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THE FIRST STAGE ZOEA OF *GAILLARDIELLUS ORIENTALIS* (ODHNER, 1925), WITH NOTES ON THE SUBFAMILY ACTAEINAE (CRUSTACEA: DECAPODA: BRACHYURA: XANTHIDAE)

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ABSTRACT. - The first zoeal stage of the actaeine crab, *Gaillardiellus orientalis* (Odhner, 1925) is described. The larva differs from known xanthid larvae in having the tips of the dorsal and lateral spines, and antennal protopod rounded and not pointed. It is also one of the few known xanthid larva which lacks spines on the outer margin of the fork of the telson. Comparisons with the zoeae of other Actaeinae are provided and the taxonomy of the subfamily is briefly discussed.

INTRODUCTION

The larvae (at least first stage zoeae) of about 20 species of crabs of the family Xanthidae MacLeay, 1838 (*sensu* Guinot, 1978) are now known (see Rice, 1980; Terada, 1990; Fukuda, 1979; Martin, 1984; Ng, 1993). Within the subfamily Actaeinae Alcock, 1898, however, larvae have been reported for only three taxa, *viz. Actaea semblatae* Guinot, 1976 (as *Actaea savignyi* (H. Milne Edwards, 1834) (*fide* Terada, 1983, 1987), *Novactaea pulchella* (A. Milne Edwards, 1865) (*fide* Terada, 1990), and *Gaillardiellus orientalis* (Odhner, 1925) (as *Paractaea rueppellii orientalis*, *fide* Fukuda, 1978). However, the report on *Gaillardiellus orientalis* by Fukuda (1978: 14) was only a very brief comment, lacking figures, and has no value for comparative studies.

Recently the first author obtained an ovigerous female of *Gaillardiellus orientalis* (Odhner, 1925) from Singapore from which the first zoeae was obtained. *Gaillardiellus orientalis* had not previously been reported from Singapore, although there is a good series of older and more recent Singapore specimens of this species in the Zoological Reference Collection, Department of Zoology, National University of Singapore (ZRC) (Yang, 1979). *Gaillardiellus orientalis* was previously regarded as a variety or subspecies of *G. rueppelli* (Krauss, 1843) until Guinot (1976) recognised it as a distinct species. Goh *et al.* (1990: 36) reported

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Gaillardiellus rueppelli from the bases of acroporid and agaraciid coral heads in Singapore and their specimens (in the ZRC) prove to be *G. orientalis* instead. The first male pleopods of the Singapore specimens agree well with that figured by Guinot (1976: Fig. 43B, b), although the granules on the carapaces of adult Singapore specimens appear to be less dense than that figured by Guinot (1976: Pl. 16 fig. 2). This is probably a consequence of size, as the type specimen from Hong Kong examined by Guinot (1976: 257) was rather small (carapace width 16.0 mm, carapace width 11.4 mm). Singapore specimens of *G. orientalis* reach at least twice the size of the type reported by Guinot (1976).

The larval characters of the first zoeae of *Gaillardiellus orientalis* support Guinot's (1976) establishment of the genus *Gaillardiellus*, made mainly on the basis of the sternal plastron, and casts more light on the taxonomy of this difficult group. The first zoea of *G. orientalis* is, however, rather unusual in many aspects, even within the Xanthidae. The present note serves to describe the first zoea of *Gaillardiellus orientalis* and offers some comments on the taxonomy of the Actaeinae.

MATERIALS AND METHODS

The ovigerous female was collected in October 1992, from a disturbed littoral coral reef on Sentosa, an island south of Singapore. The reef has since been reclaimed. The female was kept alone in an aerated aquarium until the first zoeae were released on 27 October 1992. No prezoeal stage was observed. The female has since been preserved in the ZRC. The undissected first zoeae are preserved in buffered formalin and kept in the ZRC and The Natural History Museum, London (reg. 1993.3408-3417).

