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***EUCYCLOPS ALBUFERENSIS* SP. NOV. (CYCLOPIDA: COPEPODA: CRUSTACEA)
FROM ALBUFERA LAKE, VALENCIA, SPAIN**

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ABSTRACT

A new species of *Eucyclops* (Copepoda: Crustacea) is described from the ancient oligosaline lagoon Lake Albufera (Spain). *Eucyclops albuferensis* sp. nov. belongs to the *Eucyclops-serrulatus*-group of species and can be clearly separated from other conspecifics by a combination of characters that includes very long setules on distal side of caudal rami, absence of teeth on hyaline membrane on distal segments of antennules, micropatterns of hairs and teeth on both sides of basipodite of antenna and hair reduction on inner coxal spine in P4. This species is suggested to be a local endemic of the Valencia area, which is well known as a Pleistocene refuge during glaciation.

Key words: Cyclopoida, description, new characters, new species, Spain

РЕЗЮМЕ

В статье описывается новый вид рода *Eucyclops* (Copepoda: Crustacea) из древней олигосалинной лагуны озера Альбуфера (Испания). *Eucyclops albuferensis* sp. nov. относится к группе видов группы *E.-serrulatus* и отличается от сходных по морфологии видов сочетанием признаков, включающих очень длинные зубчики на латеральной стороне дистальной части каудальных ветвей, отсутствие зазубрин на гиалиновой мембране дистальный члеников антенн, микро вооружение базиподита антенн и редукцию волосков на внутреннем коксальном шипе 4 пары плавательных ног. Описываемый вид возможно является локальным эндемиком округа Валенсии, известного как район выживания южных форм во время Плейстоценовых ледниковых периодов.

INTRODUCTION

The Iberian Peninsula, belonging to the Palearctic realm, is close to the African continent and has tropical elements in its flora and fauna. This area is separated from the continent proper by the Pyrenees Mountains and sea barriers, and it is also suggested as one of the Pleistocene refuges for freshwater organisms during glaciation periods (Miracle 1982). Up to now, no endemic or tropical species of cyclopoid copepods was found in Iberian surface waters that

could be a result of either or both, insufficient studies on small-sized crustaceans in the Iberian area, or the slow-paced revision of the fauna in this group (Dussart 1964).

Lake Albufera (Valencia area) has a special interest for Iberian zoogeography, as it has several local endemics such as cyprinodont fishes and decapods. Although Lake Albufera is the largest oligohaline coastal lagoon in Spain, very few studies on its zooplankton have been published (Oltra and Miracle 1992).

This study aims at the taxonomy of the cyclopoid fauna in the Albufera Lake in order to find tropical or endemic species in Spanish inland waters. Main attention was paid to the genus *Eucyclops*, which was recently revised for European and North American species (Alekseev and Defaye 2004; Alekseev et al. 2006).

MATERIAL AND METHODS

Lake Albufera (39°20'N, 0°20'W) is situated in the community of Valencia, northeastern Spain. It is a shallow (1 m mean depth), oligohaline (up to 2 g/l), and hypertrophic (400 µg chlorophyll/l) lagoon, with a surface area of about 20 sq. km. A few zooplankton species are known in the lake, and the phytoplankton is dominated by cyanobacteria (Oltra and Miracle 1992).

This lagoon was originally linked with the sea. Since its coastal area has been intensively used for rice cultivation since the Middle Ages, the lake now functions as a reservoir regulated by floodgates. Lake Albufera with surrounding lands that include marshes, sandbars, springs and pine forests form the Albufera Natural Reserve Park with limited human activity such as sport fishing and ecological tourism.

In January 2007 in the Albufera Natural Reserve Park, three samples were collected in coastal areas of Lake Albufera. A dip net with mesh size 90 µm was used for filtering about 50 l of water. Samples were preserved with 4% formalin and stored in 85% ethanol.

The samples were analyzed in the laboratory under a dissection microscope "Olympus" immediately after collection. Before dissection, adults of cyclopids were measured with an ocular micrometer (5 µm maximum resolution) and photographed with a digital camera. After dissection they were placed on slides in pure glycerol, and covered with a cover slip ringed with Canada balsam. These slides were then observed at maximum resolution of 1000× (Plan objective 100×, oil immersion) under a compound microscope "Nikon" equipped with Nomarski optics and a drowning tube. Initial pencil drawings were converted to India ink and placed on A4 size tracing paper. The tables were scanned at a resolution of 600 pxl/sm, numbered and reorganized with "Adobe Photoshop 7" program. Abbreviations used: END, endopodite; EXP, exopodite; BAS, basipodite, P1–P4, swimming legs 1–4, P5–P6, rudimentary legs 5 and 6.

