PROC. BIOL. SOC. WASH.
101(4), 1988, pp. 853–860

REDESCRIPTIONS OF *TETRALIA CAVIMANA* HELLER, 1861 AND *TRAPEZIA CYMODOCE* (HERBST, 1799) FIRST STAGE ZOEAS WITH IMPLICATIONS FOR CLASSIFICATION WITHIN THE SUPERFAMILY XANTHOIDEA (CRUSTACEA: BRACHYURA)

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Abstract.—The first stage zoea of *Tetralia glaberrima* (Herbst, 1790) (now *T. cavimana* Heller, 1861) and *Trapezia cymodoce* (Herbst, 1799) of Gurney (1938) are redescribed and compared both with the original description and with the description of *Tetralia glaberrima* by Al-Kholy (1963). Differences between the two larvae are tabulated and larval characters that appear to support the separation of the families Platyxanthidae and Trapeziidae, as proposed in a classification of adult xanthoids by Guinot (1977 and 1978), are identified.

Guinot (1978) proposed a new classification of adult Brachyura based primarily on the position of female and male genital openings. Eight families were recognized within the superfamily Xanthoidea, and she supported Ortmann (1897) in giving the rank of family to the Trapeziinae as defined by Miers (1886). But for a few minor changes, Guinot indicated that the family contained all the genera listed by Balss (1957) in his subfamily Trapeziinae. Guinot did not use any larval characters to corroborate her classification.

Rice (1980) and Martin (1984) related larval groupings, based on chaetotaxy, to various classifications of adult xanthoids. Both found that many existing descriptions of xanthoid larvae were inadequate or unreliable, and each attempted to use larval evidence to resolve incongruences between different schemes of adult classification. Rice found that his larval groupings did not correspond to the simple divisions of the Xanthidae by Balss (1957), while Martin (1984) endorsed the scheme proposed by Glaessner (1969) because it was based on fossil and recent forms. But later, Martin et al. (1985) stated that evidence appeared partly to support Balss, as their group I corresponded to the subfamily Xanthinae. Rice (1980) and Martin et al. (1985) agreed that the genus *Homalaspis* warranted separation from the remainder of the Xanthinae of Balss and thereby corroborated the Platyxanthidae of Guinot. Rice therefore tended to support the more complex divisions suggested by Guinot.

The larval descriptions of *Tetralia glaberrima* (Herbst, 1790) (now *T. cavimana* Heller, 1861; see synonomy of Galil, 1988) and *Trapezia cymodoce* (Herbst, 1799) by Gurney (1938) and of *Tetralia glaberrima* by Al-Kholy (1963) are incomplete. Therefore, the aim of this paper is to redescribe these larvae and use this information to reexamine the classification of the xanthoids.

Materials and Methods

Material collected and hatched at the Biological Station, Ghardaqa, Egypt, by Gurney (1938) was fixed originally in formalin and recently transferred to 70% ethanol. The female and the first zoea of *Trapezia cy-*

