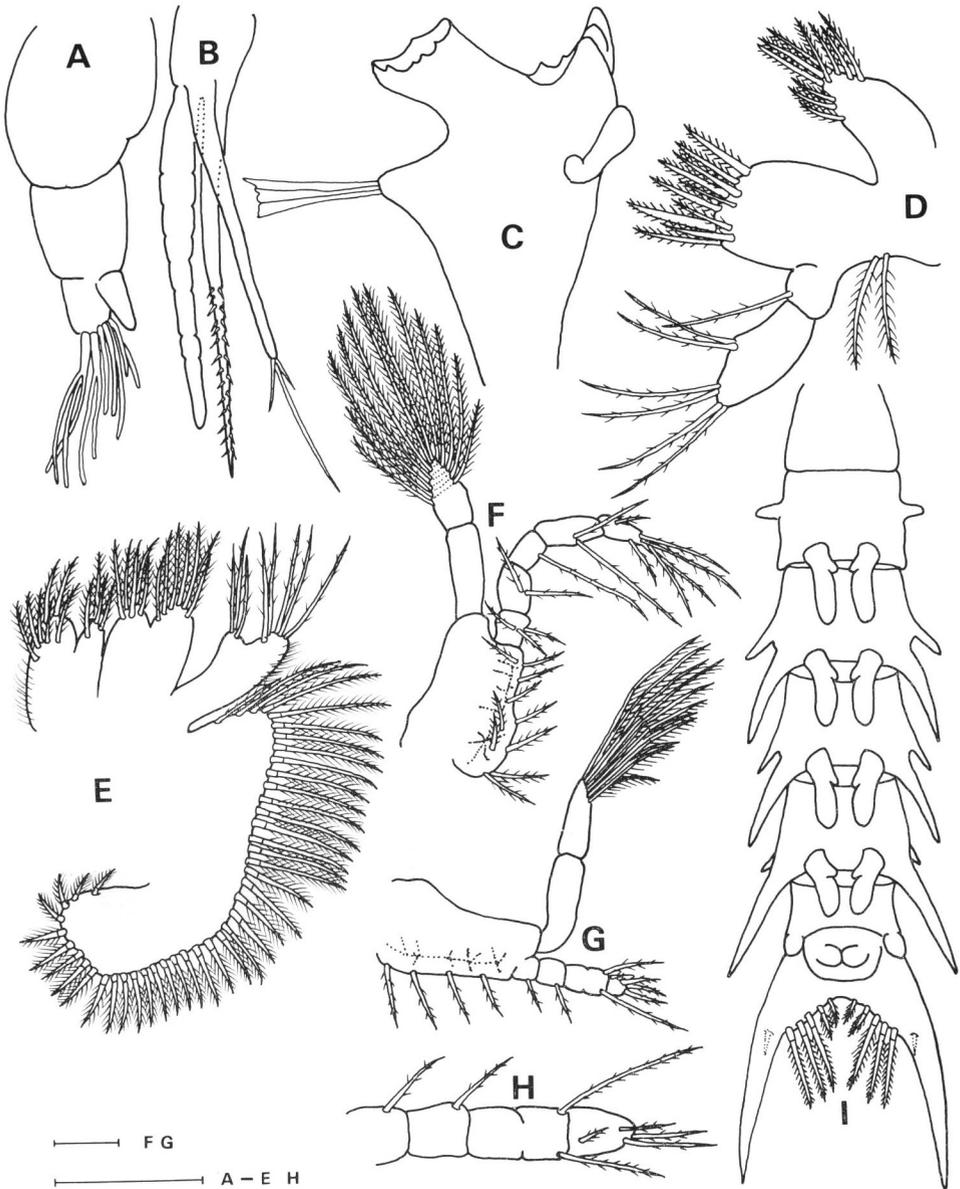


Fig. 2. Second zoea. — A, Antennule; B, antenna; C, mandible; D, maxillule; E, maxilla; F, 1st maxilliped; G, 2nd maxilliped; H, endopod of 2nd maxilliped; I, abdomen (ventral view). Scales represent 0.1 mm.