The samples at all three sites were dominated by adult and copepodid stages of *Acanthocyclops americanus* (Marsh, 1893), which is the most common zooplankton species in the Valencia area (Prof. Maria Miracle, University of Valencia, personal comm.). A new species, *Eucyclops albuferensis* sp. nov. in low densities (about 1–5% of total copepod density) was also found, only in littoral samples. This species, a member of the *E. serrulatus*-group, is described below.

SYSTEMATICS

Order Cyclopiformes Starobogatov, 1994

Family Cyclopidae G.O. Sars, 1913

Genus *Eucyclops* Claus, 1893

Eucyclops albuferensis, sp. nov.

(Figs. 1–5)

Type material. Holotype: ZIN RN 55050, female dissected on 1 slide; Lake Albufera, Valencia vicinity, Spain (39°20'N, 0°20'W). Coll. V. Alekseev, 2007.

Paratype: ZIN RN 55051, male dissected on 1 slide; Lake Albufera, Valencia vicinity, Spain (39°20'N, 0°20'W). Coll. V. Alekseev, 2007.

Holotype and paratype are deposited in the Zoological Institute of the Russian Academy of Sciences (St. Petersburg, RUSSIA).

Non type material. ZIN RN 55050/1, 5 females and 1 male in glass tube conserved with formalin (4%) and glycerol (5%) mixture Lake Albufera, Valencia vicinity, Spain (39°20'N, 0°0'W). Coll. V. Alekseev, 2007.

Etymology. The name originates from the type locality, Lake Albufera.

Diagnosis. The new species differs from all other species of the genus by a combination of characters in the female, that includes: dense saw with 4–5 very long dentiform spinules on the distal side of the caudal rami, absence of serration in the hyaline membranes on distal segments of the antennules, a unique combination of groups of hairs and spinules on both sides of basipodite of antenna, and the ornamentation of the inner coxal spine on the fourth swimming legs.

Description. *Female* (Figs. 1–4). Body bluish violet, genital double-somite yellowish brown (Fig. 1A).

Length measurements: Abdomen 700 µm, including: cephalothorax 418 µm and 4 free thoracic segments 1/2/3/4 = 90/70/70/40 µm. Abdomen 460 µm, including genital double-somite 130 µm, 3

following abdominal segments 1/2/3 = 80/60/60 μm and caudal rami 130 μm . Full body length without caudal setae 1160 μm , with caudal setae 1655 μm . Variation among 5 females measured: full body length without caudal setae 1080–1210 μm , with caudal setae 1634–1720 μm .

Cephalothorax as long as wide, with maximum width close to middle.

Last thoracic segment with a group of hairs on lateral margin.

Genital double-somite 0.9 times as long as wide, with seminal receptacle as in Fig. 1E.

Caudal rami (Fig. 1B) slightly divergent, about 5 times as long as wide, lateral margins with a long saw; saw teeth rather long and setiform, 4 distal teeth longer than half of ramus width (Fig. 1C). Variation among 5 females measured: length/width proportion 4.7–5.2; 3–5 distal teeth longer than half of ramus width.

Length proportions of terminal setae, beginning from outermost caudal seta: 1./3.75/6.85/1.38. Dorsal seta 0.63 and lateral seta 0.42 of length of outermost seta.

Antennules with 12 segments, reaching middle of first free thoracic segment, last three segments with very narrow and smooth hyaline membrane (Fig. 2A). Setation of segments beginning from first: 8/4/2/6/4/2/2/3/2/2/3/8. First segment with row of long setae at its basis.

Antenna 4-segmented, with seta number and length common to members of genus (Fig. 2B).

Antennal basipodite micropatterns (Fig. 2C, D); anterior surface with two sets of long hair-like spinules distally and laterally, with 3 parallel rows of spinules placed diagonally on central part, 2 groups of long spinules on right and 2 groups of shorter spinules on left lateral sides (Fig. 2C); posterior surface with very wide spiniform process near lateral setae, and group of long spinules on right distal part, 4–5 strong spinules on centre of distal part and with 6 groups of small spinules on central part, as illustrated in Fig. 2D.