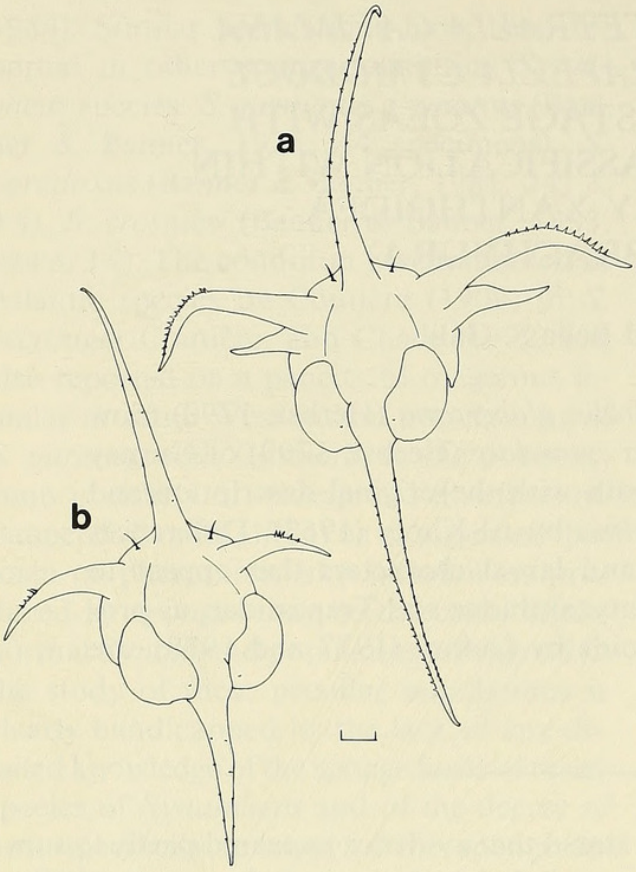

Fig. 1. Carapace of a, *Tetralia cavimana*; b, *Trapezia cymodoce*. Scale bar = 0.1 mm.

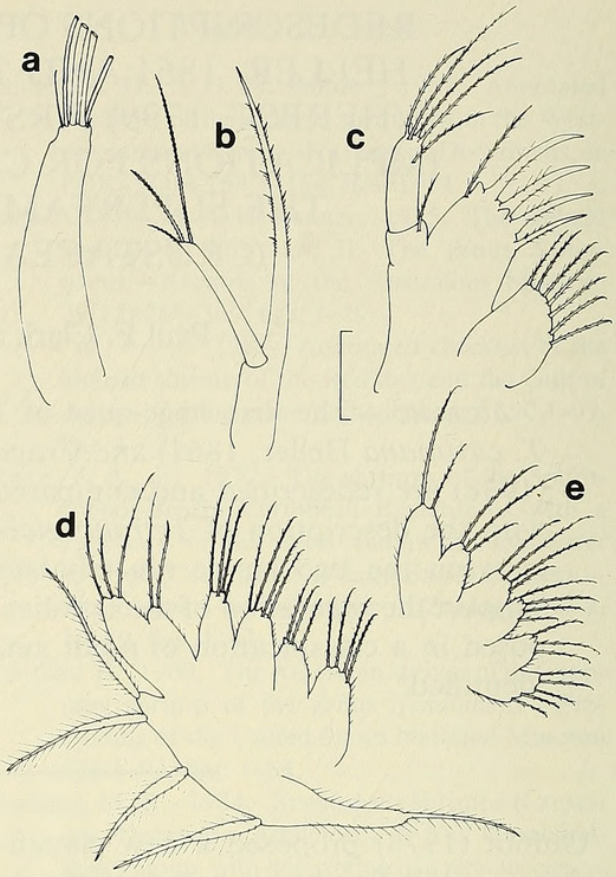

Fig. 2. *Tetralia cavimana*: a, Antennule; b, Antenna; c, Maxillule; d, Maxilla. *Trapezia cymodoce*: e, Setation of maxilla coxal, basial and endopod lobes. Scale bar = 0.1 mm.

modoce (Herbst) are stored in the British Museum (Natural History), registration number 1986:915, and those of *Tetralia cavimana* Heller, were registered as 1986: 53. Dissected appendages were mounted in polyvinyl lactophenol and examined using an Olympus BH-2 microscope with Nomarski interference contrast. Drawings were made with the aid of a camera lucida. When comparing the first stage zoea of the two species, the setal arrangement on many appendages was similar and it was only necessary to figure fully the chaetotaxy of one species, *Tetralia cavimana,* and illustrate the differences in *Trapezia cymodoce.*

Tetralia cavimana Heller, 1861
Figs. 1a, 2a–d, 3a, b, 4c, d

Tetralia glaberrima (Herbst, 1790).—Gurney, 1938:77, pl. III, figs. 29–33.—Al-Kholy, 1963:138, pl. I, figs. 1–7.—Williamson, 1970:37.

non *Tetralia glaberrima* (Herbst, 1790).—Al-Kholy 1963:139–140, pl. I, figs. 8–21, pl. II, figs. 22–33.

First zoea.—Carapace (Fig. 1a): Long dorsal and rostral spines spinulate; 2 pairs of lateral spines, dorsal pair j-shaped and spinulate on dorsal margin, ventral pair smaller than dorsal pair, unarmed; one pair of posterodorsal setae; ventral margin of carapace with minute denticles, marginal setae absent; one pair of posterodorsal carapace setae; eyes sessile with small setule on each eye.

