Male claspers and lobes homology of the first thoracopod among cladocerans (Branchiopoda)

Lourdes M. A. Elmoor-Loureiro

Laboratório de Zoologia, Universidade Católica de Brasília, QS 7, Lote 1, Bloco M, Sala 331, 71966-700, Taguatinga, DF, Brazil. E-mail: lourdes@ucb.br

Abstract

There is some doubt concerning the lobes homology of the first trunk limb among cladoceran families. Notwithstanding, we believe that male claspers found in Cyclestherida and Cladocera are homologous and therefore derived from the endopodite. The present study employed the male claspers as markers to investigate homology among lobes of the trunk limb I. The comparison among members of different cladoceran taxa supported the traditional view that the inner (IDL) and outer distal (ODL) lobes found in Radopoda are homologous to, respectively, the fourth endite and exopodite present in Daphniidae, Moinidae, and Ctenopoda. For Bosminidae, whose endites are not individualized, it has been confirmed that their exopodite and the radopod ODL are homologous. The absence of claspers in Ilyocryptidae males does not permit any conclusion about them.

Key words: Anomopoda, Ctenopoda, Cladocera, trunk limbs, homology, endite lobes.

Introduction

The five or six pairs of trunk limbs (thoracopods) of Anomopoda and Ctenopoda (Cladocera) are phyllopodial as those observed on branchiopods (Dumont and Negrea, 2002), however, due to their endopodite absence they assume an uniramous aspect. Trunk limbs are lobed and their morphology is variable in comparison to each other, as well as between families.

All six thoracopods of Ctenopoda are foliaceous and similar in structure, possessing gnathobase, four well-individualized endite lobes, and an elongated and flabelliform exopodite. Except for the endopodite absence, the trunk limbs of Ctenopoda resemble the ones present in Cyclestherida, and could illustrate the plesiomorphic state of the cladoceran thoracopod morphology.

Among anomopod families, trunk limb I is used in different ways in manipulating food, and its morphology is variable as a result of the endite lobes fusion and the exopodite reduction. It is possible to distinguish the Daphniidae+Moinidae (daphniid) type and the Macothricidae+Chydoridae (radopod) type (Dumont and Silva-Briano, 1998). Although being different in morphology, five lobes are present in both types. Traditionally, the distalmost is considered the exopodite, often called outer distal lobe or ODL, and the remaining four are endite lobes. In the radopod type, the fourth endite is well individualized and frequently called inner distal lobe or IDL. However, according to Dumont and Negrea (2002), identifying the ODL as exopodite, and the IDL as fourth endite, are merely conventional and do not guarantee true homologies. Kotov (2000) proposed another interpretation, suggesting that both the ODL and the IDL were derived from the exopodite.

As the endites in Bosminidae and Ilyocryptidae are even more fused, the recognition of homologies are even more difficult to establish.

Olesen *et al.* (1996) redescribed the male of *Cyclestheria hislopi* (Branchiopoda, Cyclestherida), and concluded that the male moving finger of the

clasper of trunk limb I is derived from the endopod and homologous to the male hook present in Cladocera. Assuming the veracity of this statement it is possible to use the male hook as a marker in identifying homologous lobes of first trunk limb among cladocerans.

In the present study, the morphology of first trunk limbs of male and females cladocerans of various species were investigated, in order to recognize the homology among their lobes.

Material and Methods

The trunk limb I of the following cladoceran taxa were examined and figured: Sididae – *Diaphanosoma birgei* (2 males and 2 females); Bosminidae – *Bosmina freyi* (3 males and 2 females); Daphniidae – *Simocephalus mixtus* (2 males and 2 females); Moinidae – *Moina micrura* (1 male and 2 females); Macrothricidae – *Macrothrix spinosa* (1 male and 8 females); Chydoridae – *Alona verrucosa* (1 male and 4 females). The absence of a male clasper on the first thoracopod of Ilyocryptidae does not allow the inclusion of this family in the present study.

Specimens were dissected and mounted in PVL medium under a binocular stereoscopic microscope. Drawings were prepared using a camara lucida attached to an Axiolab Zeiss phase microscope.