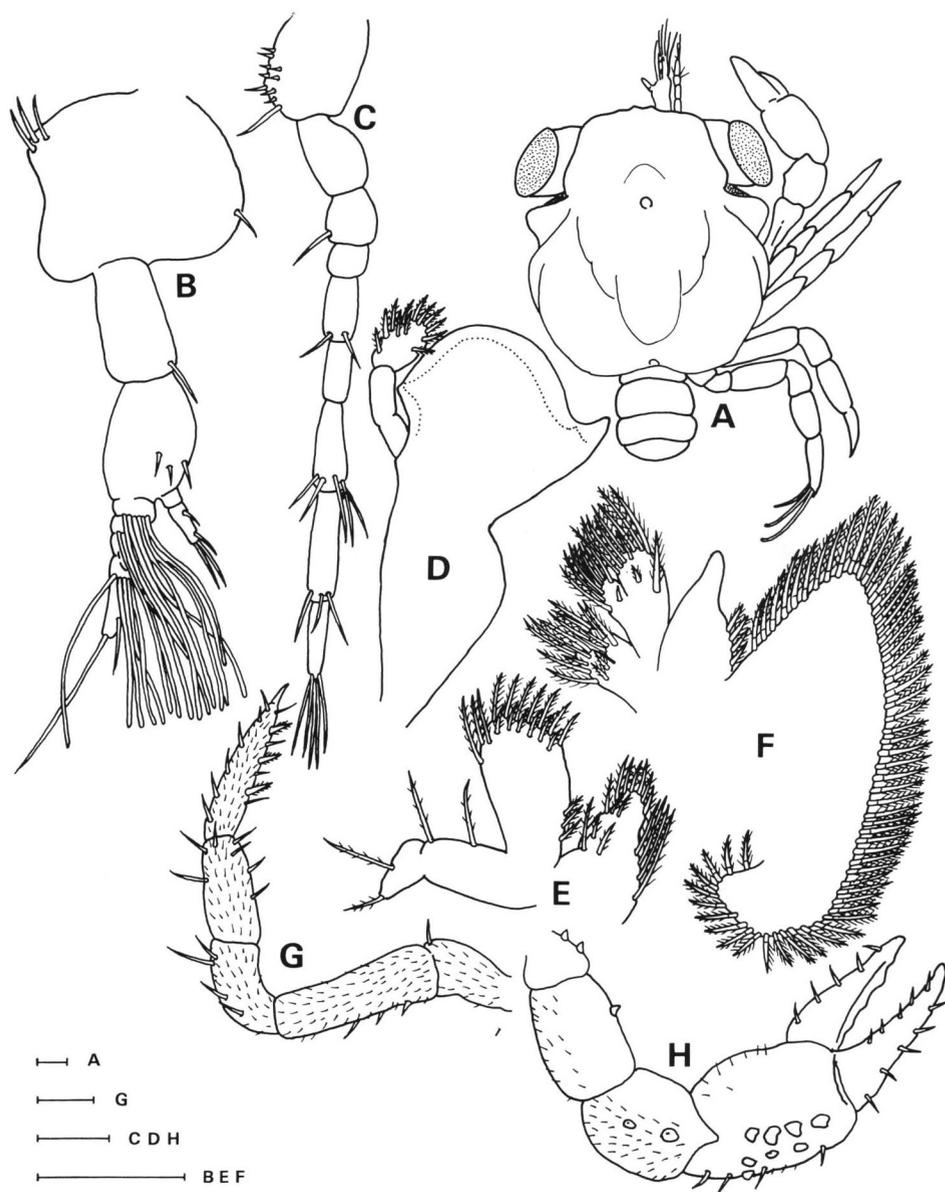


Fig. 3. *Megalopa*. — A, Dorsal view; B, antennule; C, antenna; D, mandible; E, maxillule; F, maxilla; G, 3rd ambulatory leg; H, cheliped. Scales represent 0.1 mm.

