




The first larval stage (Zoea I) description of the caridean shrimp *Ogyrides occidentalis* (Ortmann, 1893) (Alpheoidea: Ogyrididae) reveals congruence with taxonomic status

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Abstract: A complete and detailed description of the first zoeal stage of *Ogyrides occidentalis* is provided. Larvae were obtained in the laboratory from a female with embryos collected in Ubatuba, State of São Paulo, Brazil. The morphological characters are compared with previous description of the close related *O. alphaerostris*. Despite of some similarities (number of appendages, pleonites, and setae on the majority of appendages) substantial differences were found between the two species, as the size of larvae and rostrum and segmentation of some structures (antenna exopod, first maxilliped coxa and basis). However, these differences must be interpreted carefully because larval description of *O. alphaerostris* was conducted before the proposed standardization for decapod larval morphology descriptions. The present larval description furnished additional information to corroborate the recent resurrection of *O. occidentalis* and will be useful for future comparative and ecological research.

Keywords: Caridea; Decapoda; larval morphology; post-hatching development.

Descrição do primeiro estágio larval (Zoea I) do camarão carídeo *Ogyrides occidentalis* (Ortmann, 1893) (Alpheoidea: Ogyrididae) revela congruência com o status taxonômico

Resumo: Foi realizada uma descrição completa e detalhada da primeira zoea de *Ogyrides occidentalis*. As larvas foram obtidas em laboratório a partir de uma fêmea com embriões coletada em Ubatuba, estado de São Paulo, Brasil. Os caracteres morfológicos são comparados com a descrição anterior da espécie proximamente relacionada *O. alphaerostris*. Apesar de algumas semelhanças (número de apêndices, somitos abdominais e cerdas na maioria dos apêndices) foram encontradas diferenças substanciais entre as duas espécies, como o tamanho das larvas e do rostro, e segmentação de algumas estruturas (exopodito da antena e entre coxa e base do primeiro maxilípede). No entanto, essas diferenças devem ser interpretadas com cuidado porque a descrição larval de *O. alphaerostris* foi realizada antes da padronização proposta para as descrições da morfologia larval de decápodes. A presente descrição larval forneceu informações adicionais para corroborar a recente ressurreição de *O. occidentalis* e será útil para futuros estudos ecológicos e comparativos.

Palavras-chave: Caridea; Decapoda; desenvolvimento pós-embrionário; morfologia larval.

Introduction

The genus *Ogyrides* Stebbing, 1914 is the only representative of the caridean family Ogyrididae. Considering the recently resurrection of *Ogyrides occidentalis* (Ortmann, 1893) (Terossi & Mantelatto 2020), this genus comprises 13 valid species distributed along tropical and subtropical coasts around the world (De Grave & Franssen 2011, Ayón-Parente & Salgado-Barragán 2013, De Grave et al. 2020, WoRMS 2020).

Three species of *Ogyrides* have been recorded from Brazilian waters: *O. hayi* Williams, 1981 in the State of Ceará by Pachellet et al. (2016); *O. alphaerostris* (Kingsley, 1880), an apparently ampho-American species and the occurrence in Brazil is uncertain (Williams 1981, Wicksten & Méndez 1988, Hendrickx 1993, Ayón-Parente & Salgado-Barragán 2013, Almeida et al. 2013, Terossi & Mantelatto 2020); and *O. occidentalis* trawled in waters up to 52 m deep, with occurrence in Pará, Ceará, Bahia, Espírito Santo, Rio de Janeiro, São Paulo, Paraná, Santa Catarina, Rio Grande do Sul (Christoffersen 1979, Almeida et al. 2013, Terossi & Mantelatto 2020). These three species, together with *O. tarazonai* Wicksten & Méndez, 1988 and *O. wickstenae* Ayón-Parente & Salgado-Barragán, 2013, both from the eastern tropical Pacific (Wicksten & Méndez 1988, Ayón-Parente & Salgado-Barragán 2013), account for five species with occurrence in American waters.

Larval descriptions of ogyridid shrimps are scanty. An incomplete description was accomplished for *O. delli* Yaldwyn, 1971 by Packer (1985), with only data on dorsal view of cephalothorax and the maxilla of the fourth zoea from New Zealand. The single detailed and complete description available is about *O. limicola* Williams, 1955 from Virginia, USA by Sandifer (1974). However, according to De Grave & Franssen (2011), *O. limicola* is currently considered a junior synonym of *O. alphaerostris*. Thus, the larval descriptions of *O. limicola* (Sandifer 1974) actually refers to *O. alphaerostris*, a species from the Western Atlantic (Terossi & Mantelatto 2020).

