JOURNAL OF PLANKTON RESEARCH | VOLUME 26 | NUMBER 1 | PAGES 5–10 | 2004

Morphology of *Coenophthalmus tridentatus* first zoea (Crustacea: Portunidae: Polybiinae) hatched in the laboratory

EDUARDO D. SPIVAK* AND TOMÁS A. LUPPI[1]

DEPARTAMENTO DE BIOLOGÍA, FACULTAD DE CIENCIAS EXACTAS Y NATURALES, UNIVERSIDAD NACIONAL DE MAR DEL PLATA, CASILLA DE CORREOS 1245, 7600 MAR DEL PLATA AND [1]CONSEJO NACIONAL DE INVESTIGACIONES CIENTÍFICAS Y TÉCNICAS DE LA REPÚBLICA ARGENTINA

*CORRESPONDING AUTHOR: espivak@mdp.edu.ar

The swimming crab Coenophthalmus tridentatus A. Milne Edwards, 1879 (Decapoda, Portunidae) is an endemic species of the Southwestern Atlantic, from southern Brazil to northern Patagonia (Argentina). Larvae of C. tridentatus from one female collected on beds of oysters and mussels at 50 m depth in the Argentine continental shelf (38°21′S, 57°38′W) were hatched in the laboratory. Zoea I morphology is described for the first time and compared with known zoeae of other portunid species.

INTRODUCTION

The swimming crab *Coenophthalmus tridentatus* A. Milne Edwards, 1879 (Decapoda, Portunidae: Polybiinae) is a shallow-water (10–40 m deep) species distributed along the Southwestern Atlantic shores, from Rio de Janeiro (Brazil) to Comodoro Rivadavia (Argentina) (Boschi *et al.*, 1992; Melo, 1996; Spivak, 1998). The morphology of *C. tridentatus* zoeae has not been described yet, except for a brief comment and a figure of a zoea I that was included by Boschi (Boschi, 1981) and reproduced by Pohle *et al.* (Pohle *et al.*, 1999). This description did not allow for comparisons among species [(Fransozo *et al.*, 2002); see also Pohle *et al.* (Pohle *et al.*, 1999)]. In the present study we describe the first zoea stage of *C. tridentatus* hatched in the laboratory, and compared their morphology with known zoeae of other portunid species.

METHOD

Ovigerous females of *C. tridentatus* were collected from the BIP 'Capitán Cánepa' (Instituto Nacional de Investigación y Desarrollo Pesquero, Argentina) on the continental shelf (38°21′S, 57°38′W) on 17 November 2000. The bottom (50 m deep) was covered by beds of oysters and mussels. One ovigerous female was transported to the laboratory of the Departamento de Biología, Universidad de Mar del Plata, and maintained in an aquarium containing natural sea water until the eggs hatched (20 November 2000).

Measurements and drawings were made using an Olympus CH30 compound microscope equipped with a camera lucida. The following measurements were made with a micrometer eyepiece (×40): rostro-dorsal length (RDL), from the tip of the rostral spine to the tip of the dorsal spine; carapace length (CL), from the base of the rostrum to the posterior margin; and carapace width (CW), as the distance between the tips of the lateral spines. Drawings were based on five larvae, and measurements on 10 larvae per stage. Descriptions were arranged according to previously proposed standards (Pohle and Telford, 1981; Clark *et al.*, 1998). The long setae of the first and second maxilliped endopod were drawn truncated (Figure 2). The ovigerous females and larvae were deposited in the Museo Argentino de Ciencias Naturales 'Bernardino Rivadavia', Buenos Aires, Argentina, under the numbers MACN-In 35868 (adult) and MACN-In 35869 (larvae).