Larval specimens were dissected and drawn in lactophenol using a WILD stereoscope and an OLYMPUS BH-2 with Nomarski interference contrast with attached *camera lucida*. At least seven replicates of each structure or appendage was observed to determine variation.

DESCRIPTION

Gaillardiellus orientalis (Odhner, 1925)

(Figs. 1-4)

Description of first zoea. - Size of carapace: *ca.* 0.3 mm.

Carapace (Fig. 1a): dorsal spine long, straight with rounded termination, spinulation absent; rostral spine shorter than dorsal spine, approximately equal in length to protopod of antenna, curves distally upward and terminates in a point, spinulation absent; lateral spines present, shorter than rostral spine and curving ventrally, with swollen rounded terminations, spinulation absent; 1 pair of posterodorsal setae; each ventral margin without setae; eyes sessile.

Antennule (Fig. 1b): endopod absent; exopod unsegmented with 2 broad, long, 1 short, slender terminal aesthetascs and 2 unequal terminal setae.

Antenna (Fig. 1c, d): protopod not spinulate, approximately equal in length to rostral spine with swollen rounded termination; endopod absent; exopod small, about 7% length of protopod, 1-segmented with 3 unequal setae, 2 shortest setae terminal, longest seta subterminal.

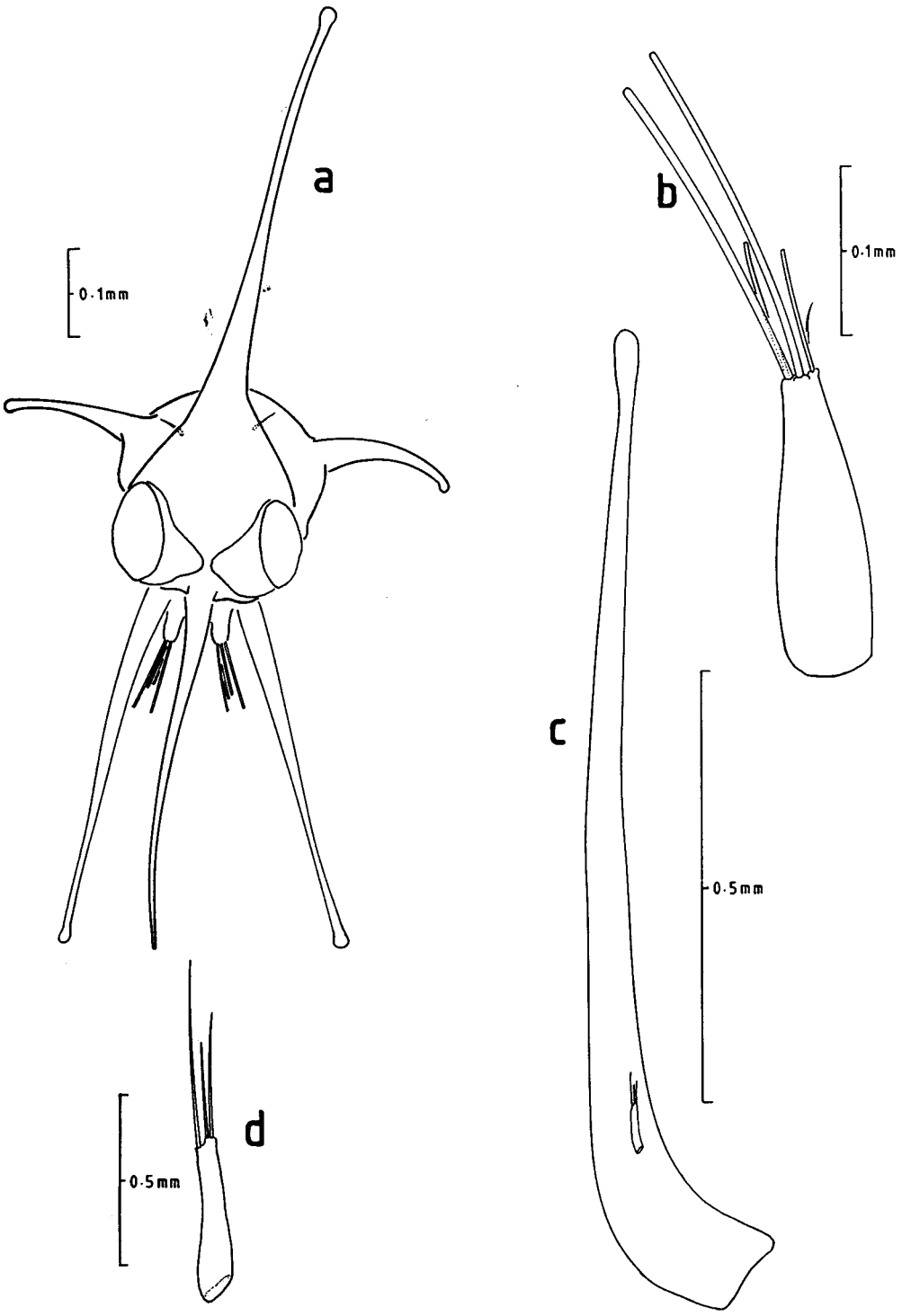

Fig. 1. *Gaillardiellus orientalis* (Odhner, 1925): a, anterior view of first stage zoea; b, antennule; c, antenna; d, exopod of antenna.

Mandible: endopod palp absent.

Maxillule (Fig. 2a): coxal endite with 7 setae; basial endite with 5 setae, inner margin with 2 teeth, single seta absent from outer margin; endopod 2-segmented, proximal segment with 1 seta; distal segment with 2 subterminal, 4 terminal setae.

Maxilla (Fig. 2b): coxal endite bilobed with 4+4 setae; basial endite bilobed with 5+4 setae; endopod bilobed, with 3+2 subterminal, 3 terminal setae; exopod (scaphognathite) margin with 4 setae and 1 distal stout process.

