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Some noteworthy free-living copepods from surface freshwater in Belgium

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ABSTRACT. *Cyclops singularis* Einsle, 1996 has only recently been separated from *Cyclops strenuus* Fisher, 1851. It was described from temporary waters in South Germany and has now been rediscovered in a similar environment in Flanders. Of the confused genus *Acanthocyclops*, we find that there is at least three species living in Belgium. One of these, here named *Acanthocyclops americanus* (Marsh, 1892) is related to but different from *A. robustus* (Sars, 1863) and *A. vernalis* (Fischer, 1853), both of which were previously known from Belgium. These three species are all subject to nomenclatorial uncertainty, which we suggest should be solved by the designation of neotypes by a college of representative copepodologists. *Paracyclops affinis* (Sars, 1863) and *Elaphoidella gracilis* (Sars, 1863), both from a smallest artificial pond, are second records from Belgium.

KEY WORDS: Copepod fauna, fresh water, Belgium, cyclopoids, harpacticoids, biogeography.

INTRODUCTION

Until recently, the list of free-living fresh- and brackish-water copepods of Belgium stood at 71 species and subspecies (DUMONT, 1989). A recent paper on the fauna of leaf litter copepods increased that number to 80 species (FIERS & GHENNE, 2000). However, since over 500 species of copepods are known from the continental waters of Europe (KIEFER, 1978), it should not come as a surprise that each sampling effort adds one of more species to the Belgian list.

MATERIAL AND METHODS

Most of our material was collected in May-October 1999 in a series of water-bodies in the vicinity of Ghent and in some city ponds: seven ponds, four temporary pools, four drainage canals and two roadside ditches in all. Plankton and near-shore communities were sampled with a plankton net with a mesh size of 100 um. For each sample about 100 l. of water were filtered. Samples were preserved in 70% ethanol and analysed few days after collection. Animals were placed in glycerol, dissected and drawn with a camera lucida, using a Leitz-Wetzlar microscope under oil immersion.

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For comparison we also collected *A. vernalis* from its type locality, a pond in the vicinity of St. Petersburg, Russia (spring 2001), and in lake Shohsee, Ploen, Germany (spring, 2002). All material used is kept in the collection of the Zoological Institute, Academy of Sciences, St Petersburg.

RESULTS

Thirty species of copepods were found. Two of these are new to Belgium, while two are second records for the country. Here, we give a brief description of these species, with illustrations of distinctive characters, as well as information on their ecology and status.

Cyclops singularis Einsle, 1996
(Fig 1, Fig. 5 B-D)

Material examined: 10 females and 4 males from the central park of Ghent and 3 females and 3 males from the botanical garden of Ghent University.

Female. Full body length without caudal setae 1.97-2.23 mm. Cephalosome 1.1 times as long as wide, with maximum width in the middle. Genital double somite conical, as long as wide, with small, round seminal receptacle. Distal part of the segment covered with pustules (Fig. 1A). Male spermatophores on ventral surface of the seg-

ment, shaped as in Fig 1A. Other segments of abdomen also with pustules on their surface. Caudal rami 6.1-6.3 times as long as wide, with long, dense hairs on their internal surface. Inner caudal seta bent distally. Relative lengths of distal setae, beginning from outer seta 1/3.6/4.1/2. Dorsal seta as long as outer seta. Antennule of 17 segments, reaching the middle of the first free somite. Basipod of second antenna at frontal side (Fig. 1C) with long line of robust spinules and group of small spinules mixed with small dots near insertion of two apical setae. At caudal side (Fig. 1D) this segment with three groups of large and three groups of tiny spinules. The above- mentioned pattern of small spinules mixed with small dots also present on the caudal side.