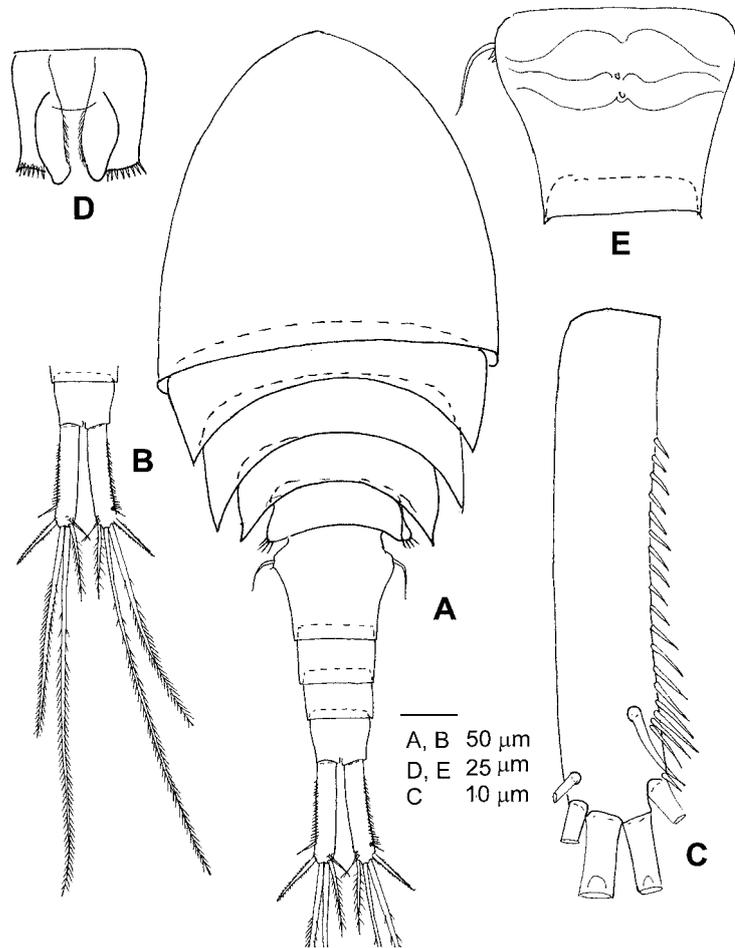


Fig. 1. ZIN 55050 (holotype), *Eucyclops albuferensis* sp. nov., female. A – common ventral view; B – caudal rami, dorsal view; C – caudal ramus with lateral setules, dorsal view; D – caudal somite, dorsal view; E – genital double somite, ventral view.

Mandible (not shown) typical for genus, with 6 teeth distally, rudimentary endopod with 2 long setae and 1 short seta.

Maxilla (Fig. 3F) comprising precoxa with 6 strong teeth and 2 strong setae; 2-segmented palp, distal article with 3 long hair-like setae and proximal article with 4 strong setae subequal in length and without spinules on lateral surface.

Maxillula (Fig. 2E) of 4 segments: precoxa with 2 strong setae in middle; coxa with strong spine in middle, small seta and strong spine distally; basal endite with 2 very strong spines and small setae near place of