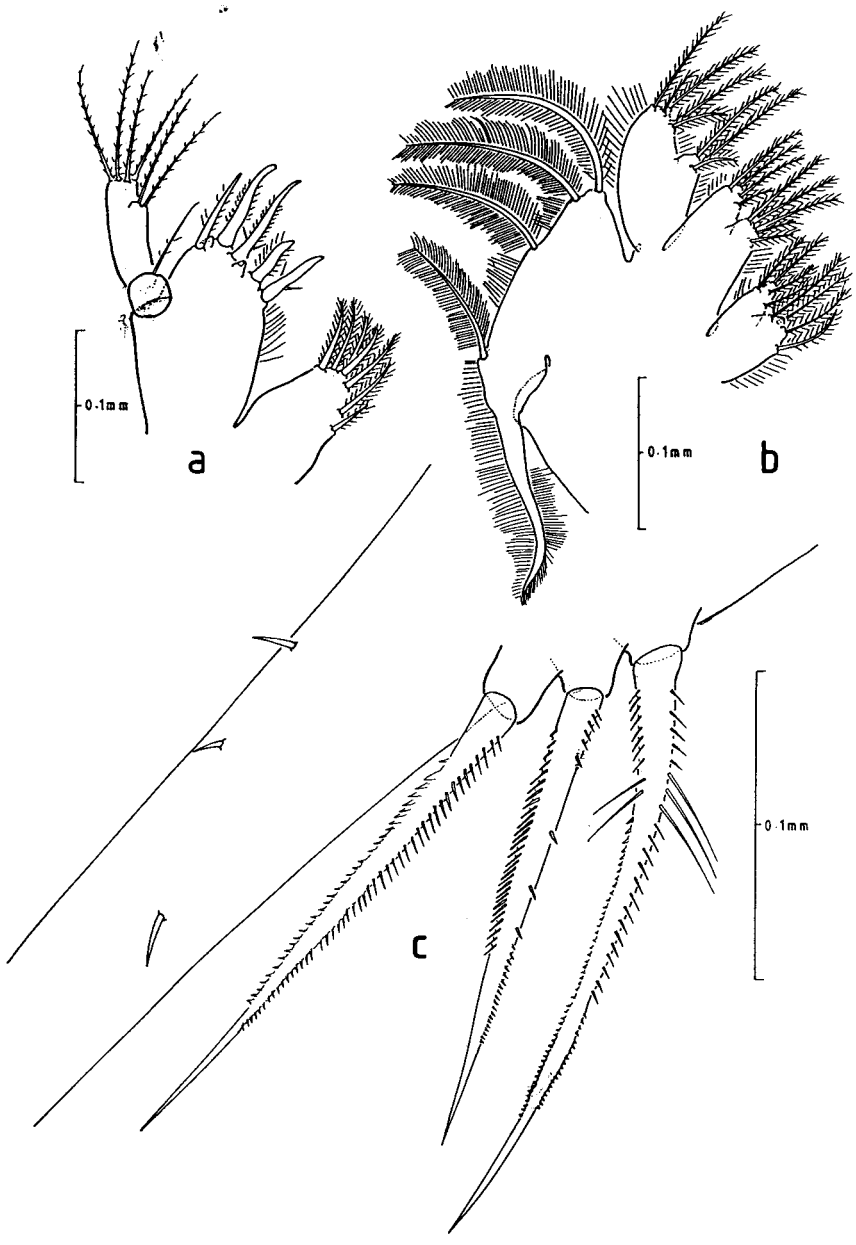

Fig. 2. *Gaillardiellus orientalis* (Odhner, 1925): a, maxillule; b, maxilla; c, telson.

First maxilliped (Fig. 3a): basis with 10 setae arranged 2,2,3,3; endopod 5-segmented with 3,2,1,2,4+1 setae respectively; exopod 2-segmented, distal segment with 4 terminal plumose natatory setae.

Second maxilliped (Fig. 3b): basis with 4 setae; endopod 3-segmented, with 1,1,4+2 respectively; exopod 2-segmented, distal segment with 4 terminal plumose natatory setae.

Third maxilliped: absent.

Pereiopods: absent.