RESULTS

Larval description

Coenophthalmus tridentatus A. Milne Edwards, 1879 (Figures 1 and 2).

doi: 10.1093/plankt/fbh007, available online at www.plankt.oupjournals.org

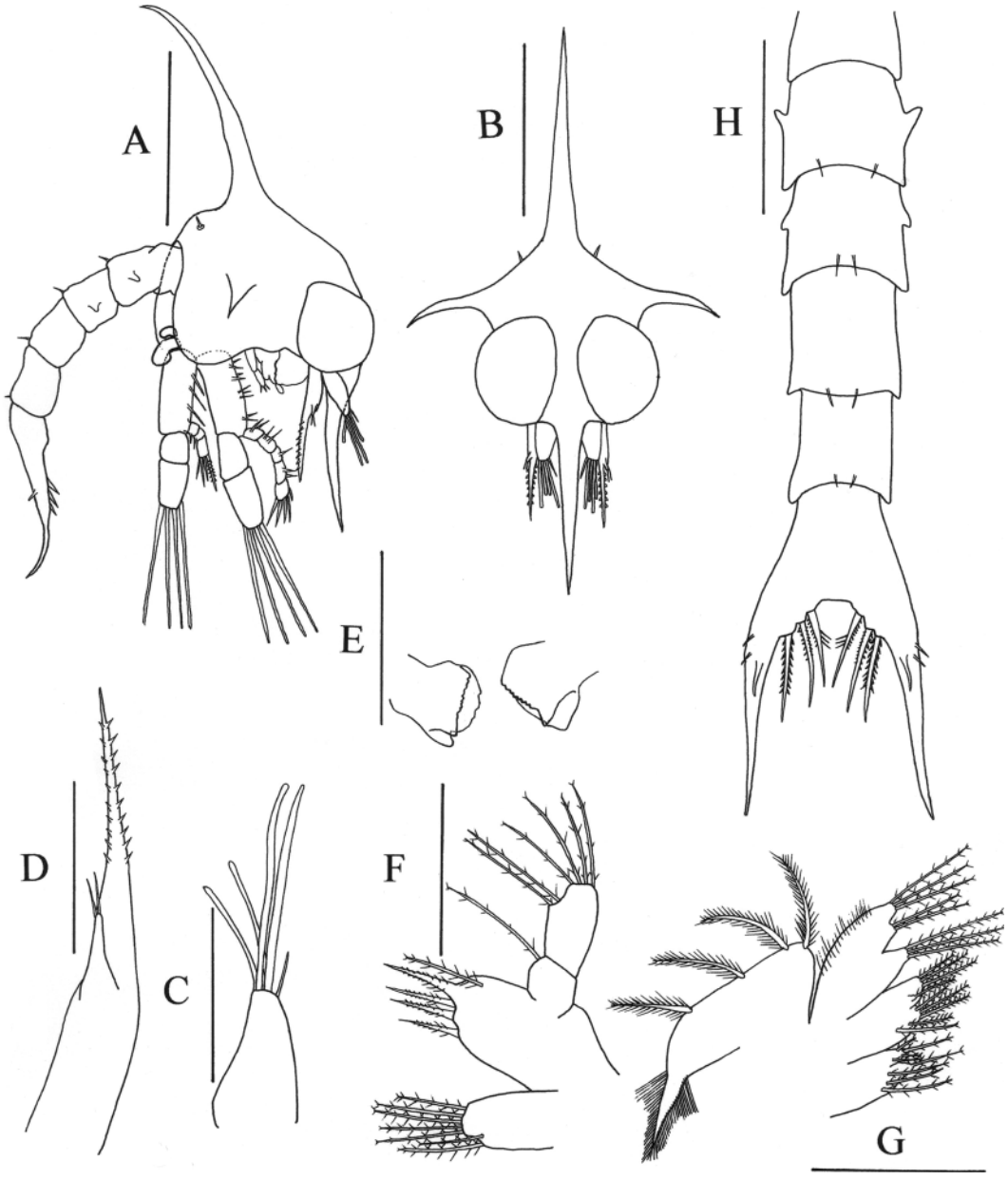

Fig. 1. *Coenophthalmus tridentatus* A. Milne Edwards, 1879, zoea I. (**A**) Whole animal, lateral view; (**B**) frontal view; (**C**) antennule; (**D**) antenna; (**E**) mandible; (**F**) maxillule; (**G**) maxilla; (**H**) pleon. Scale bars: A, B, H = 0.2 mm; C, D, F, G = 0.1 mm.