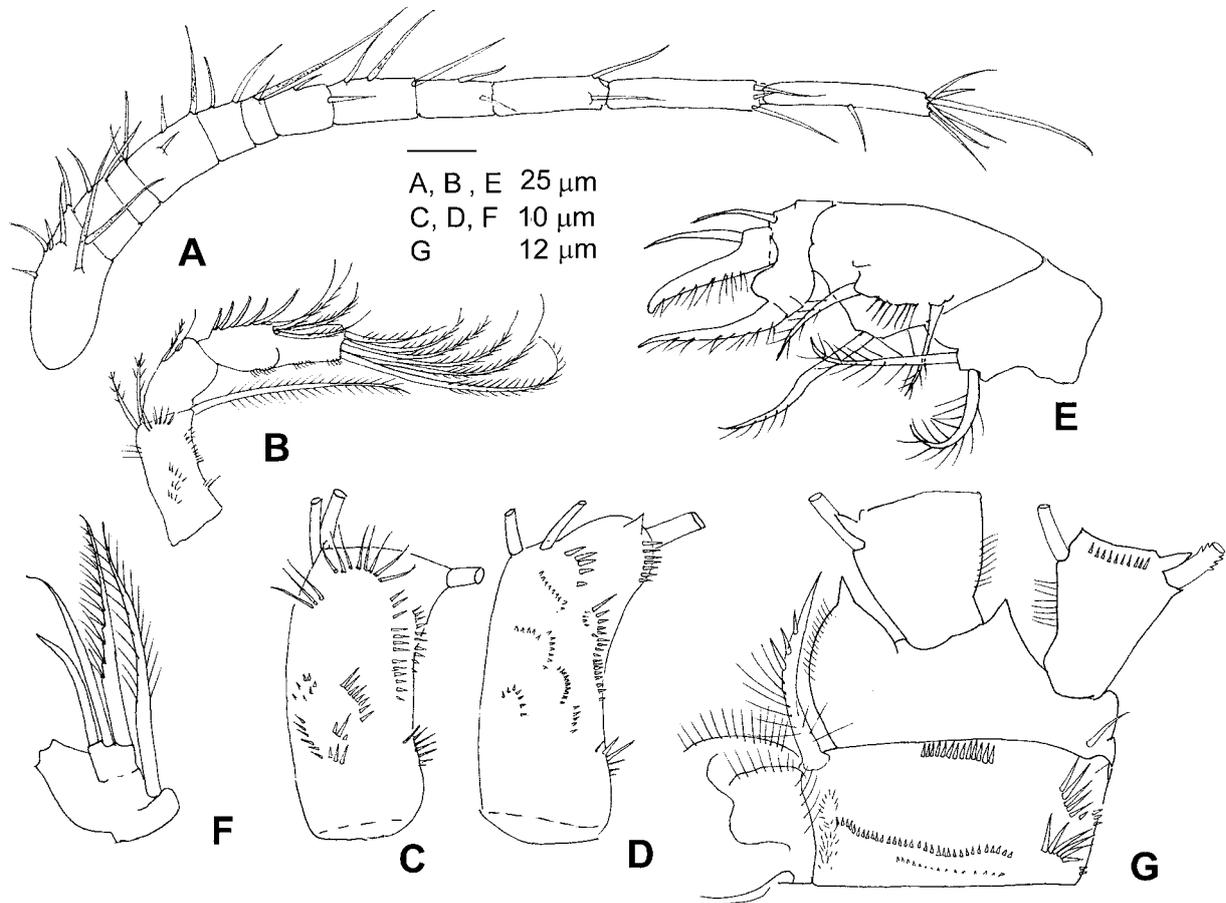


Fig. 2. ZIN 55050 (holotype), *Eucyclops albuferensis* sp. nov., female. A – antennula; B – antenna, ventral view; C, D – antennal basipodite anterior and posterior view; E – maxillula, ventral view; F – maxillar palp, ventral view; G – coxa PIV, ventral view.

fusion of rudimentary tip, bearing 2 long spines, seta with long hairs and 2 naked setae.

Maxilliped (not shown) typical for genus with 4 segments: precoxa + coxa with 2 strong setae in middle part; basis with 3 setae of different lengths and group of strong spinules in middle near insertion of lateral seta; 1 segment of endopodite with strong spine, rudimentary remaining segments of endopodite with strong spine and 2 naked setae.

P1–4 (Figs. 3, 4) with 3-segmented rami; spine (Arabic)-seta (Roman) formula of EXP/END P1–4 as follows: 3V/1V–4V/1V–4V/1V–3V/2V. Distal segment END P4 elongated, 2.47 times as long as wide, with two strong spines distally, inner spine 1.4 times as long as outer spine. Variation among 5 females measured: ENDP4 2.42–2.54 as long as wide, inner spine 1.34–1.45 times as long as outer spine.

Distal spines of P4 EXP about half of nearest seta and about half of distal segment length (Fig. 4C). Inner edge of basipodites P1–4 with long hair-like setae. Basipodite of P1 with relatively short spine on inner process, reaching distal end of second segment of END. Intercoxal sclerite P1 with row of small spinules in middle part and without hairs on free edge. Intercoxal sclerites of P2–3 curved on free edge and with groups of hair-like setae. Intercoxal sclerite P4 curved, with short posterior hair-like setae on its free edge, with 2 groups of long hairs as shown in Fig. 3A. Coxa P4 with strong spine bearing 3–4 dentiform spinules on distal part and dense hair-like setae on proximal part on inner margin of coxal spine and without hair-like setae on its outer side. Caudal side of coxa P4 with many tiny spinules on inner side in groups and several groups of spinules and hairs, as shown in Fig. 2G.