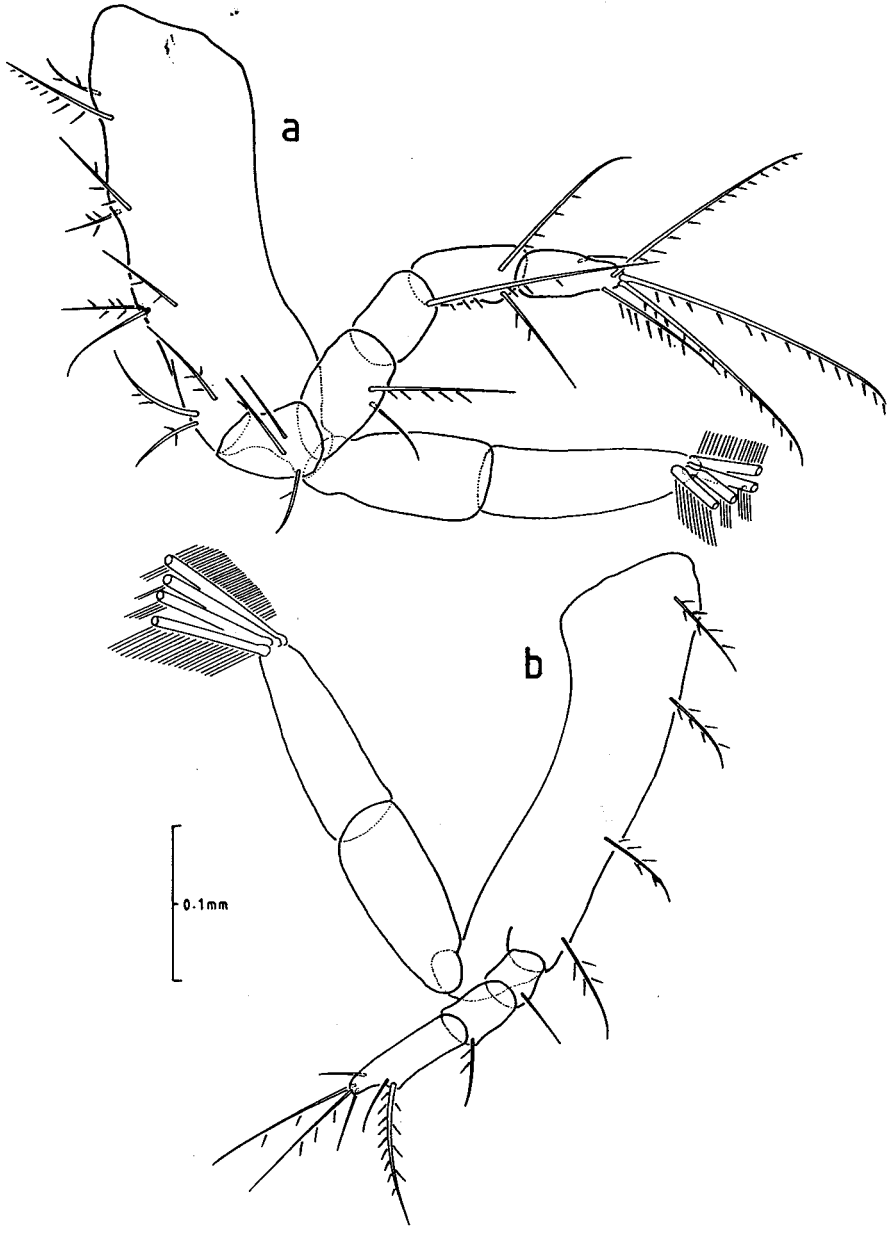

Fig. 3. *Gaillardiellus orientalis* (Odhner, 1925): a, first maxilliped; b, second maxilliped.

Abdomen (Fig. 4a, b): 5 somites; somite 2 with 1 pair of lateral processes directed anteriorly; somite 3 with 1 pair of lateral processess directed posteriorly; somites 3-5 with short posterolateral processes; somites 2-5 with 1 pair of posterodorsal setae; pleopod buds absent.

Telson (Fig. 2c): each fork long, gradually curved, not spinulated, tips curled terminally towards dorsal plain, 2 lateral setae, 1 dorsal medial seta present, posterior margin with 3 pairs of stout spinulate setae.