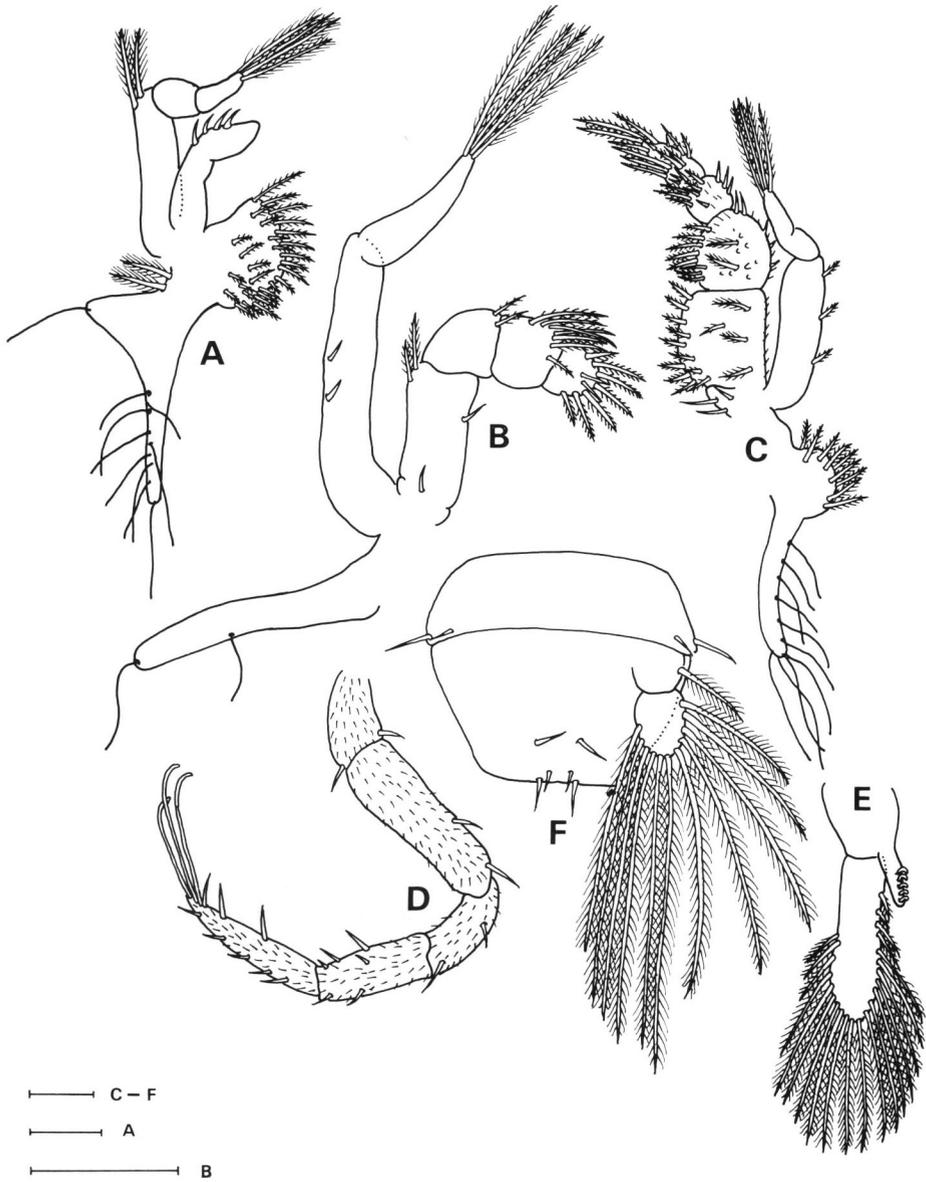


Fig. 4. Megalopa. — A, 1st maxilliped; B, 2nd maxilliped; C, 3rd maxilliped; D, 4th ambulatory leg; E, 1st pleopod; F, 5th pleopod and telson. Scales represent 0.1 mm.

2 plumose setae on its proximal half (Fig. 4, A). Endopod of second maxilliped four-segmented, bearing 2 non-plumose setae on first segment, 2 distal plumose setae on the second, 7 plumose setae on the third, and 5 long and 4 short plumose setae on the fourth; exopod composed of 2 segments, the distal of which terminates in 4 long plumose setae; epipod with 2 hairs (Fig. 4, B). Endopod of third maxilliped five-segmented, bearing some 10 plumose setae on fourth segment and 5 strong and 1 short plumose setae on the fifth; inner margin of the fifth serrated; exopod composed of 2 segments, the distal of which terminates in 5 long plumose setae; epipod with 10 non-plumose hairs on its distal half and 9 short plumose setae on its proximal half (Fig. 4, C). Both chelipeds equal in size, without hook on ischium (Fig. 3, H). Ambulatory legs 1 to 3 with 3 strong plumose setae on posterior margin of each dactylus; fourth ambulatory leg with 3 long feelers and 2 short strong plumose setae on dactylus (Figs. 3, G; 4, D).