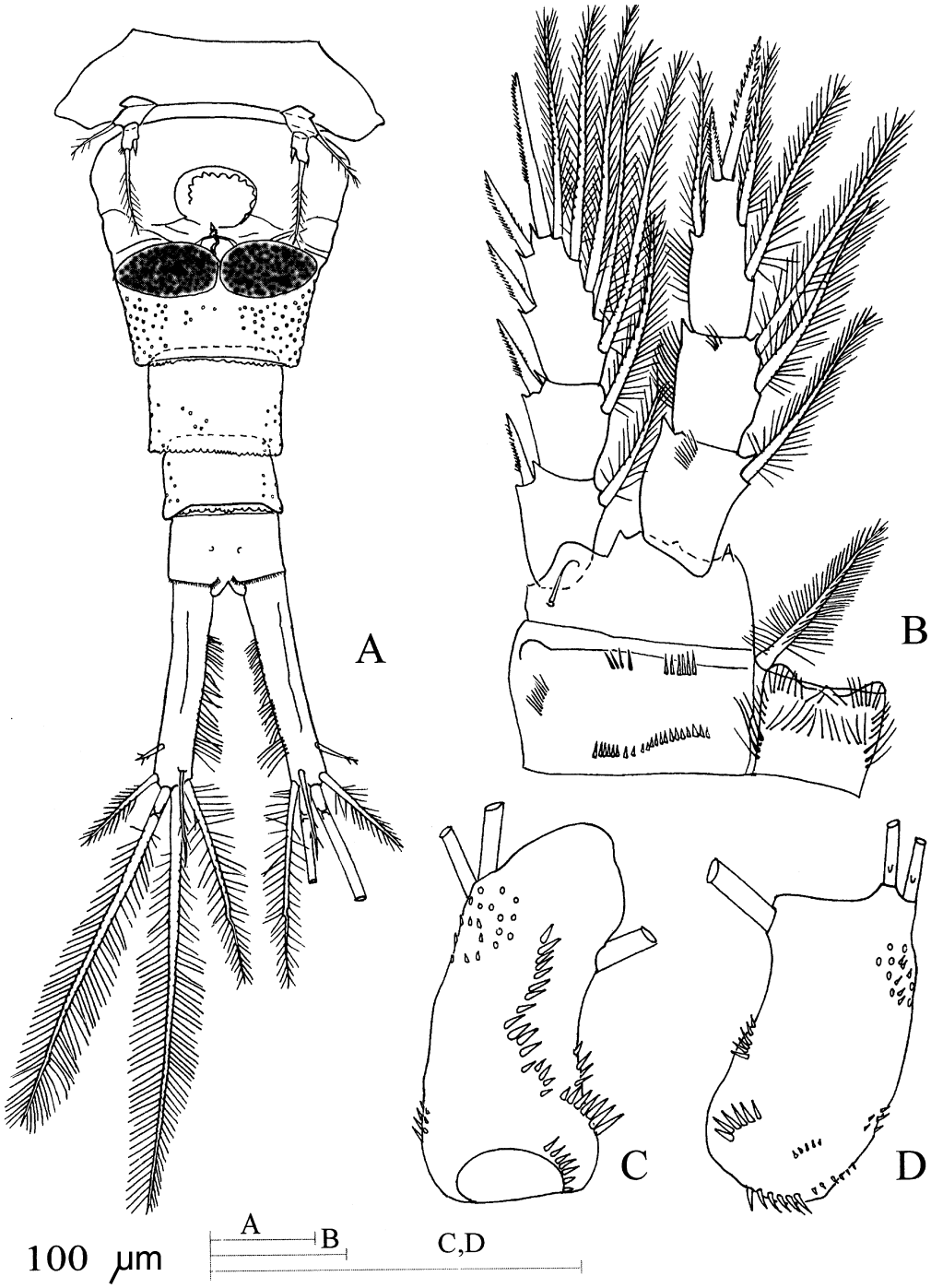

Fig. 1. – *Cyclops singularis* Einsle, female, Ghent, Belgium. A - abdomen, ventral view; B - Leg 4, caudal side; C,D -antennal basipod, frontal and caudal sides.

Swimming legs 3-segmented, with spine formula of distal exopod segments 3/4/3/3. Distal segment of endopod leg 4 about 2.5 times as long as wide. Distal inner spine of the segment about twice the length of outer spine. Coxal segment of leg 4 with three groups of spinules and a group of hair-spinules as shown in Figure IB. Intercoxal sclerite of leg 4 with two lines of hair-spinules and rather high hillocks on its free edge. Rudimentary fifth leg of 2-segments with rather weak inner spine at distal segment. Both setae of leg 5 relatively short.