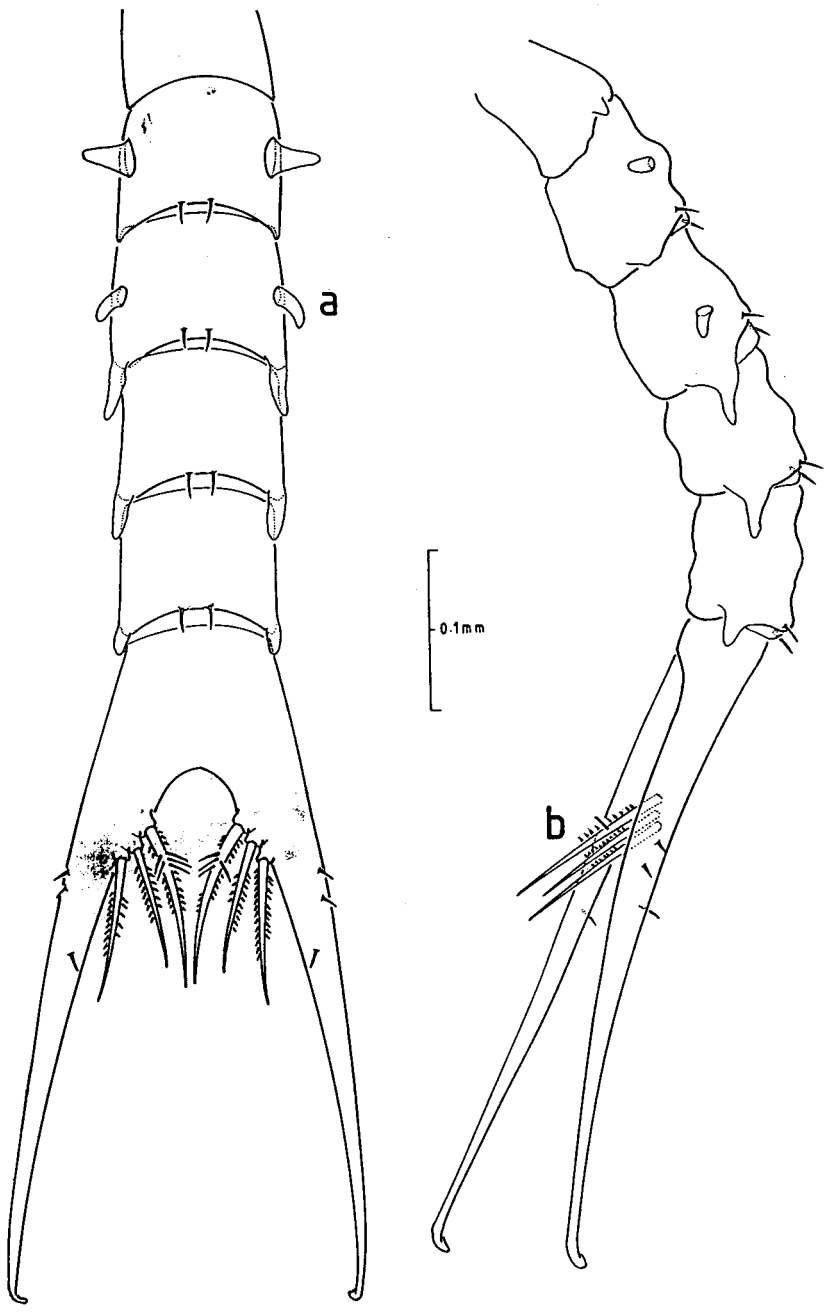

Fig. 4. *Gaillardiellus orientalis* (Odhner, 1925): a, dorsal view of abdomen; b, lateral view of abdomen.

DISCUSSION

Eight subfamilies are currently recognised in the family Xanthidae MacLeay, 1838, *sensu* Serène, 1984 (see Serène, 1984; Ng, 1993; Ng & Chia, 1994). Of these, the taxonomy of the subfamily Actaeinae, which contains 14 Indo-Pacific genera and some 40 species (Guinot, 1976; Serène, 1984), is especially difficult. The taxonomy of the Actaeinae was substantially clarified by Guinot (1976) who first used the anterior sternal plastron to help define the various genera. Guinot (1976) also transferred *Banareia* A. Milne Edwards, 1869, and *Calvactaea* Ward, 1933, two genera previously placed in the Actaeinae, to the subfamily Trichiinae de Haan, 1849.

Terada (1983) briefly reported on zoeae from an actaeine which he identified as *Actaea savignyi* (H. Milne Edwards, 1834). Detailed descriptions and figures of the zoeae of *A. savignyi* were only provided several years later (Terada, 1987). Terada (1990) subsequently corrected the identity of his actaeine to *A. semblatae* Guinot, 1976, following the revision by Guinot (1976). Later, Terada (1990) reported the larval development of *Novactaea pulchella* (A. Milne Edwards, 1865). The larvae of *Banareia odhneri* Sakai, 1974, and *Calvactaea tumida* Ward, 1933 (*fide* Terada, 1987, 1990) have also been described.