Antennule (Fig. 2a): Endopod absent; exopod unsegmented with 4 terminal esthetascs, 1 terminal seta and 1 minute terminal spine.

Antenna (Fig. 2b): Spinous process distally spinulate; endopod absent; exopod with unequal terminal setae.

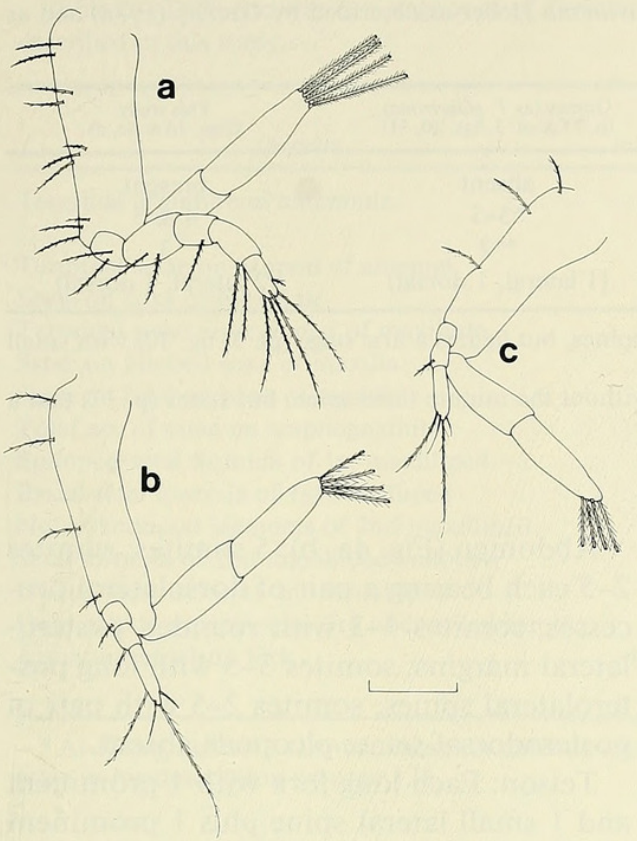

Fig. 3. *Tetralia cavimana*: a, First maxilliped; b, Second maxilliped. *Trapezia cymodoce*: c, Second maxilliped. Scale bar = 0.1 mm.

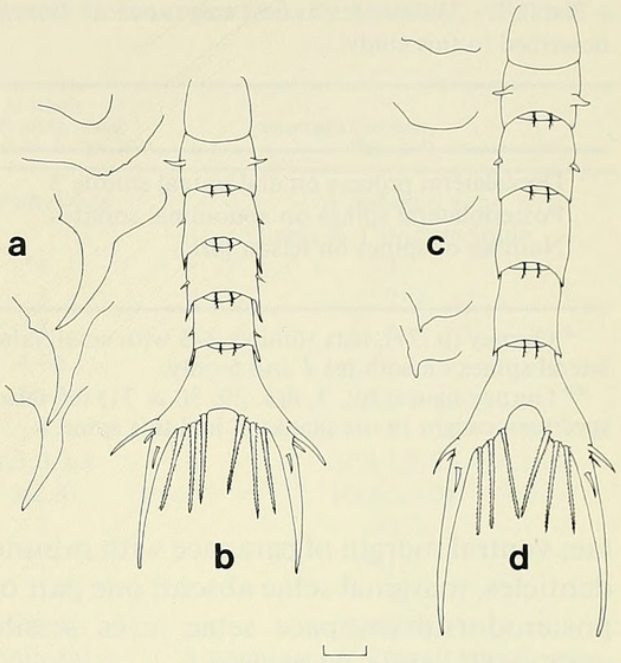

Fig. 4. *Trapezia cymodoce*: a, Dorsolateral spines of somites 1–5; b, Abdomen from dorsal aspect. *Tetralia cavimana*: c, Dorsolateral spines of somites 1–5; d, Abdomen from dorsal aspect. Scale bar = 0.1 mm.

Mandible: Endopod (palp) absent.

Maxillule (Fig. 2c): Coxal endite with 7 setae; basial endite with 5 processes on inner margin plus 2 minute teeth, single seta absent from outer margin; endopod 2-segmented, proximal segment with 1 seta, distal segment with 1 subterminal and 4 terminal setae.