Male. Full body length 1.65 mm. Genital somite without pustules and inner setae of caudal rami straight or only slightly bent in its last third. Coxal segment of leg 4, intercoxal sclerite of leg 4, and antennal basipod similar to that in female.

Differential diagnosis

C. singularis is easily separated from other *Cyclops* species by the segmentation of the antennula, the shape of the genital somite, the presence of pustules on its distal part, the inner caudal seta bent in its distal sector, the relative length of the distal spines of endopod P4, and the armament of the coxal segment of leg 4.

Distribution and ecology

This species was found in June and October in a small pond collecting water from a fountain in the central parc of Ghent, and in two micro reservoirs for water plant cultivation in the botanical garden of Ghent University. All these artificial biotopes exist in summer and dry up in winter. The maximum abundance of the species was about 500 ind. m^{-3}.

Acanthocyclops americanus (Marsh, 1892)

(Figs 2, 4, 5)

Material examined: 40 females and 15 males from a land-locked, slightly brackish-water creek in Jan-in-Eremo (Belgium) and 12 females and 5 males from the central park of Ghent.

Female. Full body length without caudal setae 1.00-1.2. mm. Cephalosome as long as wide, with maximum width in last third of its length. Genital double somite 1.3 times as long as wide, with relatively big, ellipsoid seminal receptacle. Seminal receptacle in its frontal part with wide transparent zone, regarded as a specific feature separating it from *A. vernalis* (LOWNDES, 1926; RYLOV, 1948). Caudal rami 4.7-5.3 times as long as *wide.* Inner caudal seta twice as long as outer seta. Relative lengths of distal seta, starting from outer seta, 1/5/7.3/2. Dorsal seta 1.5 times as long as outer setae.