Zoea I

Carapace (Figure 1A and B)
Globose, smooth and without tubercles, with dorsal, rostral and lateral spines (RDL = 1.30 ± 0.03 mm, CL = 0.48 ± 0.03 mm, CW = 0.62 ± 0.02 mm). Dorsal spine gently curved. Lateral spines relatively long (CW/CL = 1.30 ± 0.06) and directed more or less perpendicular to the carapace. One pair of posterodorsal setae. Eyes sessile.

Antennule (Figure 1C)
Uniramous. Endopod absent. Exopod unsegmented with four aesthetascs (two long and two thin and short) and one seta.

Antenna (Figure 1D)
Protopod well developed but not exceeding tip of rostral spine, bearing two rows of spines. Exopod short, one-quarter protopod length, with two terminal simple setae of similar size.

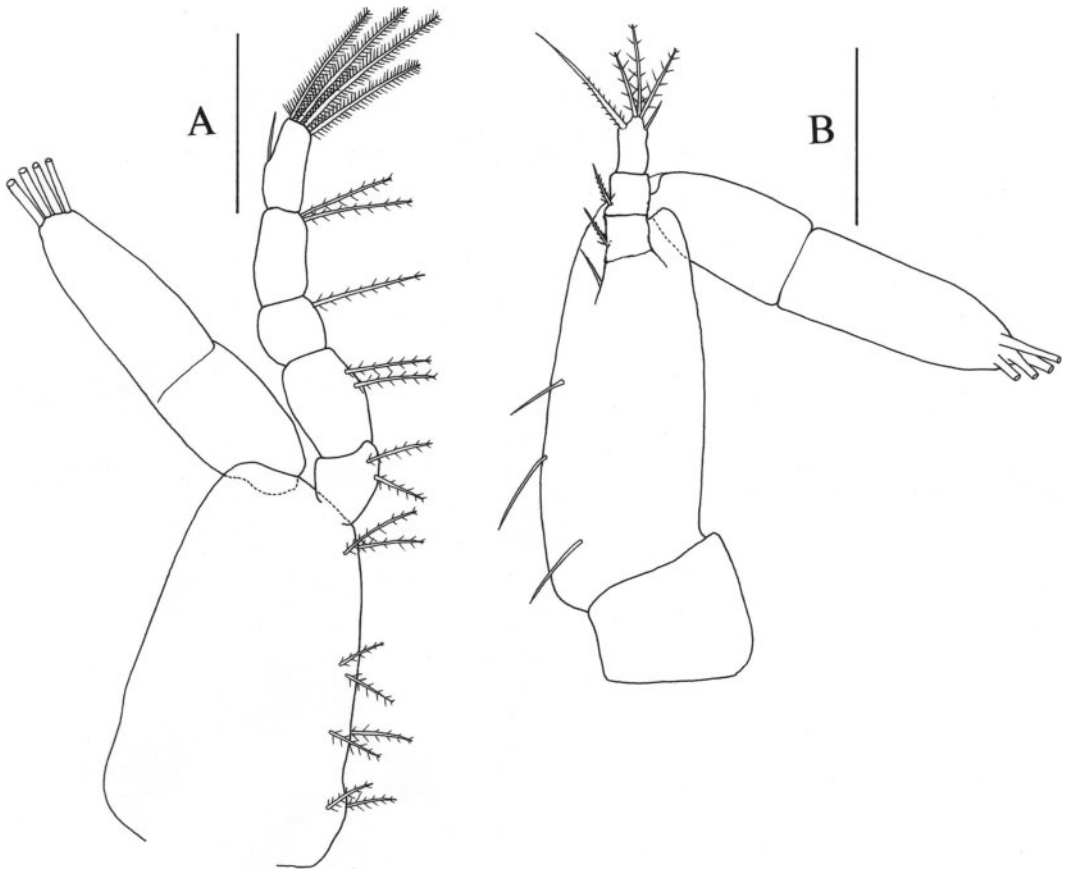

Fig. 2. *Coenophthalmus tridentatus* A. Milne Edwards, 1879, zoea 1. (**A**) First maxilliped; (**B**) second maxilliped. Scale bars: A, B = 0.1 mm.