The obtention of some fresh zoea I hatched under laboratory conditions from a parental female of the recently resurrected *O. occidentalis* lead us to hypothesize that larval characters could differ from those of *O. alphaerostris* described as *O. limicola* by Sandifer (1974). In this context, the objective of the present study was to describe the morphology of the first larval stage (zoea I) of *O. occidentalis*, and to compare its morphology with the single detailed description of the same larval stage of a congener (*O. alphaerostris*). A detailed larval description is essential for future comparisons to help the understanding about the phylogenetic relationships of the representatives of the genus, as well as the family Ogyrididae.

Material and Methods

One female with embryos of *O. occidentalis* was collected at Ubatuba, State of São Paulo, Brazil (23°26'13"S, 45°04'4"W), in August 2013. The collections were made at a depth of approximately 5 m, using a shrimp-fishing boat equipped with an otter-trawl net (mesh size 20 mm and 18 mm in the cod end) for trawling. The female with embryos was transported alive to the Laboratory of Biology of Marine and Freshwater Shrimps (LABCAM) and maintained in a 2-liter container with seawater from the sampling site and some biogenic debris (leaves, sticks and shells) for shelter, until the larval hatchings. Newly hatched larvae were conserved in a mixture (1:1) of 70% ethyl alcohol and glycerin.

Tissue sample was taken from the parental female for molecular analysis of partial fragments of the ribosomal rRNA, 16S rRNA, gene to confirm the species identification (GenBank Accession number MT365660; see details of methodology in Terossi & Mantelatto 2020). The carapace length (CL, mm) of 10 larvae was measured as the maximum length from the posterior margin of the ocular orbit to the posterior margin of the carapace. Total length (TL) is given as the distance from the tip of the rostrum to the posterior margin of the telson, excluding setae. Appendages were dissected under a Zeiss™ Stemi 200C trinocular stereomicroscope, and drawings and measurements were made using a Leica™ DM750 microscope equipped with a camera lucida. Larval description and setal counts are based on the recommendations of Clark et al. (1998) and updated by Clark & Cuesta (2015); we followed the setal terminology proposed by Garm et al. (2004) and Landeira et al. (2009). Six larvae were dissected for detailed examination and description. The long terminal plumose natatory setae on exopods of maxillipeds were drawn truncated.

Voucher of the spent parental female and respective larvae were deposited at the Crustacean Collection of the Biology Department of FFCLRP, University of São Paulo, Brazil (CCDB/FFCLRP/USP, access number: CCDB 6131).

Results

The parental female has a CL of 5.3 mm. Due to the low number of hatched larvae (16), only the zoea I of *O. occidentalis* was described and illustrated. Morphological differences between description of *O. alphaerostris* accomplished by Sandifer (1974) as *O. limicola* and the present description of *O. occidentalis* are listed in Table I.

Ogyrides occidentalis (Ortmann, 1893)

Zoea I (Figs. 1a-f; 2a-f)

Dimensions: CL = 0.358 ± 0.001 mm; TL = 1.285 ± 0.01 mm (n = 10).

Carapace (Figs. 1a-c): elongated with an acute spine in the pterygostomial region; rostrum slender, without setae, slightly overreaching the extremity of the eyes; eyes sessile.

Antennule (Figs. 1a, b, d): peduncle unsegmented; inner flagellum with 4 terminal aesthetascs and 1 terminal plumose seta; outer flagellum as a long plumose seta.

Antenna (Figs. 1a, b, e): peduncle unsegmented, with a terminal inner spine near endopod; endopod unsegmented, with two rows of 5-6 spines in the mediobasal region and 1 plumose seta in the medial region; exopod (antennal scale) unsegmented, with 8 plumose setae on inner side, and 1 plumose plus 3 short simple setae on the outer side.

Mandibles (not illustrated): incisor and molar process developed; palp absent.

Maxillule (Fig. 2a): coxal endite with 7 plumodenticulate setae (5 long and 2 short); basal endite with 5 stout plumodenticulate setae; endopod with 3 subterminal (2 plumoserrate and 1 minute simple) and 2 terminal plumoserrate setae; exopodal seta absent.