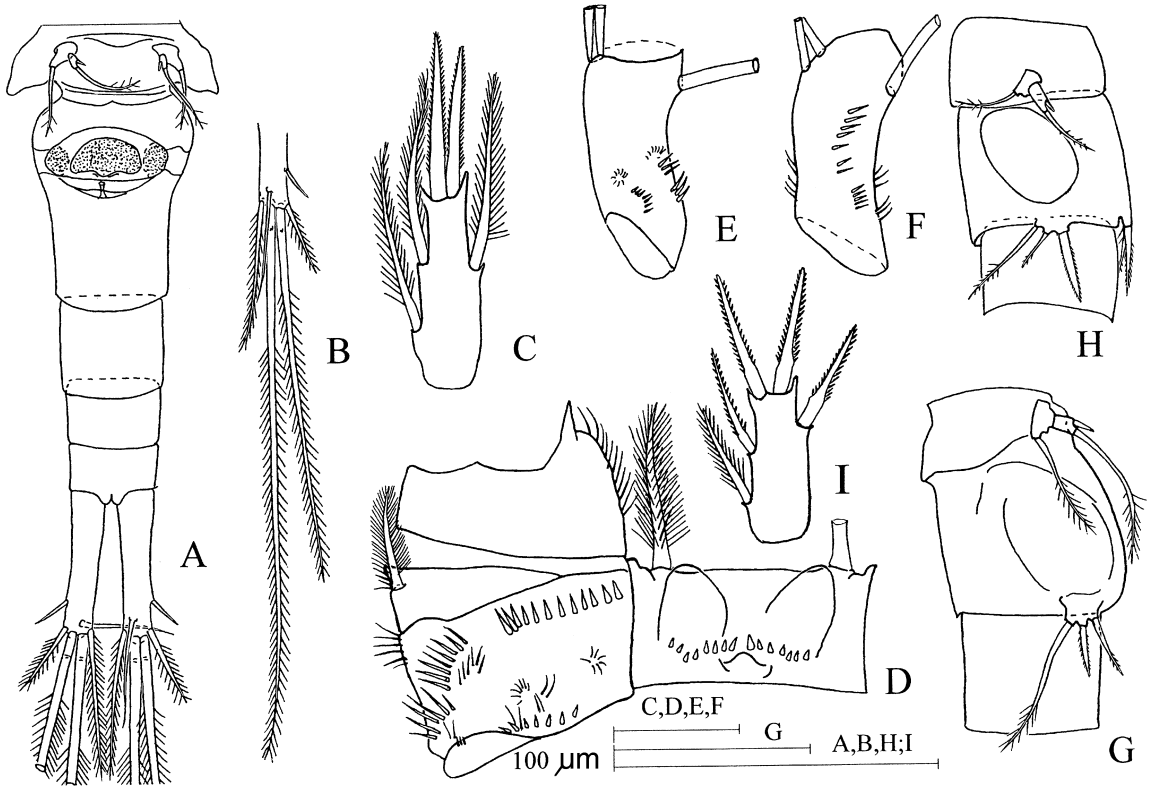

Fig. 2. – *Acanthocyclops americanus* (Marsh) (A-G) and *A. robustus* (Sars) (H-I) from Belgium. A-F -female; G-I - male. A - abdomen, ventrally; B - caudal ramus, dorsally; C - distal segment of endopod, leg4; D - coxa and intercoxal sclerite, leg 4 caudal side; E,F - antennal basipod, caudal and frontal sides; G,H - rudimentary legs 5 and 6, laterally; I - distal segment of endopod, leg4

Antennule of 17 segments, reaching first free somite. Basipod of second antenna at frontal side with three groups of spinules. Caudal side of this segment with three groups of strong spinules and two groups of hair-spinules.

Distal segment of endopod leg 4 about 2.6 times as long as wide. Distal inner spine 1.15 times longer than outer spine. Inner setae of this segment not transformed into spines.

Coxal segment of leg 4 with several groups of spinules and hair-spinules on caudal side. Intercoxal sclerite of leg 4 with line of spinules.

Rudimentary fifth leg 2-segmented, with rather strong inner spine at distal segment and two long setae, practically equal in length.

Male. Full body length 0.9-1.0 mm, rudimentary leg 6 (Fig. 2G) narrow plate with outer seta 2-2.5 times as long as inner seta or spine. Coxal segment of leg 4 with two groups of spinules and two groups of hair-spinules on caudal side. Intercoxal sclerite of leg 4 with line of spinules on top and line of spinules at the bottom.

Differential diagnosis

The discrimination of *A. americanus* from two closely related congeners is discussed below.

Distribution and ecology

A. americanus was found in abundance in the plankton of several pond-like water bodies in Belgium, e.g. the pond in the central park of Ghent, the pond of the botanical garden of Ghent University, and the brackish-water creeks of St. Jan-in-Eremo. In all of these, it was the dominant copepod species from May till October, reaching a density of 40,000 ind m^{-3} in June. The most likely explanation for the numerous records and rapid expansion of *A. americanus* in Europe and in Asia in the course of the 20th century is an involuntary man-mediated introduction from North America via Great Britain in the 19th century (Alekseev, 1998). Among other things, this may explain why Kiefer (1976) erroneously selected specimens of *A. americanus* as lectotypes of *A. robustus* from lake Mjosa in Norway (see further).

Elaphoidella gracilis
(Sars, 1863)

Material examined: 20 females from a small artificial pond in a private garden in St. Laureins (Belgium).

Female. Full body length without caudal setae 0.7-0.8 mm. Leg 1 is 3-segmented, legs 2-4 with 3-segmented exopods and 2-segmented endopods. Endopod of leg 4 with a seta at its first segment. Anal plate rounded, with numerous small spinules at free margin. Rudimentary leg 5 with elongated exopod, about twice as long as wide, bearing two short, spine-like setae, two long terminal setae and a short inner seta. Baso-endopod of leg 5 with two long medial setae and two short setae placed at both sides of the medial setae. Caudal rami conical, about two times as long as wide.

Differential diagnosis

The only congener of *Elaphoidella gracilis* currently known for Belgium is *E. leruthi* Chappuis, 1937, described from underground water (Leruth, 1939). Both are easily separated because leg 5 in *E. leruthi* has only three spiniform setae on its short exopod and three strong setae on its baso-endopod.

Distribution and ecology

This species was first found in May 2000, in a smallest artificial pond with brown-coloured water in the polder village of St. Laureins, 35 km north of Ghent, when it was the only species of copepod in the pond. Its density was about 2 l^{-1}. A second sample, collected in May 2001 again contained the species, this time accompanied by *Canthocamptus staphylinus* (Jurine, 1820) and *Paracyclops affinis* (Sars, 1863).