Abdominal segments 2 to 6 with a pair of pleopods; exopod of each pleopod with 10–21 long plumose setae, each endopod carrying 4–5 small hooks (Fig. 4, E); fifth pleopod composed of 2 segments, the proximal of which bears 1 long plumose seta and the distal with 10–11. Telson trapezoid, bearing a pair of short non-plumose setae on its posterior margin and two pairs on its dorsal surface (Fig. 4, F).

Discussion

As generally summarized by LEBOUR (1928) and WEAR (1968), most of xanthid crabs are characterized by the presence of four zoeal stages, but six stages in *Menippe mercenaria* SAY, two stages in *Heterozius rotundifrons* A. MILNE EDWARDS and one stage in *Pilumnus lumpinus* BENNETT were known by PORTER (1960) and WEAR (1967, 1968). WEAR (1968) proposed that, in some crabs living in specialized and restricted habitats, their zoeal stages are shortened according to their habitat requirements, and their populations are maintained within given ecological niche by the restricted dispersal. The present study revealed the abbreviated development only with two zoeal and one megalopa stages in *Epixanthus dentatus* (WHITE) which lives in an estuary. Furthermore, most of the larvae died in pure sea water, while survived in 80% sea water. These results agree with WEAR's proposal, suggesting that the abbreviation of the zoeal stages seems to be related with the salinity of the sea water in which the adult lives.

The zoeae of *Epixanthus dentatus* are closely related to those of *Ozium truncatus* H. MILNE EDWARDS and *Heterozius rotundifrons* reported by WEAR (1968) and *Baptozium vinosus* (H. MILNE EDWARDS) reported by SABA *et al.* (1978), justifying the classification of their adults referred to the Menippinae. Main characteristics of the zoeae of the four species are summarized in Table 1. As a result, the following characteristics are common to them: a, presence of all carapacial spines; b, setation of endopods of maxillule and maxilla; c, setation of protopod of second maxilliped; d, abdominal segments 3 to 5 with lateral spines. They are, however, clearly distin-

Table 1. Main characteristics of four xanthid zoeae.

	<i>E. dentatus</i>	<i>B. vinosus</i>	<i>O. truncatus</i>	<i>H. rotundifrons</i>
Number of zoeal stages	2	4	4	2
Carapace spines	all spines present	all spines present	all spines present	all spines present
frontal tubercle	absent	absent	present	absent
dorsal tubercle	absent	present	present	absent
Antenna	B-5	B-5	B-6	C-1
Maxillule endopod	1-6	1-6	1-6	1-6
Maxilla endopod	3-5	3-5	3-5	3-5
1st mxp. endopod	3-2-1-2-6	3-2-1-2-5(6)	1-1-1-3-4	3-2-1-2-5
protopod	2-2-3-3	2-2-3-3	3-3-3-3	2-2-2-2
2nd mxp. endopod	1-1-6 (1-1-2-4)	1-1-6	1-2-4	1-2-2-5
protopod	1-1-1-1	1-1-1-1	1-1-1-1	1-1-1-1
Abdomen dorsal spine	absent	absent	present	absent
lateral tubercle	segs. 2-5	2nd seg.	segs. 2-3	2nd seg.
lateral spine	segs. 3-5	segs. 3-5	segs. 3-5	segs. 3-5
Telson	A-2 (A-1)	A-3 (A-2)	A-2 (A-1)	A-1

guished from one another by the differences of the following particulars: a, carapacial tubercles; b, antenna; c, setation of endopods of both maxillipeds; d, lateral tubercles on abdominal segments; e, telson.

HYMAN (1925) divided xanthid zoeae into two groups based on the features of the antenna, and LEBOUR (1928) added the third group represented by *Eriphia* and *Menippe*, which possesses an antennal exopod developed to about three-quarters the length of the process. *Epixanthus dentatus* has the same exopod as those of the *Eriphia* and *Menippe* species, and thus belongs to the third group defined by LEBOUR.

In the xanthid zoeae described up to now the endopod of the second maxilliped is three-segmented through their all zoeal stages, with the exception of the case reported by WEAR (1968) from the study of *Heterozius rotundifrons* whose endopod is four-segmented through its all zoeal stages. The first zoea of *Epixanthus dentatus* has the three-segmented endopod as usual, but the second zoea has the four-segmented one. This may be a distinctive feature in *E. dentatus*.