Based on Olesen *et al.* (1996), diagrammatic figures of first trunk limb of *Cyclestheria hislopi* (Fig. 1A-B) were made and used for comparison.

Results and Discussion

The present study was conducted on the premise that the movable finger of male cladoceran clasper is homologous to the one present in Cyclestherida, which is derived from the endopodite (Olesen *et al.,* 1996). In consequence, although with variable morphology among cladocerans, the male claspers would indicate the limit between the exopodite and the endite lobes, as well as possible structures derived from them.

The *Cyclestheria* male clasper (Fig. 1B) is composed of the movable finger, its opposing palm and two palps (one of them very small). These clasping structures are located at a position equivalent to endite 5, between endite 4 (also modified) and the expopodite.

In Sididae (Ctenopoda), there are four well-individualized endite lobes, a flabelliform exopodite, and no endopodite (Fig. 2). The male clasper is a hook-shape projection located almost distally on endite 4 (Fig. 2B), clearly in a position equivalent to the endopodite, as in *Cyclestheria* (Fig. 1B) (cf. Olesen *et al.,* 1996).

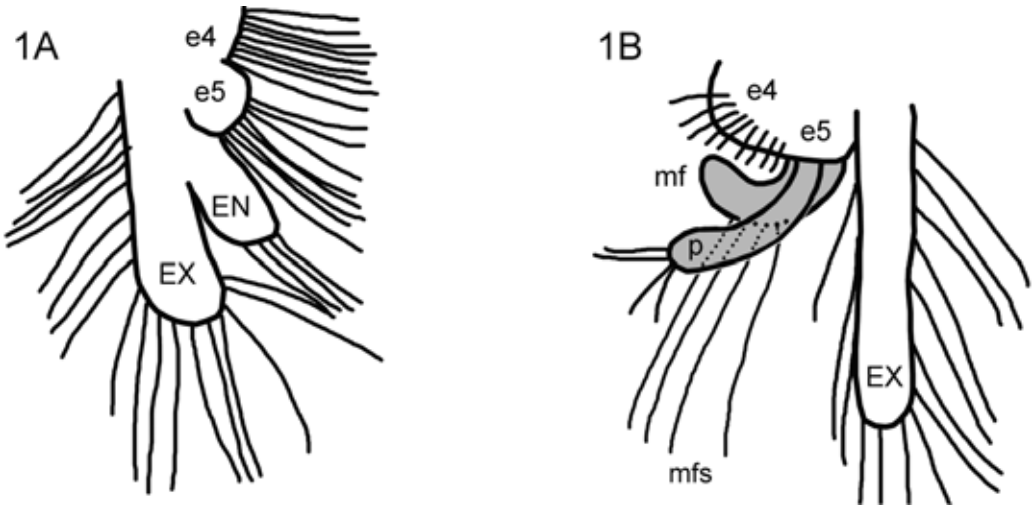
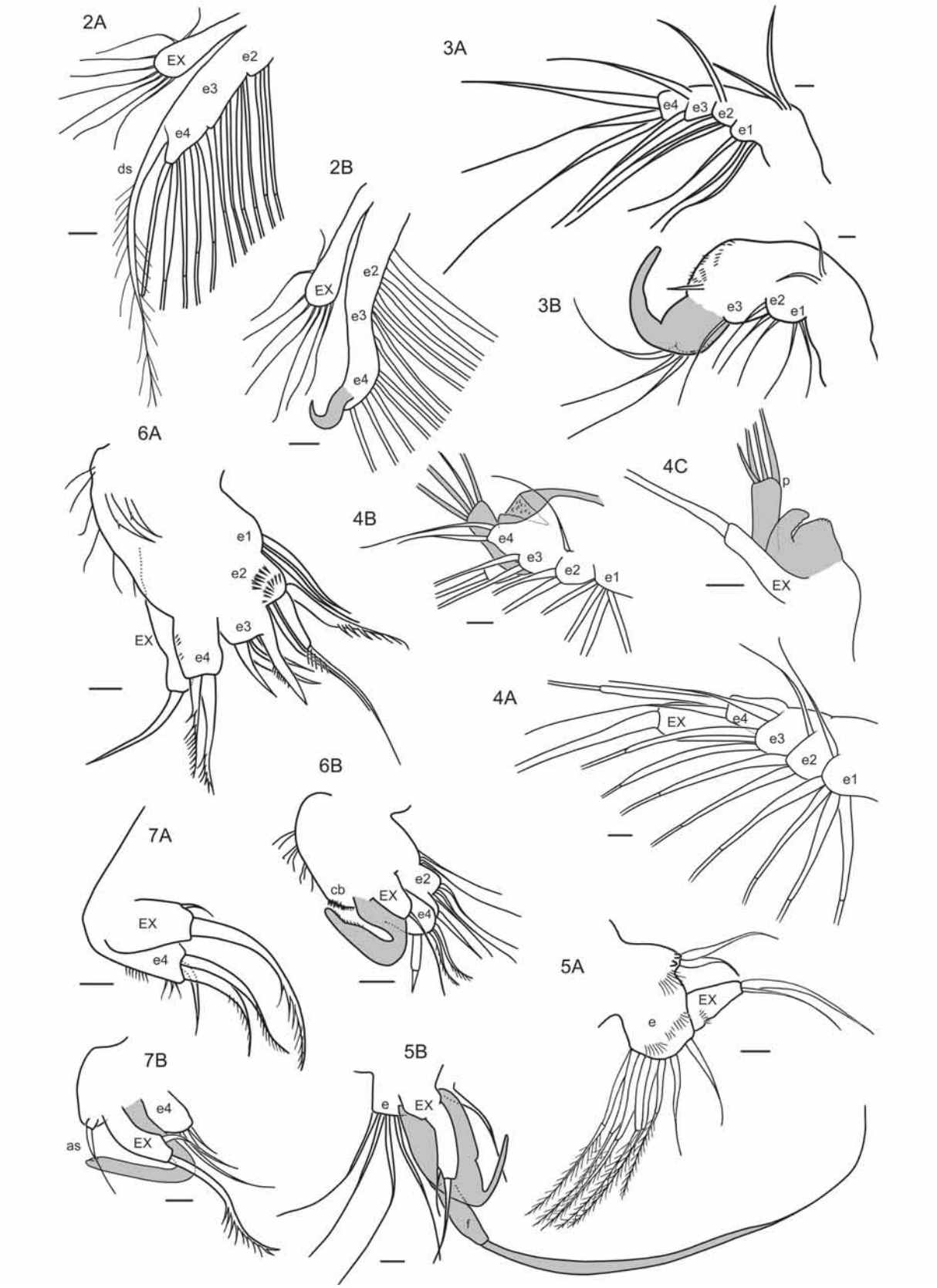