DISCUSSION

There is one previous record of *E. gracilis* from Belgium, at two sites, in leaf litter (Fiers & Ghenne, 2000), but it may have been missed by previous investigators because of its small size and low density in open water. Its recent discovery in a semi-terrestrial biotope suggests that it may be rather widespread (Fiers & Ghenne, 2000). *Paracyclops affinis* is listed in Lindberg's (1950) list of cyclopoids from Belgium, stating A. Capart as the collector, but without locality or other data. Dr Frank Fiers kindly checked the late André Capart's records at the Royal Institute of Natural Sciences, Brussels, and found one record but no voucher specimens: "Baudour, puddle in forest, 17 Oct. 1945". The present record of this highly distinctive species, the only European *Paracyclops* with an antennula of 11 segments (Karaytug, 1999), is therefore a welcome confirmation of its presence in Belgium.

In contrast, both first records represent previous confusions with related taxa. *C. singularis* has only recently been separated from some closely related congeners (Einsle, l996a), and the present record is only the second for this species, the first outside of Germany. As in the type locality, it was found in a temporary water body. Obviously, in many previous studies of this kind of environment, *C. singularis* may have been mistaken for the widespread *C. strenuus* Fischer, 1863.

A. americanus poses a more difficult problem. It was originally described by Marsh (1892) from the United States of America, but has been on record from Europe

since the early 20th century (LOWNDES, 1926). KIEFER (1976), in trying to work out the morphological differences between the related *A. robustus* and *A. vernalis,* sunk it into the synonymy of both. Its name was subsequently omitted from the world list of cyclopoids of DUSSART & DEFAYE (1985) while in EINSLE's (1996b) treatment of *Acanthocyclops*, KIEFER's view was accepted. The question, however, is whether this position can be maintained. As we will show hereunder, three species exist in Europe, one of which we here designate by the binomen *A. americanus* (Marsh, 1892). No type material of any of the three species has survived, and none of the three original descriptions or illustrations are adequate according to present-day standards. MARSH (loc. cit.) may not have had one, but two and possibly three species before him when describing *A. americanus*. However, the same applies to *A. robustus* and *A. vernalis* and, more broadly, to virtually all cyclopoids described in the nineteenth century. There is thus no ground for discriminating the name *americanus*. We also found *A. americanus* to occupy a specific niche in pond-like water bodies in Belgium, different from that of *A. robustus* and *A. vernalis*. We suggest several arguments in support of the existence of three species, and apply the name *americanus* to the "third species".

Morphological differences

Two morphological differences between *A. americanus* and *A. vernalis/robustus* were recognised by RYLOV (1948) and confirmed by MONCHENKO (1961). In female *A. americanus,* the frontal part of the genital double somite is rounded, while in *A. vernalis/robustus* it is triangular (Fig. 2). This character is clearly recognisable in Marsh's original description, and is our main argument upon which to found the specific nature of *A. americanus*. Unfortunately, KIEFER's (1976) revision of the "robustus-group" only added to the confusion, because at the outset, the specimens from Norway selected by him as lectotypes of *A. robustus* (KIEFER's figures 1-20) represented specimens of *A. americanus*, sensu the present paper. We have little doubt that these invaded Norway, as they did the rest of Europe, after Sars' time.

Males can be separated by the difference in length of the seta of rudimentary leg 6. In *A. americanus* the outer seta of leg 6 is 2-2.5 times the length of the seta-like inner spine.

In male *A. vernalis* the outer seta P6 is not more than 1.3-1.8 times the length of the strong inner spine (Fig. 2G-H, 3G).