Maxilla (Fig. 2d): Coxal endite bilobed with 4+3(+1 minute tooth) setae; basial endite bilobed with 4(+1 minute tooth)+4 setae; endopod bilobed with 2+3 setae; scaphognathite (exopod) with 4 marginal setae plus 1 long stout posterior seta.

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

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

Third maxilliped: Undeveloped.

Pereiopods: Undeveloped.

Abdomen (Fig. 4c, d): 5 somites; somites 2 and 3 each bearing 1 pair of dorsolateral processes; somites 1–3 with rounded posterolateral margins; somites 4 and 5 with small posterolateral spines; somites 2–5 with pair of posterodorsal setae; pleopods absent.

Telson (Fig. 4d): Each long fork with 1 prominent and 1 small lateral spine plus 1 prominent dorsal spine; posterior margin with 3 pairs of setae.

Trapezia cymodoce (Herbst, 1799)
Figs. 1b, 2e, 3c, 4a, b

Trapezia cymodoce (Herbst, 1799).—Gurney, 1938:76, pl. II, figs. 23–28.

First zoea.—Carapace (Fig. 1b): long dorsal and shorter rostral spine lightly spinulate; single pair of curved, lightly spinulate lateral spines; one pair of posterodorsal se-

Table 1.—Differences in first stage zoea of *Tetralia cavimana* Heller as described by Gurney (1938) and as described in this study.

Character	Gurney (as *T. glaberrima*) (p. 77 & pl. 3, figs. 30, 31)	This study (Figs. 3d & 4c, d)
Dorsolateral process on abdominal somite 3	absent	present
Posteriolateral spines on abdominal somites	*3–5	4 & 5
Number of spines on telson fork	**2 (1 lateral, 1 dorsal)	3 (2 lateral, 1 dorsal)

* Gurney (p. 77), lists somites 3–5 with small lateral spines, but figures a first stage (pl. 3, fig. 30) with small lateral spines on somites 4 and 5 only.

** Gurney figures (pl. 3, figs. 29, 30 & 31) the telson without the minute third spine, but states (p. 77) that a specimen caught in the plankton had this spine.

tae; ventral margin of carapace with minute denticles, marginal setae absent; one pair of posterodorsal carapace setae; eyes sessile with small setule on each eye.

Antennule: Endopod absent; exopod unsegmented with 4 terminal esthetascs, 1 terminal seta and 1 minute terminal spine.

Antenna: Spinous process distally spinulate; endopod absent; exopod with unequal terminal setae.

Mandible: Endopod (palp) absent.

Maxillule: Coxal endite with 7 setae; basial endite with 5 processes on inner margin plus 2 minute teeth, single seta absent from outer margin; endopod 2-segmented, proximal segment with 1 seta, distal segment with 1 subterminal and 4 terminal setae.

Maxilla (Fig. 2e): Coxal endite bilobed with 5+3(+1 minute tooth) setae; basial endite bilobed with 4(+1 minute tooth)+4 setae; endopod bilobed with 3+2 setae; scaphognathite (exopod) with 4 marginal setae plus 1 long stout posterior seta.

First maxilliped: Basis with 10 setae arranged 2,2,3,3; endopod 5-segmented with 2,2,1,2,5 setae respectively; exopod 2-segmented, distal segment with 4 terminal natatory setae.

Second maxilliped (Fig. 3c): Basis with 3 setae; endopod 3-segmented with 0,1,4 setae respectively; exopod 2-segmented, distal segment with 4 terminal natatory setae.

Third maxilliped: Undeveloped.

Pereiopods: Undeveloped.

Abdomen (Fig. 4a, b): 5 somites; somites 2–5 each bearing a pair of dorsolateral processes; somites 1–3 with rounded posterolateral margins; somites 3–5 with long posterolateral spines; somites 2–5 with pair of posterodorsal setae; pleopods absent.

Telson: Each long fork with 1 prominent and 1 small lateral spine plus 1 prominent dorsal spine; posterior margin with 3 pairs of setae.