Figure 1. Diagrammatic representation of the distal part of first trunk limb of *Cyclestheria hislopi,* female (Fig. 1A) and male (Fig. 1B), based on Olesen *et al.* (1996). The structures in gray represent the male clasper. In order to facilitate the observation of clasping structures, setae of endite 4 were drawn in a very reduced length. The smallest palp was not represented. EX, exopodite; EM, endopodite; e4-5, endite lobes 4 to 5; mf, movable finger; mfs, movable finger setae; p, palp.



Figures 2-7. First trunk limb of the Cladocera. 2. *Diaphanosoma birgei,* distal end, female (2A) and male (2B). 3. *Moina micrura,* female (3A) and male (3B). 4. *Simocephalus mixtus,* female (4A), male inner side (4B), and male outer side (4C). 5. *Bosmina freyi,* female (5A) and male (5B). 6. *Alona verrucosa,* female (6A) and male (6B). 7. *Macrothrix spinosa,* distal end, female (7A) and male (7B). The structures in gray represent the male clasper. EX, exopodite; as, accessory seta; cb, copulatory brush; ds, distal seta; e, fused endite lobes; e1-4, endite lobes 1 to 4; f, flagellum; p, palp. Scale bars denote 10 μm.

Assuming that the clasper of Cyclestherida and Anomopoda are homologous (Olesen *et al.,* 1996), it is necessary to accept that its position relative to endite 4 had changed during the evolution of the Anomopoda. In Cyclestherida, the clasper is located continuous to endite 4 (Fig. 1B), but in Anomopoda its position seems to be at base of the well developed endite 4 (Figs. 3B-7B).

The first thoracopod of Daphniidae and Moinidae are similar and bear four endite lobes, but while an individualized lobe (EX) is present in daphniids (Fig. 4A), it is lost in moinids (Fig. 3A). This individualized lobe is traditionally considered the exopodite (Dumont and Negrea, 2002), which is supported by the position of male clasper in both families (Figs. 3B, 4B-C). Different from any other cladoceran genera, the clasper of the daphniid *Simocephalus* bears a stout hook and a lobe with terminal setae (Fig. 4C). According to Olesen *et al.* (1996), this structure is homologous to the movable finger of *Cyclestheria*. However, the present interpretation is that the lobe and the hook are homologous to the large palp and the movable finger, respectively, present in *Cyclestheria*. This alternative view, however, does not affect the conclusion that the individualized lobe represents the exopodite.

In Bosminidae, there are no individualized lobes in female trunk limb I, except the one usually considered as exopodite (Fig. 5A). The male clasper is a hook shaped structure armed with a long seta (flagellum), and it is placed between the exopodite and the endite (Fig. 5B).

Trunk limb I of *Alona verrucosa* and *Macrothrix spinosa* are typically radopodals (Figs. 6-7, respectively; for *M. spinosa* only the distalmost portion was represented). In females there are three endites largely merged with the corm, and two well individualized lobes (Fig. 6A and 7A). In males of the genera, a hook arises between these two lobes (Figs. 6B and 7B), suggesting they represent endite 4 and exopodite. Therefore the position of the male clasper supports the traditional view that the IDL is homologous to endite 4, as well as the ODL is homologous to exopodite. Consequently, the present study does not agree with Kotov (2000), who suggested that both IDL and ODL are derived from the exopodite.

In brief, the comparison among cladoceran families supported the traditional view (e.g. Dumont and Negrea, 2002) that the IDL and the ODL found in Radopoda are respectively homologous to the fourth endite and exopodite of Daphniidae, Moinidae, and Ctenopoda. For the Bosminidae, whose endites are fused, it has been confirmed that their exopodite and the radopod ODL are homologous. The absence of claspers in Ilyocryptidae males does not permit any conclusion about them.

The correct interpretation of homology among diverse structures in male claspers of different cladoceran families – such as palp, flagellum, additional setae (including the male seta), and copulatory brush – is out of the scope of the present paper and demands a broader comparison among species.

Acknowledgements

I would like to thank Ms. Laurinda Abdu El-moor for helping with the figures and an anonymous reviewer for valuable comments.

References

Dumont, H. J. and Negrea, S.V. 2002. Introduction to the Class Branchiopoda. Vol 19. Guides to the identification of the microinvertebrates of the continental waters of the world. Backhuys Publishers, 398 p.

Dumont, H. J. and Silva-Briano, M. 1998. A reclassification of the Anomopoda families Macrothricidae and Chydoridae, with the creation of a new suborder, the Radopoda (Crustacea, Branchiopoda). Hydrobiologia, 384: 119-149.

Kotov, A. A. 2000. Morphology and variability of *Eurycercus lamellatus* (O.F. Müller, 1776) (Branchiopoda: Anomopoda: Eurycercidae) from Lake Glubokoe, Moskow Area, central Russia. Arthropoda Selecta, 9: 159-173.

Olesen, J.; Martin, J. W. and Roessler, E. W. 1996. External morphology of the male of *Cyclestheria hislopi* (Baird, 1859) (Crustacea, Branchiopoda, Spinicaudata), with a comparison of male clasper among the Conchostraca and Cladocera and its bearing on phylogeny of the 'bivalved' Branchiopoda. Zoologica Scripta, 25(4): 291-316.

Received: January 2005
Accepted: June 2006