Mandible (Figure 1E)
Incisor and molar processes differentiated. Endopod palp absent.

Maxillule (Figure 1F)
Coxal endite with seven sparsely plumose setae. Basal endite with four plumodenticulate and one sparsely plumose setae. Endopod two-segmented, with one sparsely plumose seta in proximal segment, and two subterminal and four terminal sparsely plumose setae in distal segment. Exopod absent.

Maxilla (Figure 1G)
Coxal endite slightly bilobed with 4+4 sparsely plumose setae. Basal endite bilobed with 5+4 sparsely plumose setae. Endopod unsegmented, bilobed with 3+5 sparsely plumose setae and a fringe of lateral small setae. Scaphognathite with four plumose marginal plumose setae and a very long setose posterior process.

First maxilliped (Figure 2A)
Coxa without seta. Basis with 8/9 medial sparsely plumose setae arranged 2,2,2,2 or 2,2,3,2. Endopod five-segmented with 2,2,1,2 sparsely plumose and five (one simple subterminal + four plumose terminal) setae. Exopod two-segmented with four long terminal plumose natatory setae.

Second maxilliped (Figure 2B)
Coxa without seta. Basis with four medial simple setae arranged 1,1,1,1. Endopod three-segmented with one plumodenticulate, one plumodenticulate and five (one plumodenticulate subterminal + one simple subterminal + three plumose terminal) setae. Exopod two-segmented and with four long terminal plumose setae.

Third maxilliped (Figure 1A)
Present as small bud.

Pereiopods
First pereiopod bud.

Abdomen (Figure 1H)
Five abdominal somites. Somites 2 and 3 with pair of dorsolateral processes. Dorsolateral process on somite 2, with tip directed anteriorly; on somite three shorter, with posteriorly pointed tip. Somites 2–5 with rudimentary

posterolateral spines, each with posteriorly pointed tip. Somites 2–5 with pair of posterodorsal setae. Pleopods absent.

Telson (Figure 1H)
Bifurcated with three pairs of serrulate setae, inner pair with three long spinules medially on inner margin; three spines on proximal part of each furcal arm: two small lateral and one large dorsomedial. Telson and dorsomedial spine not spinulated.

DISCUSSION

According to Stephenson and Campbell, the family Portunidae includes the following six subfamilies: Carcininae, Polybiinae (= Macropininae), Portuninae, Catoptrinae, Caphyrinae and Podophthalminae (Stephenson and Campbell, 1960). Larvae of only the first three of these are known, as occurred almost 30 years ago (Rice and Ingle, 1975), except for the description of the megalopa of *Lissocarcinus orbicularis* Dana, 1852 (Caphyrinae) (Lyskin and Britayev, 2002). Rice and Ingle summarized the differences among the zoeae of Carcininae, Polybiinae and Portuninae on the basis of the presence of carapace lateral spines, the number of abdominal somites with dorsolateral projections (and the ontogenetic changes of this character), the length of the posterio-lateral processes of abdominal somites 3 and 4, the telson fork armature, the number of setae of the telson posterior border and the armature of the middle segment of the endopod of the first maxilliped in stage I (Rice and Ingle, 1975). Two of these characters can be studied in zoeae I: (i) carapace lateral spines are well developed in Polybiinae and Portuninae, but not in Carcininae; and (ii) the middle segment of the endopod of the first maxilliped is armed in Polybiinae and unarmed in Portuninae (Rice and Ingle, 1975).