Discussion

The differences between the descriptions by Gurney (1938) and Al-Kholy (1963) of *Tetralia cavimana* Heller (as *T. glaberrima* Herbst) and the present study are listed in Tables 1 and 2. In his description of *Trapezia cymodoce* Gurney (1938) figured only abdominal somites 2 and 3 with dorsolateral processes, but on re-examination of this material they were found additionally on somites 4 and 5 (Fig. 4b). Although the first stage zoeas of *Trapezia guttata* Rüppell, 1830 and *Trapezia maculata* (MacLeay, 1838) have been described by Gurney (1938) and Al-Kholy (1963) respectively, these descriptions are inadequate for comparison. Differences in appendage chaetotaxy between *Trapezia cymodoce* (Herbst) and *Tetralia cavimana* Heller first stage zoeas are listed in Table 3.

Rice (1980), from larval descriptions, divided the Xanthidae into 4 groups. He com-

Table 2.—Differences in first stage zoea of *Tetralia cavimana* Heller as described by Al-Kholy (1963) and as described in this study.

Character	Al-Kholy (as *T. glaberrima*) (p. 138 & pl. 1, figs. 2–7)	This study (figs. 2–4)
Terminal armature of antennule	2 esthetascs	4 esthetascs 1 seta & 1 minute spine
Terminal setae on exopod of antenna	*4	3
Setae on coxa of maxillule	5	7
Terminal setae on endopod of maxillule	3	4
Setae on bilobed coxa of maxilla	4+5	4+3
Setae on bilobed basis of maxilla	2+3	4+4
Total no. of setae on scaphognathite	4	5
Endopod setal formula of 1st maxilliped	1,3,0,0,3	2,2,1,2,5
Basial setal formula of 1st maxilliped	5(2,3)	10(2,2,3,3)
No. of endopod segments of 2nd maxilliped	2	3
Setal formula of 2nd maxilliped endopod	2,3	1,1,4
No. of basial setae of 2nd maxilliped	1	4
Dorsolateral processes on 3rd abdominal somite	absent	present
Armature of telson fork	1 prominent lateral spine	1 prominent & 1 small lateral spine + 1 prominent dorsal spine

* Al-Kholy figures 3 terminal setae on antenna exopod (pl. 1, fig. 2), but scores an exopod with 4 terminal setae in his description on page 138.

pared these groupings with several adult classifications, and concluded that they gave some support to the divisions proposed by Guinot (1978). Martin (1984) recognized six groups (I–VI) within the Xanthidae, based on zoeal characters, but gave his groupings no formal taxonomic status. He adopted the classification of xanthoids proposed by Glaessner (1969), because his larval groups did not correspond to the eight families of Guinot.

Rice (1980) and Martin (1984) agree on the suite of characters that defines their xanthoid group III. The genera that they assigned to their respective groups III differs. *Eriphia, Homalaspis, Ozius* and *Tetralia* form the group III of Rice. The group III of Martin contains *Baptozius, Carpilius, Epixanthus, Paramedaeus, Pilumnoides, Platyxanthus* and *Trapezia* in addition to those of Rice. Both include ASM 26 in group III. However, the present redescription of *Trapezia cymodoce* (Herbst) and *Tetralia cavimana* Heller first stage zoeas indicates that the group III of both workers can be divided into two subgroups A and B, the characters of which are defined in Table 4.

Group A includes the first stages zoeas of *Tetralia cavimana* Heller and *Trapezia cymodoce* (Herbst) and corresponds to the Trapeziidae of Guinot (1978). Group B comprises her Platyxanthidae and contains the zoeas of *Homalaspis plana* (A. Milne Edwards) (Fagetti 1970), *Platyxanthus*

Table 3.—Differences in chaetotaxy of appendages between first zoea stages of *Trapezia cymodoce* (Herbst) and *Tetralia cavimana* Heller.

Character	*Trapezia cymodoce*	*Tetralia cavimana*
No. of lateral carapace spines	1	2
Setation of maxilla endopod	3+2	2+3
Setation of maxilla coxa	5+3	3+4
Setal formula of endopod of 2nd maxilliped	0,1,4	1,1,4
Basial setae of 2nd maxilliped	3	4
Abdominal somites with dorsolateral processes	2–5	2 & 3
Abdominal somites with dorsolateral spines	3–5 (long)	4 & 5 (short)

Table 4.—Proposed characters that subdivide the xanthid group III of Martin (1984) and Rice (1980).