Maxilla (Fig. 2b): coxal endite bilobed with 9 marginal setae (3 sparsely plumose, 5 plumose with short setules and 1 serrate) on proximal lobe and 4 setae (1 sparsely plumose, 2 plumose and 1 serrate) on distal lobe; basal endite bilobed with 5 setae (3 sparsely plumose, 1

Table 1. Morphological comparison (mainly differences) between the first zoeal stage (zoea I) of *Ogyrides occidentalis* (Ortmann, 1893) and *O. alphaerostris* (Kingsley, 1880).

Source	Sandifer (1974)	Present study
Species	<i>O. alphaerostris</i>	<i>O. occidentalis</i>
Locality	Virginia, U.S.A.	São Paulo, Brazil
Type locality	Virginia, U.S.A.	Pará, Brazil
Characteristics		
Total length (mm)	2.03 (1.74-2.11)	1.285 ± 0.01
Rostrum	Not reaching the extremity of the eyes	Slightly overreaching the extremity of the eyes
Antenna (exopod)	3-segmented; 8 ps + 2 ss	Unsegmented; 9 ps + 3 ss
Maxillule (endopod)	4 s (strong)	5 s (4 strong + 1 small ss)
Maxilla (coxal endite proximal lobe)	7-9 s	9 s
Maxilla (basal endite)	4-5 s on each lobe	5 s on each lobe
1st Maxilliped (coxa and basis)	Fused	Not fused
2nd Maxilliped (coxa)	†	1 s
2nd Maxilliped (basis)	2-3 longer s + 3-4 ss	2 longer s + 4 ss
3rd Maxilliped (coxa)	†	0 s
3rd Maxilliped (basis)	2-3 s	3 s
Pleon (setae on fourth pleonite)	absent	present

Abbreviations: s, setae; ps, plumose setae; ss, simple setae; (†) no data.

simple and 1 hardy plumose) on proximal lobe and 5 setae (4 sparsely plumose and 1 hardy plumose) on distal lobe; endopod 5-lobed, with 3 (2 sparsely plumose and 1 hardy plumose), 2 (1 sparsely plumose and 1 hardy plumose), 1 hardy plumose, 1 hardy plumose, and 2 (1 hardy and 1 plumose) setae, respectively; exopod (scaphognathite) margin with 5 plumose setae; microtrichia on margins of endopod and exopod as illustrated.

First maxilliped (Fig. 2c): coxa with 4 setae (1 simple and 3 sparsely plumose) arranged 1 + 1 + 1 + 1; basis with 11 sparsely plumose setae arranged 1 + 2 + 2 + 3 + 3; endopod 4-segmented with 3 terminal sparsely plumose, 1 terminal sparsely plumose, 2 terminal sparsely plumose and 4 (3 terminal sparsely plumose + 1 subterminal simple) setae, respectively; exopod unsegmented with 1 subterminal plumose and 4 terminal long plumose natatory setae.

Second maxilliped (Fig. 2d): coxa with 1 sparsely plumose seta; basis with 6 setae (2 sparsely plumose and 4 simple) arranged 1 + 1 + 2 + 2; endopod 4-segmented with 3 terminal sparsely plumose, 1 terminal sparsely plumose, 2 terminal sparsely plumose, and 5 (3 terminal sparsely plumose, 1 terminal plumodenticulate and 1 subterminal simple) setae, respectively; exopod unsegmented with 2 subterminal plumose and 4 terminal long plumose natatory setae.

Third maxilliped (Fig. 2e): coxa without setae; basis with 3 (1 plumose and 2 sparsely plumose) setae arranged 1 + 1 + 1; endopod 3-segmented with 3 (2 marginal and 1 subterminal) sparsely plumose, 3 (1 terminal simple and 2 subterminal sparsely plumose), 3 terminal long sparsely plumose setae, respectively; exopod unsegmented with 4 marginal plumose and 5 (1 simple and 4 terminal long plumose natatory) setae.

Pereiopods (Fig. 2f): first as a uniramous bud.

Pleon (Figs. 1a, b): with 5 pleonites, fourth pleonite with one pair of posterodorsal simple setae, pleonite 6 fused with the telson; pleopods and uropods absents; anal spine present.

Telson (Figs. 1a, b, f): broad at posterior margin, with 7 + 7 plumose setae (the outer 2 setae plumose only in the inner margin), outermost pair subterminal, inner pair shorter; one row of minute spinules on distal margin between and around bases of the 6 + 6 inner setae.