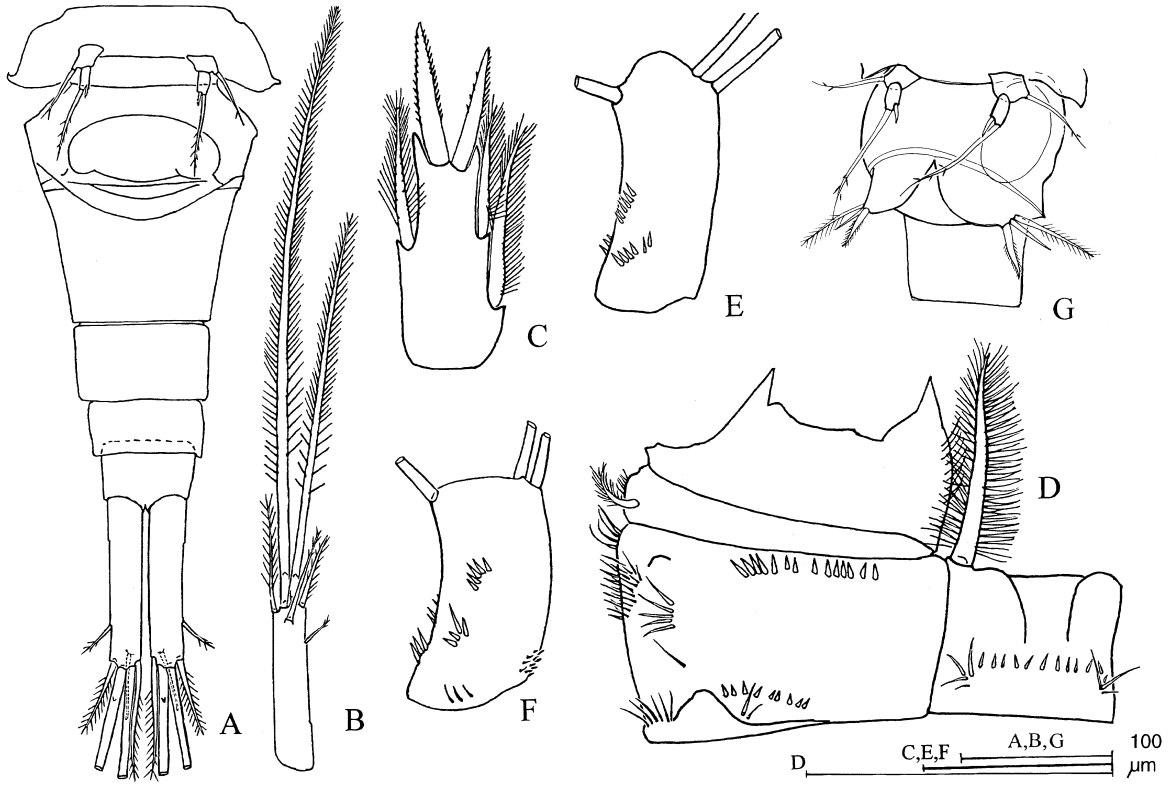

Fig. 3. – *Acanthocyclops vernalis* (Fischer), female, St. Petersburg, Russia (A-D) and male, Plön, Germany (G). A - abdomen, ventral view; B- caudal ramus, dorsally; C - distal segment of endopod, leg4; D - coxa and intercoxal sclerite, leg 4, caudal side; E,F - antennal basipod, frontal and caudal sides; G. P5 and P6.

A. robustus was discriminated from *A. vernalis* by SARS (1863) on evidence of the transformation of the inner seta of the distal segment of endopod leg 4 into a spine. Other taxonomic signatures of *A. robustus-vernalis* include the shape of the genital somite in females, while leg 6 in males is similar in both (GURNEY, 1933; RYLOV, 1948).

We confirm that *A. robustus* sensu Sars (1863) really exists in nature, by finding 5 females and 3 males of the species in a near-road ditch in the vicinity of Gent (see Fig. 2H-I, 4A,C,E). Some morphological features of *A. vernalis,* a species described by S. FISCHER from Russia, can also be seen in Fig. 4. All these differences were well exemplified by specimens of *A. americanus* from Belgium. We could easily separate it from *A. vernalis* as well as from *A. robustus* by the shape of the genital somite in females and the armament of P6 in male. There are also differences between the three species in the armament of the intercoxal sclerite of leg 4. In *A. americanus,* we found a curved row of strong denticles on the caudal surface of the sclerite. In *A. vernalis* these denticles were slender and never produced a wavy row, and two groups of hair-like spinules occurred on both sides of the line of denticles. In *A. robustus,* the denticles were strong and formed a straight line.

Fig. 4. – SEM's of A. *Acanthocyclops robustus*, endopod 3 of P4; B. *A. americanus*, endopod 3 of P4; C. *A. robustus*, P6; D. *A. americanus*, P6; E. *A. robustus*, furca, F. *A. americanus*, furca (terminal external seta arrowed). All scales represent 10 micrometers.