The xanthid zoeae have the lateral tubercles on the abdominal segments 2 to 3 (LEBOUR, 1928) and the tubercles on the third segment are often absent (WEAR, 1968). It is notable that the zoea of *Epixanthus dentatus* has the lateral tubercles on the segments 2 to 5. Such a distinctive feature is at present known in three species, viz., *Grapsizoea spinifera* and *G. sumatraensis* figured from the planktonic material and tentatively named by AIKAWA (1933) and *Goneplax rhomboides* (LINNAEUS) reported by LEBOUR (1928), which is now known as *G. angulata* (PENNANT). This remarkable feature has hitherto been unknown in the xanthid zoeae.

The telson of *Epixanthus dentatus* is a common form among the xanthid zoeae, and as LEBOUR (1928) mentioned, a lateral spine disappeared in the second zoea. A pair of dorsal spines on the telson-forks are not so strong as those of *Ozius truncatus* and *Baptozius vinosus*.

Table 2. Main characteristics of four xanthid megalopae.

	<i>E. dentatus</i>	<i>B. vinosus</i>	<i>O. truncatus</i>	<i>H. rotundifrons</i>
Carapace length	1.8 mm	2.5 mm	2.00 mm	1.12 mm
width	1.6 mm	2.0 mm	1.95 mm	1.12 mm
Antennule endopod	1 seg. 4 setae	1 seg. 5 setae	2 segs. 4 setae	1 seg. 2 setae
exopod	4 segs.	4 segs.	6 segs.	?
Antenna	9 segs.	9 segs.	9 segs.	5 segs.
	(1-0-1-0-2-0-5-3-5)	(4-3-2-0-2-0-4-4-4)	(0-4-4-0-4-0-4-4-4)	(0-0-0-0-1)
Mandible palp	3 segs.	3 segs.	3 segs.	3 segs.
Maxillule endopod	2 segs. 2-2	2 segs. 2-3	2 segs. 2-3	1 seg. no setae
Maxilla endopod	4 setae	7 setae	5-6 setae	no setae
1st mxp. endopod	4 setae	4 setae	4 setae	a few setae
exopod	2-4	2-4	3-4	no setae
2nd mxp. endopod	4 segs.	4 segs.	4 segs.	4 segs.
exopod	0-4	0-5	0-4	0-2,3
3rd mxp. endopod	5 segs.	5 segs.	5 segs.	5 segs.
exopod	3-5	3-7	0-8	0-4
Cheliped	no hook on ischium	no hook on ischium	no hook on ischium	?
1st to 3rd pereopods	3 strong setae on dactylus	3 strong setae on dactylus	3 strong setae on dactylus	no strong setae on dactylus
4th pereopod	3 feelers, 2 strong setae on dactylus	3 feelers, 2 strong setae on dactylus	3 feelers, 1 strong seta on dactylus	no feelers, no setae on dactylus
Pleopod endopod	5-4 small hooks	5 small hooks	?	?
exopod	16-21 setae	20-25 setae	20-22 setae	8 setae
5th pleopod exopod	1-10,11	1-13	0-12	no fifth pleopod
Telson	trapezoidal	semicircular	trapezoidal	triangular

The general megalopal characteristics of the Xanthidae suggested by LEBOUR (1928) are: a, rostrum pointed and bent, or rudimentary; b, cheliped with a hook on ischium; c, dactylus of fourth ambulatory leg with long feelers. The megalopa of *Epixanthus dentatus* conforms with LEBOUR's characters a and c, but it has no hook on the ischium. The same exception is pointed out by WEAR (1967) from the study of *Pilumnus novaezealandae* FILHOL and *P. lumpinus* BENNETT of the Pilumninae, and by SABA *et al.* (1978) of *Baptozius vinosus*.

The megalopal characteristics of the four species aforementioned are summarized in Table 2. As a result, *Heterozius rotundifrons* has many specific characters different from the others, and as WEAR (1968) suggested, it should be classified in another group. *Epixanthus dentatus* is similar to *Baptozius vinosus* and *Ozius truncatus* in the following characters: a, antenna; b, palp of mandible; c, endopod of maxillule; d, first to third maxillipeds; e, ambulatory legs; f, pleopods. *E. dentatus* is, however, readily distinguished from the others by the following characters: a, setation of antenna; b, setation of exopods of second and third maxillipeds; c, setation of fifth pleopod;

d, shape of telson.

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