Discussion

The morphology of the first larval stage of the recently resurrected *O. occidentalis* showed conspicuous dissimilarities when compared with the same larval stage of *O. alphaerostris*, described more than 40 years ago (Sandifer 1974). Unfortunately, the larval morphology scenario for the genus did not receive new descriptions and no additional comparison on larval features among the other 10 recognized species of *Ogyrides* (De Grave & Fransen 2011, Ayón-Parente & Salgado-Barragán 2013, Terossi & Mantelatto 2020) is possible due the lack of descriptions. Additionally, the zoea of *O. delli* described by Packer (1985) is incomplete, with no details and no standard characterization that allows comparison. This background illustrates the importance of new and accurate descriptions of some larvae of Decapoda to fill out the tremendous lack of information.

Despite the similarities (number of appendages, pleonites, and numbers of setae on some appendages) between the first larval stage of *O. occidentalis* presented here and *O. alphaerostris* (Sandifer 1974), some morphological characters were remarkably distinct (see Table 1). In *O. alphaerostris*, the rostrum does not reach the extremity of the eyes, while in *O. occidentalis* this structure slightly overreaches the sessile eyes. Total length of larvae was smaller in *O. occidentalis* than in *O. alphaerostris* (1.285 ± 0.01 mm and 2.03, respectively). Regarding CL, Sandifer (1974)