The larvae of many species of the subfamily Polybiinae have been described, most of them after 1975: *Bathynectes longipes* (Ingle, 1985), *Bathynectes longispina* [as *Bathynectes superba*; (Roberts, 1969)], *Bathynectes maravigna* (Rice and Ingle, 1975), *Liocarcinus marmoreus* (Goldstein, 1971), *Liocarcinus pusillus* (Rice and Ingle, 1978), *Liocarcinus holsatus* (Rice and Ingle, 1975), *Liocarcinus arcuatus* (Clark, 1984), *Liocarcinus corrugatus* (Clark, 1984; Kin and Hong, 1999), *Liocarcinus depurator* (Clark, 1984), *Macropipus corrugatus* (Wear and Fielder, 1985), *Macropipus tuberculatus* (Guerao and Abelló, 1999), *Necora puber* (Rice and Ingle, 1975), *Ovalipes catharus* (Wear and Fielder, 1985), *Ovalipes ocellatus* (Costlow and Bookhout, 1966), *Ovalipes punctatus* (Terada, 1980) and *Ovalipes trimaculatus* (Schoeman and Cockcroft, 1996). The similar morphology of all these larvae makes the diagnosis difficult, even to generic level (Guerao and Abelló, 1999), and the zoea I of *C. tridentatus* is not an exception.

Most of the subtle morphological differences between the known polybiinid zoeae I are meristic, e.g. the setation of the antennular exopod, the setation of the maxillar coxal endite, basal endite and endopod, the setation of the basis of the first maxilliped, and the setation of the distal segment of the second maxilliped endopod (Table I). Other observed differences are: the number and relative size of the antennal exopod setae, and the presence of buds of third maxilliped and pereiopods.

The diagnostic characters of *C. tridentatus* zoea I are listed in Table I. *Coenophthalmus tridentatus* is the only polybiinid zoea I that bears two equal-sized setae in the exopod of antennae, 4+4 setae in the coxal endite of maxillae and eight or nine setae (instead of 10) in the basis of the first maxilliped. However, the most obvious character is the relative size of furcal spines. Each furca of *C. tridentatus* has two small lateral and one large dorsomedial in the zoea I. In all other studied polybiinid species, except *O. ocellatus* (Costlow and Bookhout, 1966), each furca has one long and one shorter lateral spines, and one relatively small dorsomedial spine; the long lateral spine is prominent, and directed perpendicularly, in *Ovalipes*, *Bathynectes* and *Macropipus* (Table I). It should be noted that the information on telson spines of some polybiinid zoeae presented by Pohle *et al.* [table 13, (Pohle *et al.*, 1999)] is incorrect: these authors stated that *C. tridentatus* has one dorsal spine, and that *O. trimaculatus*, *O. catharus* and *O. puntatus* have one lateral and one dorsal spine, although three spines can be seen in the telson of *O. catharus*, originally drawn by Wear and Fielder [figure 131, (Wear and Fielder, 1985)], which was included in figure 21I of Pohle *et al.* (Pohle *et al.*, 1999).

Only two polybiinids inhabit coastal waters of the Southwestern Atlantic, from 21 to 46°S: *C. tridentatus* and *O. trimaculatus*. The first zoeae of both species have similar size and morphology. However, they can be identified by means of the following combination of characters: setation of the antennular exopod, relative size of the antennal exopod setae, setation of maxillae, basis of the first maxilliped and distal segment of the second maxilliped, and relative size of furcal spines (Table I).

The zoeae I of all the species of Polybiinae that have been described since 1975, when Rice and Ingle discussed the sub-familial larval characters within the Portunidae (Rice and Ingle, 1975), bear a seta in the middle segment of the endopod of the first maxilliped. The larval stages of several species of Portuninae [e.g. (Bookhout and Costlow, 1974, 1977; Shinkarenko, 1979; Stuck and Truesdale, 1988; Dineen *et al.*, 2001;

Table I: Comparison of selected morphological characters among zoea I of Polybiinae