The first zoea of *Gaillardiellus orientalis* reported in this paper is only the third known for any actaeine and the first for the genus. It is rather unusual in several aspects compared with descriptions of most known xanthid larvae. In particular, the tips of the dorsal and lateral spines are rounded (against pointed), the tips of the spinous processes of the antennae are swollen and rounded (against tapering and pointed), the margins are smooth and not spinulated (against armed with numerous setae and/or spines), the outer margin of the fork of the telson is armed with short setae, without any spines, and the tips of the fork of the telson are curled upwards (against straight). The tip of the fork of the telson are rather difficult (often impossible) to decipher from the descriptions and figures of many published descriptions of xanthid larvae, but in the case of *G. orientalis*, it is so distinct that they cannot be overlooked or ignored.

It is interesting to note that the unusual structures of the tip of the antennal protopod and upturned furca of the telson of *G. orientalis* are characters also shared with the panopeid *Panopeus bermudensis* Benedict & Rathbun, 1891, from the Gulf of Mexico (Martin *et al.*, 1984). The first larva of *P. bermudensis* has an antennal protopod which terminates "... in [a] slightly dilated distal tip" and the tip of the furca of the telson is "... recurved dorsally" (Martin *et al.*, 1984: 86). The Panopeidae however, are not closely related to the Xanthidae (see Guinot, 1978, 1979), and the similarities between the larvae of *P. bermudensis* and actaeines should be regarded as due to convergence.

The larva of *Actaea semblatae* (Terada, 1987:110-111, as *A. savignyi*) has the same kind of unspinulated furcae of the telson and round-tipped spinous processes as in *G. orientalis*, but otherwise has normal lateral spines. Terada (1987:111, Fig. 11AI, AII, as *A. savignyi*) depicts a slightly rounded tip of the dorsal spine, but the condition is less obvious than in *G. orientalis* (Fig. 1a). The antenna of *A. semblatae* possesses an endopod, absent in *G. orientalis*, but this is probably associated with the semi-abbreviated development of *A. semblatae* which has only two zoeal stages. The antennal endopod tends to appear in the first zoeal stage of xanthids which have two or three instead of the usual four zoeal stages (Rice, 1980; Terada, 1990). More importantly, Terada (1987:111, Fig. CI, CII, as *A. savignyi*) figures an antennal exopod which has no setae in the first zoeal stage and only one seta in the second zoeal stage, in sharp contrast to the three setae present on the antennal exopod of the first

zoeal stage of *G. orientalis*. The inner margin of the basial endite of the maxillule has two teeth in *G. orientalis* but only one in *A. semblatae*, but this structure is very small and could have easily been missed by Terada (1987). The coxal endite of the maxillule in *A. semblatae* also has one more setae (eight) compared with *G. orientalis*. All other setal counts for the other structures and segments are the same for both species (Table 1).

Compared with *Novactaea pulchella* however (*fide* Terada, 1990: 29, 35), the differences with *G. orientalis* are more substantial (Table 1). The tips of the lateral and dorsal spine, and protopod of the antenna are sharp in *N. pulchella* (rounded in *G. orientalis*), the outer margin of the fork of the telson carry a distinct spine (a seta in *G. orientalis*), the antennule has only four aesthetascs and setae (five in *G. orientalis*), the antennal exopod is proportionately longer (24% of protopod in *N. pulchella* against 7% in *G. orientalis*), the coxal endite of the maxillule has eight setae (seven in *G. orientalis*), and the basial endite of the maxilla has 4+4 setae (5+4 in *G. orientalis*). The antenna of *N. pulchella* also posssesses a small endopod, but as mentioned earlier for *A. savignyi*, this is probably associated with the 2-zoeal staged development of the species.