Character	Group A	Group B
Setation of distal endopod segment of maxillule	1 subterminal + 4 terminal	2 subterminal + 4 terminal
Setation of maxilla endopod	subterminal setae absent (2 or 3 terminal setae only)	subterminal setae present (2 subterminal + 3 terminal setae)
Setation of basal endopod segment of 1st maxilliped	2	*3
Setation of distal endopod segment of 2nd maxilliped	4	**6

* Lumare & Gozzo (1972) figure the zoeal stages of *Eriphia verrucosa* as variously having 2 or 3 setae on this segment. Examination of *E. verrucosa* 1st stage zoeas from Ischia, Italy (plankton caught material by Galil) revealed 3 setae in this position. Hashmi (1970) described and figured the 1st zoeal stage of *Eriphia laevimana smithii* (MacLeay) with 2 setae, but re-examination of his material, BM(NH) registration number 1986:908, also revealed 3 setae. Wear (1968) illustrated the 1st maxilliped of *Ozius truncatus* H. Milne Edwards stage I zoea with only 1 seta on the basal endopod segment. Other zoeas in this group have 3 setae.

** The following 1st stage zoea all have 6 setae present on the distal segment of second maxilliped endopod; *Baptozius vinosus* (H. Milne Edwards), *Eriphia laevimanus smithii* MacLeay, *Eriphia verrucosa* (Forskal), *Homalaspis plana* (A. Milne Edwards), *Monodeus couchii* (Couch) & *Platyxanthus patagonicus* A. Milne Edwards.

crenulatus (A. Milne Edwards) (Menu-Marque 1970) and *P. patagonicus* A. Milne Edwards (Iorio & Boschi 1986). Guinot (1978) also lists the genera *Homalaspis* and *Platyxanthus* in her Platyxanthidae. Other larvae that fit in group B include the menippids *Baptozius vinosus* (H. Milne Edwards) (Saba et al. 1978a), *Epixanthus dentatus* (White) (Saba et al. 1978b), *Eriphia laevimana smithii* MacLeay (Hashmi 1970), *E. spinifrons* (Herbst) (Bourdillon-Casanova 1960; Hyman 1925; Paolucci 1910), *E. verrucosa* (Forskål) (Lumare and Gozzo 1972), *Ozius rugulosus* Stimpson (Kakati and Nayak 1977), *O. truncatus* H. Milne Edwards (Wear 1968) and the pilumnid *Pilumnoides perlatus* (Poeppig) (Fagetti & Campodonico 1973). None of these are listed in Guinot's classification, but on the basis of larval characters these genera appear to have affinities with the Platyxanthidae. The xanthids *Monodaeus couchi* (Couch) (Ingle 1983) and *Paramedaeus noelensis* (Ward) (Suzuki 1979) are also grouped in the Platyxanthidae. In her classification of adult Xanthidae, Guinot (1978) placed *Monodaeus* and *Paramedaeus* in the sub-family Euxanthinae Alcock, 1898. Apart from this anomaly, the larval evidence presented here appears to correspond to the classification of adult Platyxanthidae and Trapeziidae as proposed by Guinot (1978).

The status of the third stage zoea of "ASM 26 (Menippinae or Trapeziinae)," as described by Rice and Williamson (1977:52–54, fig. 27) remains uncertain; it does not have a menippid type antenna, maxillule or maxilla endopod. Martin (1984) believed that "ASM 26" was more likely to be in the Trapeziinae, but from evidence presented here it does not appear to share the characters defining group A (see Table 4).

Carpilius was placed by Martin et al. (1985) in xanthid group III. Laughlin et al. (1983) described the zoeal stages of the coral crab *Carpilius corallinus* (Herbst) and noted a number of diagnostic characters: 5 zoeal stages, the separation of the 6th abdominal somite from the telson in stage II zoea, appearance of pleopod buds in stage II, the large size of the zoea, the increased numbers of natatory setae in the maxillipeds in later stages (i.e., zoea IV with 15–16 and zoea V with 20–22 natatory setae), and the large size of the mandibles. In combination, these larval characters are interpreted by Laugh-

lin et al. (1983) as evidence supporting the establishment of the family Carpiliidae by Guinot (1978).

Careful re-examination of other xanthoidean larval descriptions may further substantiate the classification proposed by Guinot (1978).

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