	Coenophthalmus tridentatus	*Ovalipes trimaculatus*	*Ovalipes catharus*	*Ovalipes ocellatus*	*Ovalipes punctatus*	*Bathynectes longipes*	*Bathynectes longispina*	*Liocarcinus arcuatus*	*Liocarcinus corrugatus*	*Liocarcinus depurator*	*Liocarcinus holsatus*	*Liocarcinus marmoreus*	*Liocarcinus pusillus*	*Macropipus tuberculatus*	*Necora puber*
Source	This paper	10	12	2	11	5	9	1	6, 1	1	7, 1	3, 1	8, 1	4	7, 1
Antennule															
Exopod a, s	4+1	2+2	nd	3+2	2+3	3+1	4+2	3+3	3+1	3+3	3+2	4+2	3+2	4+1	3+1
Antenna															
Exopod s	2 (=)	2 (≠)	nd	2 (≠)	2 (≠)	2 (≠)	2 (≠)	2 (≠)	2 (≠)	2 (≠)	2 (≠)	2 (≠)	2 (≠)	2 (≠)	2 (≠)
Maxilla															
Coxal endite s.	4+4	4+3	nd	4+3	4+3	4+3	4+3	4+3	4+3	4+3	4+3	4+3	4+3	4+3	4+3
Basal endite s.	4+5	4+4	nd	4+5	4+5	4+5	4+5	4+5	4+5	4+5	4+5	4+5	4+5	4+5	4+5
Endopod distal seg. s.	5+3	4+3	nd	4+3	4+3	5+3	5+3	5+3	5+3	5+3	5+3	5+3	5+3	4+3	4+3
First maxilliped															
Basis s.	2,2,2,2 or 2,2,3,2	2,2,3,3	nd	4(?)	nd	2,2,3,3	2,2,3,3	2,2,3,3	2,2,3,3	2,2,3,3	2,2,3,3	2,2,2,3	2,2,3,3	2,2,3,3	2,2,3,3
Second maxilliped															
Endopod distal seg. s.	5	4	nd	4	4	5	5	5	5	5	5	5	5	5	5
Third maxilliped and pereiopod buds	Present	Absent	nd	Absent	Absent	Absent	Present	Present	Present	Present	Present	Present	Present	Absent	Present
Telson															
Spines	2 short L; 1 long D	1 short L; 1 very long L; 1D	1 short L; 1 very long L; 1D	1 short L; 1 very long L;	1 short L; 1 long L; 1D	1 short L; 1 long L; 1D	1 short L; 1 very long L; 1D	1 short L; 1 long L; 1D	1 short L; 1 long L; 1D	1 short L; 1 long L; 1D	1 short L; 1 long L; 1D	1 short L; 1 long L; 1D	1 short L; 1 long L; 1D	1 short L; 1 very long L; 1D	1 short L; 1 long L; 1D

Abbreviations: s, setation; a, aesthetacs; seg., segment; L, lateral; D, dorsal; nd, no data. Sources: 1, Clark (1984); 2, Costlow and Bookhout (1966); 3, Goldstein (1971); 4, Guerao and Abelló (1999); 5, Ingle (1985); 6, Kim and Hong (1999); 7, Rice and Ingle (1975); 8, Rice and Ingle (1978); 9, Roberts (1969); 10, Schoeman and Cockcroft (1996); 11, Terada (1980); 12, Wear and Fielder (1985). (?) possibility of error.

Franzoso *et al.*, 2002)] have also been described since 1975. The middle segment of the endopod of the first maxilliped of zoea I is unarmed in most of them, except in *Portunus pelagicus* (Shinkarenko, 1979). The systematics and phylogeny of portunids will be clarified only by the simultaneous comparison of the morphology of adults and larvae, and of DNA sequences.

ACKNOWLEDGEMENTS

This paper was funded by the Universidad de Mar del Plata grant 15/E149 to E.D.S., and by fellowships of the Consejo Nacional de Investigaciones Científicas de la República Argentina to T.A.L. We are grateful to the authorities and colleagues from the the Instituto Nacional de Investigación y Desarrollo Pesquero (Argentina) for the invitation to E.D.S. to take part in the BIP 'Capitán Cánepa' research cruises and to Dr Antonio Rodríguez, from the Instituto de Ciencias Marinas de Andalucía, for laboratory facilities and friendly advice.

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Received on January 10, 2002; accepted on October 8, 2003