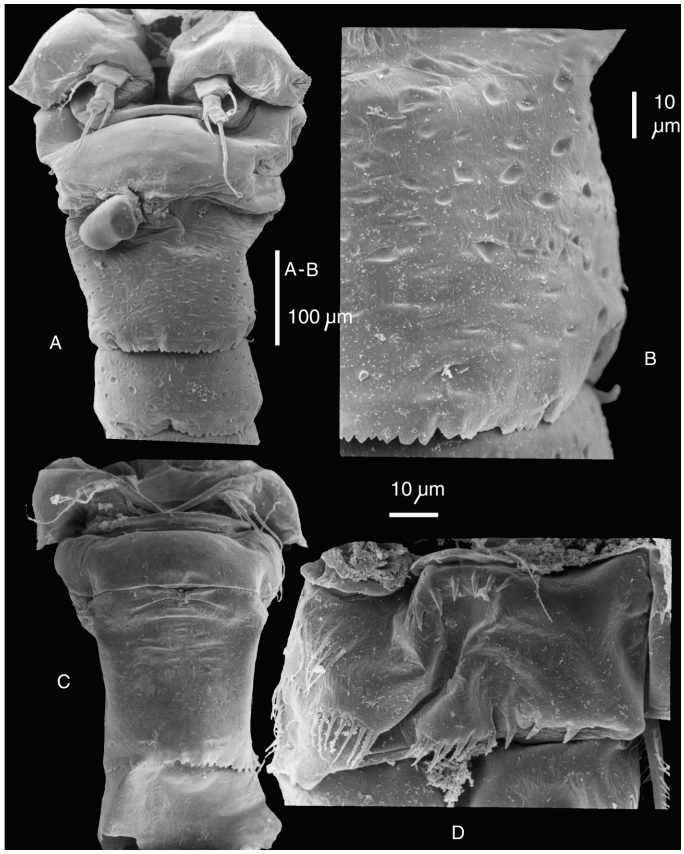

Fig. 5. – SEM's. A. *Acanthocyclops americanus*, P5 and genital segment in ventral view; B-D. *Cyclops singularis*. B. P5 and genital segment, ventral view, C. Pitted surface of the genital segment, D. Coxa of P4.

Ecological differences

A. americanus is a pelagic animal, inhabiting eutrophic water bodies. In recent decades, it became the dominant form of the summer limnetic plankton in reservoirs on the River Volga and the Dniepr (MONCHENKO, 1961, 1974; ALEKSEEV & KOSOVA, 1977). Its abundant representation in eutrophic lakes and lakelets in Belgium may, likewise, be of relatively recent date.

A. vernalis and *A. robustus* inhabit the near-shore area and/or near-bottom zone in lakes. They are rarely collected mixed with truly planktonic species.

Some differences in behaviour between nauplii of *A. vernalis* and *A. americanus* have also been documented (ALEKSEEV, 1983). These reflect the ecological preferences of each species. Nauplii of *A. vernalis* live a benthic life. In samples, they often attach to glass walls. When shaking a jar, they seek refuge on the bottom. Nauplii of *A. americanus*, conversely, behave like planktonic animals. They never attach to surfaces and, when stressed, swim around in the water column.

Finally, in all cases where we found *A. vernalis* and/or *A. robustus* together with *A. americanus,* no hybrids were detected (ALEKSEEV & KOSOVA, 1986).

CONCLUSION

Rather than creating a new name, we maintain *A. americanus* (Marsh, 1892) as a valid species, morphologically and ecologically separated from *A. vernalis* (Fischer, 1853) and *A. robustus* (Sars, 1863). This species is currently an important element of eutrophic, limnetic plankton communities in Europe but is likely an early invader from North America. We realise that the objection "original description insufficient" may be raised, but at least one diagnostic female character can be seen on the original illustrations. Stability may thus be served best by preserving the available name *A. americanus* beside those of *A. robustus* and *A. vernalis*, after – *inter alia* – selecting a neotype for each. We refrain from doing this here, because we would rather see a representative group of todays' copepodologists reach a consensus on this question.

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