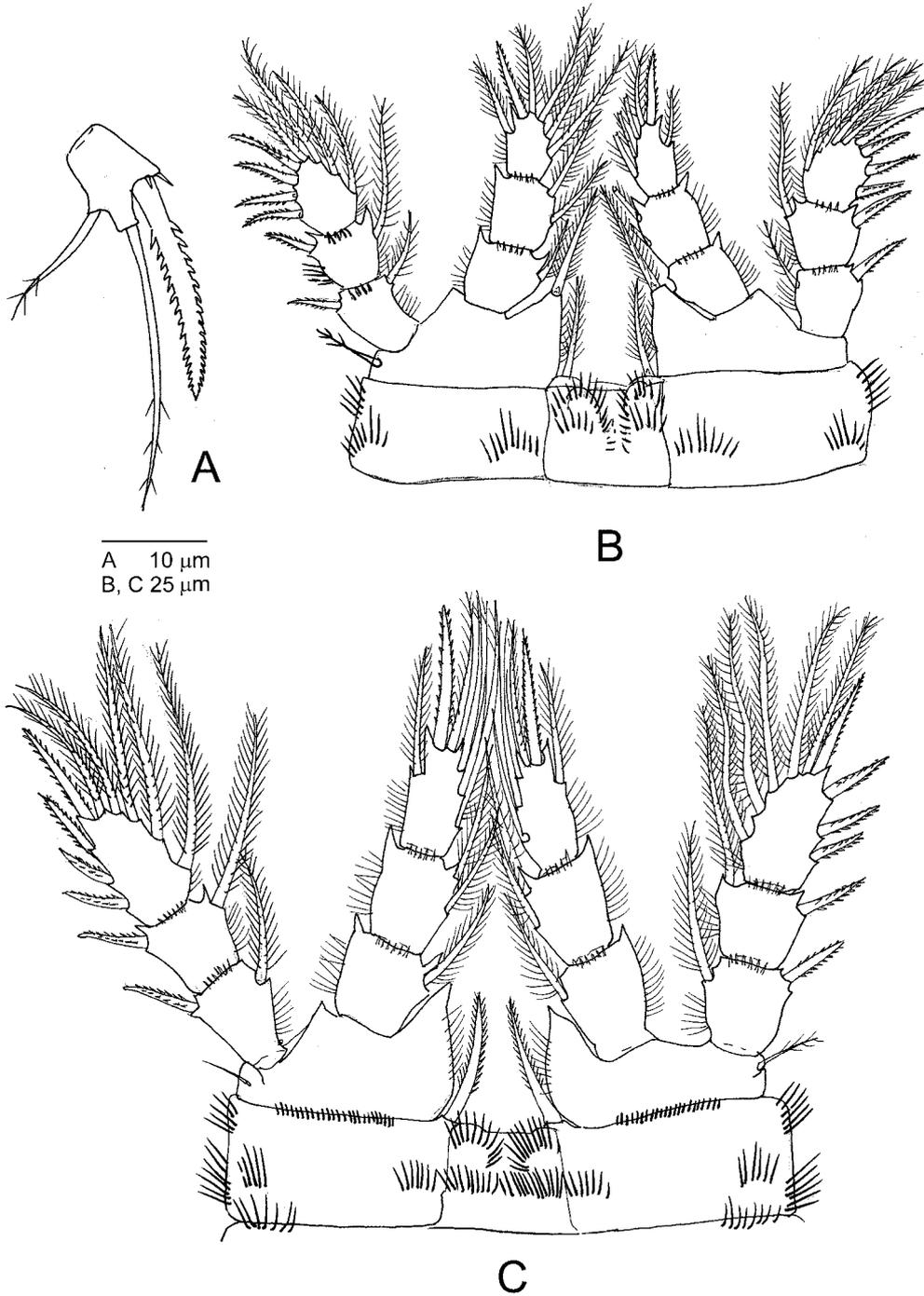


Fig. 3. ZIN 55050 (holotype), *Eucyclops albuferensis* sp. nov., female. A – P5, ventral view; B – P1, ventral view; C – P2, ventral view.