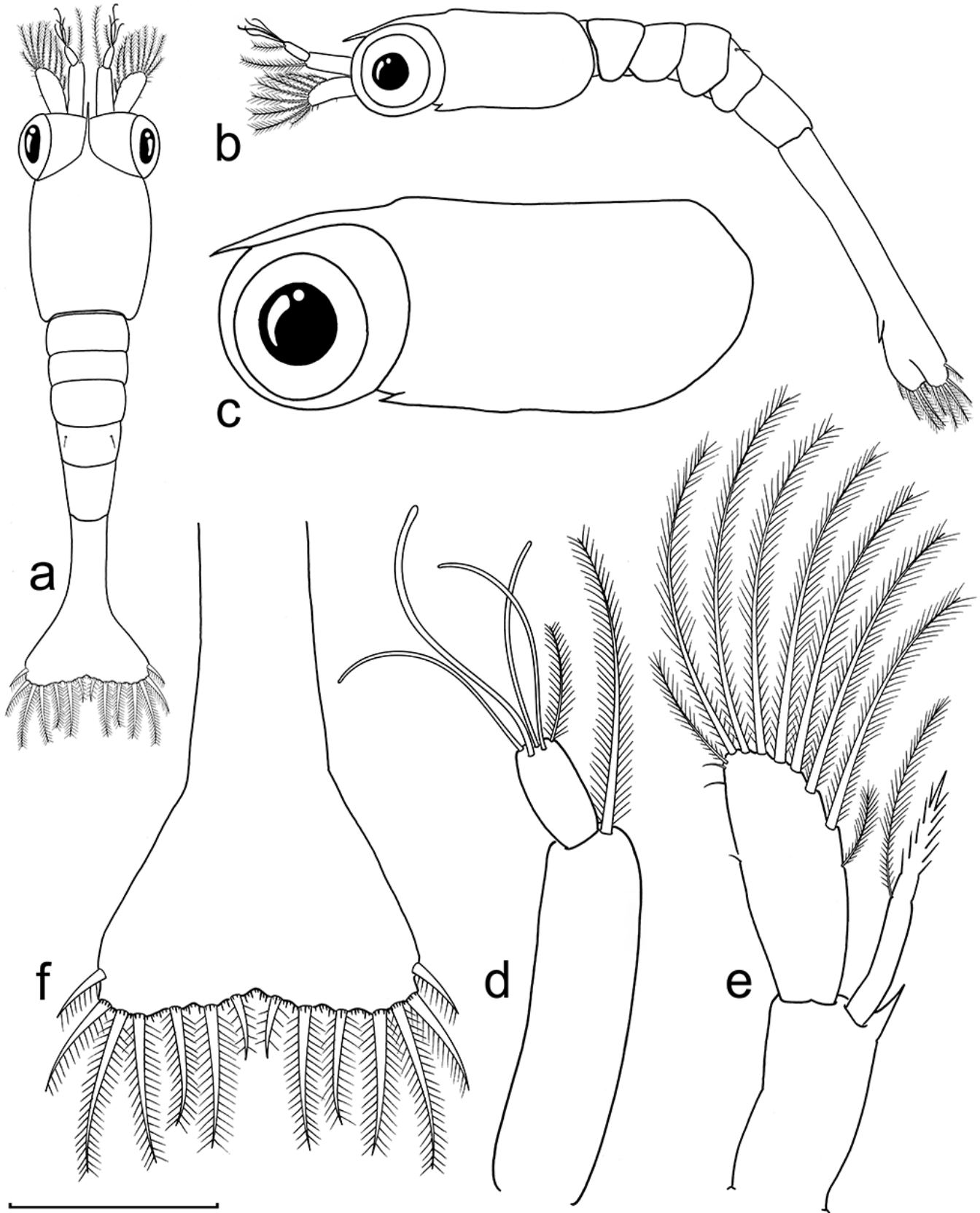


Figure 1. *Ogyrides occidentalis* (Ortmann, 1893), Zoea I. a. Dorsal view; b. Lateral view; c. Magnification of the carapace, lateral view; d. Antennule; e. Antenna; f. Telson. (Scale bar: a, b = 0.5 mm; d, e = 0.125 mm; c, f = 0.25 mm).

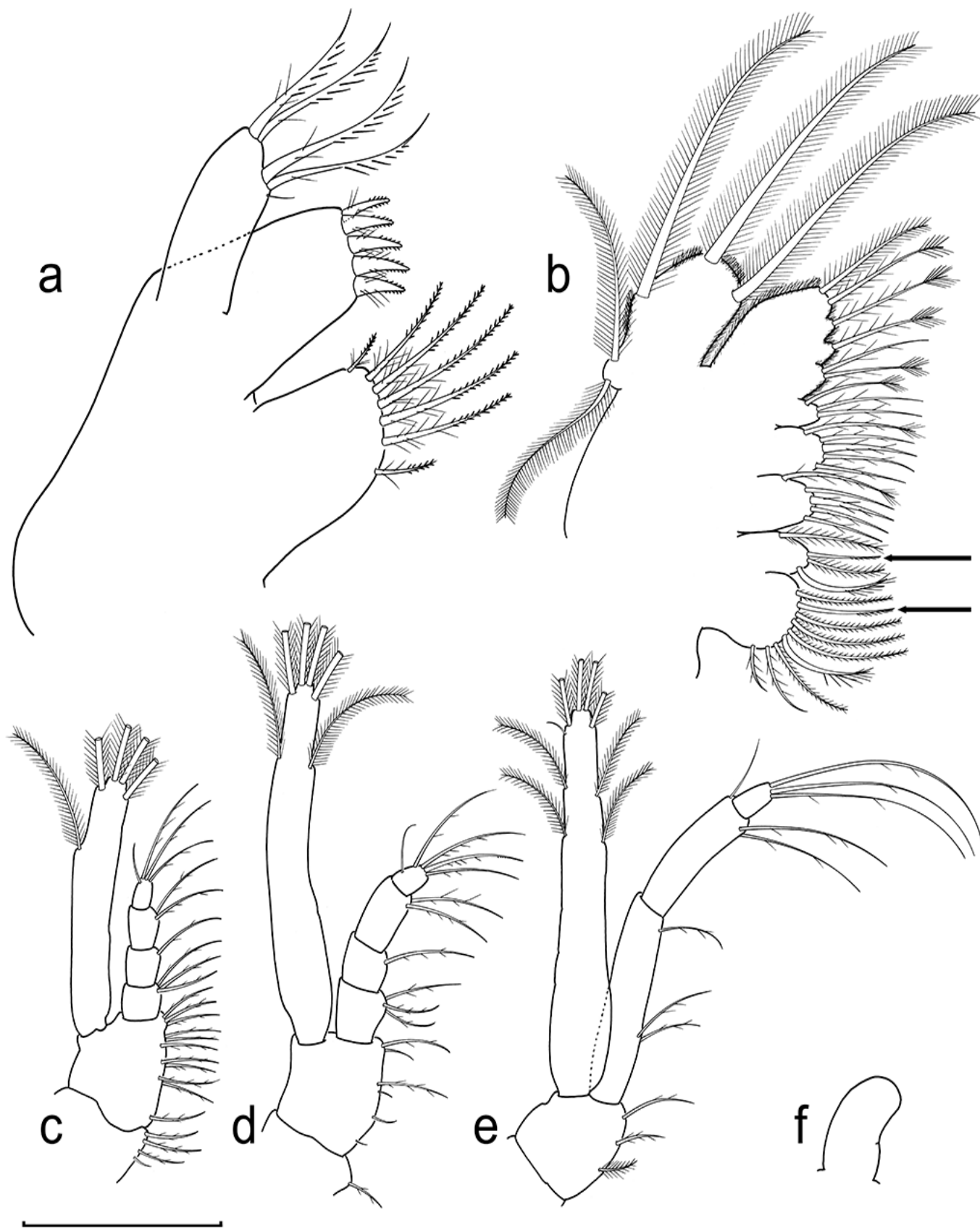


Figure 2. *Ogyrides occidentalis* (Ortmann, 1893), Zoea I. a. Maxillule; b. Maxilla; c. First maxilliped; d. Second maxilliped; e. Third maxilliped; f. First pereopod. Arrows indicate serrate setae on the coxal endite of maxilla. (Scale bar = a = 0.05 mm; b = 0.1 mm; c-f = 0.15 mm).