A common feature of all three actaeine zoeae seems to be the unspinulated antennal protopod, but how reliable this character is remains to be seen once more actaeine larvae are known. The possession of a rounded and/or swollen tip of the dorsal/lateral spine and/or antennal protopod also seems to be an actaeine character but is not always present. It is very obvious in *G. orientalis*, less so in *A. savignyi*, but absent in *N. pulchella*.

The larvae of *Banareia odhneri* and *Calvactaea tumida* (*fide* Terada, 1987, 1990) appear to differ from those of *Actaea*, *Novactaea* and *Gaillardiellus* much more substantially in having fewer aesthetascs and setae on the antennule (three against four to five), a spinulated antennal protopod (against completely unspinulated), and fewer setae on the endopod of the second maxilliped (seven against eight) (*fide* Terada, 1987, 1990). Especially significant is the different setal pattern on the endopod of the second maxilliped of *Banareia* and *Calvactaea*, both of which are 1,1,5 against the 1,1,6 of actaeines. These differences appear to support Guinot's (1976) removal of these genera from the Actaeinae. Their current classification in the Trichiinae de Haan, 1849, however, still seems less than satisfactory (Ng & Chia, in press). The two genera differ from *Trichia s. str.* in several key features, especially in their mouthparts, and their classification in the Trichiinae will probably have to re-evaluated. The larvae of *Trichia*, when they become available, may throw some light on this matter.

In conclusion, the larval characters as discussed in this paper appear to support the separation of *Actaea s. str.*, *Novactaea* Guinot, 1976, and *Gaillardiellus* Guinot, 1976, by Guinot (1976).

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Table 1. Differences between first zoeae of *Gaillardiellus orientalis*, *Actaea semblatae* and *Novactaea pulchella*

	G. orientalis (present study)	*A. semblatae* (Terada, 1987)	*N. pulchella* (Terada, 1990)
Carapace			
dorsal spine tip	distinctly rounded	slightly rounded	sharp
rostral spine tip	sharp	sharp	sharp
lateral spine tip	rounded, swollen	sharp	sharp
Antennule	5 setae+aesthetascs	5 setae+aesthetascs	4 setae+aesthetascs
Antenna			
protopod	not spinulate, about as long as rostral spine, tip rounded, swollen; exopod small, about 7% length of spinous process, with 3 setae	not spinulate, about as long as rostral spine, tip rounded, swollen; exopod small, about 11% length of spinous process, with no setae	not spinulate, about as long as rostral spine, tip sharp; exopod well developed, about 24% length of spinous process, with 3 setae
Maxillule			
coxal endite	7 setae	8 setae	8 setae
basial endite	5 setae, 2 teeth	5 setae, 1 tooth	5 setae, 2 teeth
endopod			
proximal segment	1 seta	1 seta	1 seta
distal segment	2 subterminal, 4 terminal setae	2 subterminal, 4 terminal seta	2 subterminal, 4 terminal setae
Maxilla			
coxal endite	4+4 setae	4+4 setae	4+4 setae
basial endite	5+4 setae	5+4 setae	4+4 setae
endopod	3+2 subterminal, 3 terminal setae	3+2 subterminal, 3 terminal setae	3+2 subterminal, 3 terminal setae
First maxilliped			
basis	2,2,3,3 setae	2,2,3,3 setae	2,2,3,3 setae
endopod	3,2,1,2,4+1 setae	3,2,1,2,4+1 setae	3,2,1,2,4+1 setae
Second maxilliped			
basis	1,1,1,1 setae	1,1,1,1 setae	1,1,1,1 setae
endopod	1,1,4+2 setae	1,1,3+3 seta	1,1,3+3 setae
Telson			
fork	not spinulated, tips curled terminally towards dorsal plain; 2 lateral, 1 dorsal medial setae	not spinulated, not curled terminally; 2 lateral, 1 dorsal medial setae	not spinulated, not curled terminally; 1 lateral spine, 1 lateral seta, 1 dorsal medial spine

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