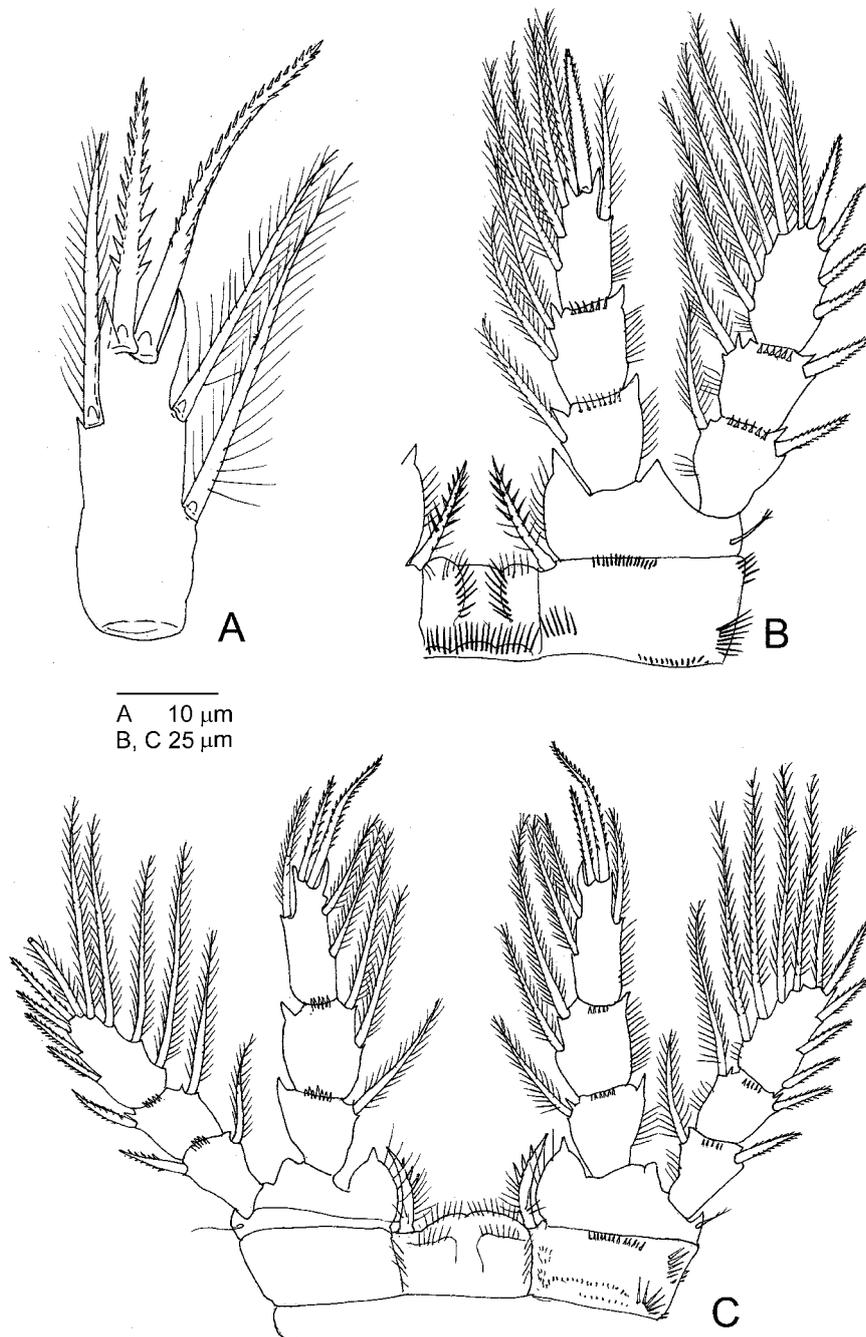


Fig. 4. ZIN 55050 (holotype), *Eucyclops albuferensis* sp. nov., female. A – distal segment ENDP4, ventral view; B – P3, ventral view; C – P4, ventral view.

Rudimentary P5 1-segmented, with strongly bent inner spine about twice as long as segment with 2 small spinules near its insertion; with 2 setae, outer seta shorter than spine, middle seta about 1.2 times as long as spine (Fig. 4C).