did not include any measurement, however, using the scale bars of the original illustrations it is possible to estimate a CL of approximately 0.5 mm, which is also larger than the CL of *O. occidentalis* (0.358 ± 0.001 mm). Additional differences can be noted in the segmentation of some structures: the antenna exopod is 3-segmented and first maxilliped coxa and basis were described as being fused in *O. alphaerostris*, while the antenna exopods are unsegmented, and there is a clear segmentation between coxa and basis of first maxilliped of *O. occidentalis*.

Other differences were observed in the number of setae of some structures, i.e. antenna exopod, maxillule endopods, 2nd maxilliped basis and fourth pleonite (Table 1). We also described all setal types found in the first zoea of *O. occidentalis*, including some structures that were not described for *O. alphaerostris* (coxa of 2nd and 3rd maxillipeds). Except for some plumose setae in the antennule, antenna, maxilla, maxillipeds and telson, Sandifer (1974) had used different terminology for the types of setae.

Setae of decapod crustaceans manifest a variety of structures and perform numerous functions: e.g. cleaning the body surface, providing water flows and chemo- and mechanoreception (Borisov 2016). Accurate descriptions of setal types allow the identification of the level of development of some structures that are decisive to understanding of ecological, taxonomical, and systematic features of the distinct groups of Decapoda. After the present description, it is possible to notice that the first larval stages of *Ogyrides* species exhibit particular features such as a notorious development in mouthparts (maxillule and maxilla). Morphology of the mouthparts provides useful information on feeding habits and prey characteristics (Cox & Johnston, 2003). Furthermore, information about setal types will probably be important after the description of more species of the genus, because in some circumstances, the combination of several morphological characters are necessary for the identification of the zoea I of some caridean species (e.g. Geiselbrecht & Melzer 2009, Mantelatto et al. 2014, Pescinelli et al. 2017).

The differences noted between the two species must be interpreted carefully at this time. In this sense, a future redescription of the zoea I of *O. alphaerostris* would be important to detail the types of setae and to check if some of the observed differences are real or could be the result of misidentification, e.g. segmentation in the antennal scale, absence of segmentation between coxa and basis of the first maxilliped and absence of simple setae in the pleon of *O. alphaerostris*.

The results of this study, especially the differences in some structures (e.g., length of the rostrum and setation of antennal scale) furnished support to recent taxonomical rearrangements for the genus, with resurrection of *O. occidentalis* (Terossi & Mantelatto 2020), suggesting that the zoea I described herein and those described by Sandifer (1974) do not actually belong to the same species. On the other hand, to state whether these dissimilarities refute the synonymization of *O. limicola* and *O. alphaerostris* or reflect natural groups not yet detected by systematic studies based on adult morphology is beyond the scope of the present study, especially if we consider the limited number of species with some described larval stage for the family, i.e., about 15,4% of the current representatives, disregarding *O. delli* (see Introduction for details). Given this context, we can suggest that this family probably needs a taxonomic revision, and a combination of a morphological analysis, including all zoal stages if possible, with a molecular analysis could be extremely useful in this case.

Besides the importance of larval morphology knowledge to provide useful information in the current taxonomic and phylogenetic context, the present description will also help to identify specimens of *O. occidentalis* in plankton samples, allowing the advance of ecological and biodiversity studies. An increase in the descriptions of species not yet described and redescriptions of some species, as presented here, are thus essential to generate accurate information, what will certainly bring significant gains for future comparative research on biodiversity.

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Author Contributions

João Alberto Farinelli Pantaleão: Contribution to data collection, analysis and interpretation, and manuscript preparation.

Fernando Luis Mantelatto: Substantial contribution in the concept and design of the study, contribution to data collection and critical revision, adding intellectual content.

Rogério Caetano Costa: Substantial contribution in the concept and design of the study, contribution to data collection and critical revision, adding intellectual content.

Conflicts of Interest

The authors declare that they have no conflict of interest related to the publication of this manuscript.

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