Egg sacs with 10–15 eggs each.

Male (Fig. 5). Body length 720 μm , with caudal setae 1050 μm , in live and freshly conserved specimens blue-grey in colour, genital somite yellowish orange. Second male length 780 μm , with caudal setae 1070 μm .

Cephalothorax 1.3 times as long as wide – maximum width close to caudal end.

Last thoracic segment without setae on lateral margin (Fig. 5A).

Caudal rami 4 times as long as wide, without setules on its lateral edge, inner seta about twice as large as outer seta. Lateral seta placed on dorsal side, with several spinules at its base. Dorsal seta placed near insertion of innermost seta, about as long as outermost seta (Fig. 5B).

Antennule 14-segmented, setation (Arabic)-aesthetasc (Roman) formula of segments beginning from first: 4–IV/3–I/2/1–I/1/0–II/1/3/2/2/2/5–I. First segment with row of long setules at its basis (Fig. 5C).

Antennal basipod with 2 long hair-like spinules on anterior side, other groups as in Fig. 5D. Posterior side with 3 strong spines and 3 rows of spinules in central part and with 3 hair-like spinules at distal process (Fig. 5E).

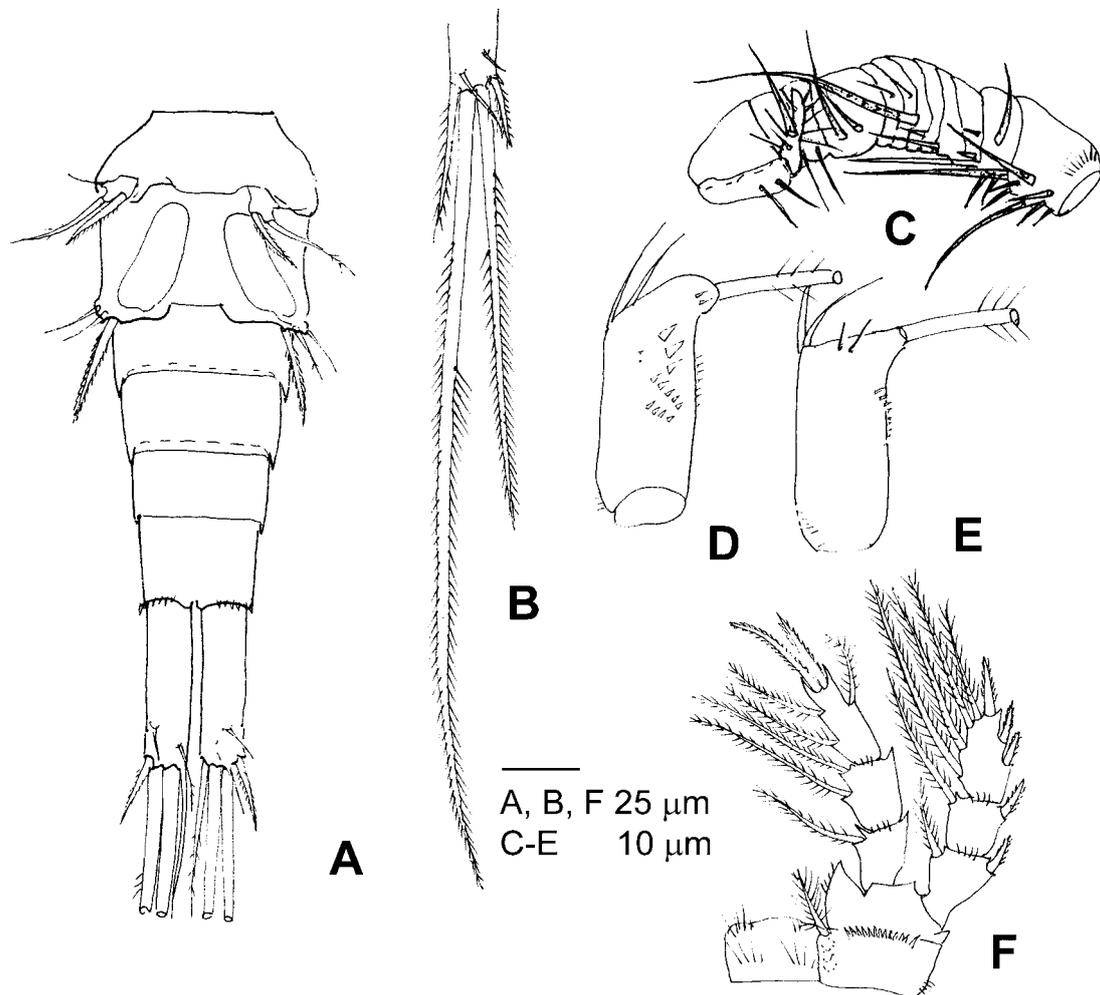


Fig. 5. ZIN 55051 (paratype), *Eucyclops albuferensis* sp. nov., male. A – abdomen, ventral view; B – caudal ramus, ventral view; C – antenna, ventral view; D, E – antennal basipodite posterior and anterior views; F – P4, ventral view.

Mouth appendages (not shown) and **P1–4** basically as in female. Distal segment END PIV 2.5 times as long as wide, with inner spine 1.3 times as long as segment and 1.4 times as long as outer spine. Inner edge of basipodite P4 with short, hair-like setae, coxa of P4 with strong inner spine (Fig. 5F). Coxa with narrow row of small spinules on inner side and several groups of spinules on its caudal side, similar to female (Fig. 5F). Coxal spine with long hairs on both sides. Intercoxal sclerites of P4 with strong hairs on free edge and several groups of hairs on surface, as shown in Fig. 5F.

Rudimentary P5 with bent spine and 2 setae, similar to female. Outer setae 1.5 times shorter than spine, middle setae 1.8 times as long as spine (Fig. 5A).

Rudimentary P6 with rather long slightly bent inner spine and 2 short setae, equal in length, about half of spine length (Fig. 5A).

Comparison. A recent re-description of *Eucyclops serrulatus* (Fischer, 1863) from the type locality indicated the significance of the micro patterns of antennal basipod and coxa of P4 as a diagnostic character for a better delineation among species in the *serrulatus*-group (Alekseev et al. 2006).

The newly described *Eucyclops albuferensis* sp. nov. belongs to the *serrulatus*-group, that includes about 35 valid species (Alekseev, unpublished). That becomes clear from the characters of the antennules (12-segmented with smooth hyaline membrane), an-

tennal basipod (with hairs on anterior surface) and caudal rami (with un-reduced setules, and an absence of hairs on the inner surface). A full list of references for the serrulatus-group is described in the above mentioned paper (Alekseev et al. 2006).

The species described here was certainly misidentified as *Eucyclops serrulatus* (Fischer, 1863) in previous studies. *E. serrulatus* also inhabits the Valencia area (Alekseev unpubl.). The here described *E. albuferensis* sp. nov., even without dissection can be distinguished from *E. serrulatus* by the observation of setules on the caudal rami. No one from known populations or morphological forms of *Eucyclops* in Europe has such long teeth on the lateral sides of the caudal rami, which in *E. albuferensis* sp. nov. are about half the width of the caudal ramus.

Only few species of the world fauna have similar construction of caudal rami. *E. bondi* Kiefer, 1934 with much shorter caudal rami (up to 3.5 as long as wide) was described from Haiti. *E. demacedoi* Lindberg, 1957 with serrated hyaline membrane on 3 distal articles of antennules is known from Peru. The most close to *E. albuferensis* sp. nov. is *E. vandouwei* (Brehm, 1909) from equatorial Africa. From the last one the new described *E. albuferensis* sp. nov. can be easily separated by more long inner spine in P5 that is twice of P5 segment length (in *E. vandouwei* the spine and the segment are almost equal in length), by shorter outermost caudal seta that about 1.5–1.7 times as long as caudal rami length (in *E. vandouwei* this seta and rami are sub equal in length). In *E. vandouwei* the distal segment of exopodite P2 with a reduced spine, and there is no such spine reduction in *E. albuferensis* sp. nov.

Eucyclops albuferensis sp. nov. is distinguishable from other conspecifics by a combination of characters that includes very long spinules on the distal outer side of the caudal rami, the absence of spinules on the hyaline membrane on the 3 distal segments of

the antennules, a unique combination of groups of hairs and spinules on both sides of the antennal basipodite, and a reduction of hairs on the inner coxal spine of P4. *Eucyclops albuferensis* sp. nov. is possibly one of the endemics of the Valencia lowland area that are also known from decapods, mollusks and cyprinodont fishes (Margalef 1983).

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