

Acanthocyclops sensitivus (Graeter & Chappuis, 1914) (Copepoda : Cyclopoida) in Austria

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Keywords : *Acanthocyclops*, Crustacea, Cyclopidae, groundwater, Austria, Lobau.

Acanthocyclops sensitivus is a widely distributed European groundwater dwelling cyclopoid. In this study, specimens collected in Austria from the environs of Vienna and the Provinces of Lower Austria and Salzburg are described in detail. *A. sensitivus* is clearly discernible from other *Acanthocyclops* species, such as *A. venustus*, *A. gmeineri*, *A. vernalis* and *A. robustus*, by the morphology of the antennule, ornamentation of the antennal basipodite, the setation of the maxilliped and the seminal receptacle. These differences suggest an only distant relationship between *A. sensitivus* and the other representatives of this genus (excluding *A. parasensitivus*).

Acanthocyclops sensitivus (Graeter & Chappuis, 1914) (Copepoda : Cyclopoida) en Autriche

Mots-clés : *Acanthocyclops*, Crustacea, Cyclopidae, eaux souterraines, Autriche, Lobau.

Acanthocyclops sensitivus est une espèce de cyclopoïde largement répandue dans les eaux souterraines d'Europe. Cette espèce est redécrite en détail en utilisant des exemplaires autrichiens provenant des environs de Vienne, ainsi que de plusieurs stations distribuées dans les provinces de la Basse Autriche et de Salzbourg. *A. sensitivus* se distingue clairement des autres espèces d'*Acanthocyclops*, comme *A. venustus*, *A. gmeineri*, *A. vernalis* et *A. robustus* par la morphologie de l'antennule, l'ornementation du basipodite de l'antenne, la chétotaxie du maxillipède ainsi que la forme du réceptacle séminal. Les différences morphologiques décrites ici suggèrent l'existence de relations lointaines entre *A. sensitivus* et les autres représentants de ce genre (à l'exception de *A. parasensitivus*).

1. Introduction

Three arguments justify a detailed description of *Acanthocyclops sensitivus* (Graeter & Chappuis 1914). First, the discovery of the sister-species in North America by Reid (1998) gave the initial impetus to a thorough investigation of my material. Second, Kiefer (1957) remarked that *A. sensitivus* had some unusual features as compared to other species of that genus, and hence proposed a new subgenus, *Rhenocyclops* Kiefer 1957. I discovered more such features (Pospisil 1994). Third, progress in cyclopoid systematics em-

phasizes the need to consider additional traits such as, for instance, the mouthparts. However, it was not state-of-the-art to include drawings of all appendages for a long time. That proved to be a great obstacle to the progress of cyclopoid systematics (Pescè 1996). I therefore supply a more detailed description of my material than was common practice in Graeter's and Chappuis' time.

2. Material and methods

Material examined : Specimens from "Lobau" riverine wetlands in Vienna, Austria (Pospisil 1994) : 13 female specimens from well A 81 (coll. 5/7/1988 and 10/8/1988), well A89 (coll. 19/7/1988 and 12/11/1992), well A87 (coll. 5/7/1988) and well D15 (coll. 27/4/1992) ; 4 male specimens from well A89

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(coll. 19/7/1988) and well D15 (coll. 27/4/1992), all about 8 to 10 m deep.

1 female from the spring of a brook in Kleinzell, Lower Austria (coll. 09/05/1991).

1 female from piezometers approx. 6 m deep and 150 m distant from Taugl-stream in Salzburg Province (coll. 05/1993).

The Lobau samples were retrieved with the double-packer-sampler (Danielopol & Niederreiter 1987). The Kleinzell sample was taken by ramming a Bou-Rouch-pump (Bou & Rouch 1967) into the mouth of the spring. The Taugl sample was taken with the help of a motor pump; groundwater was pumped out for 1 h and filtrated through a 100 µm-mesh net. All animals mounted on slides in glycerine, leg. and coll. P. Pospisil, except the Taugl specimen which was collected by D. Danielopol.

3. Description

Length of females: (excluding caudal setae) average 849 µm (range 743-930); males: average 763 µm (range 710-786).

Antennule of female of 17 articles; Cyclopinae-type (Pospisil & Stoch 1997) aesthetasc on article 12, reaching border of article 15 (Fig. 1). Antennule of male of 17 articles; 7 Cyclopinae-type (Pospisil & Stoch 1997) aesthetascs on articles 1 (3 aesth.), 4, 9, 13 and 15 (1 aesth., resp.) (Fig. 1).

Antenna 4-segmented, with ornamentation of basipodite strongly developed (Fig. 1).

Mandible, maxillula, maxilla, and maxilliped as in Fig. 2. Basipodite of maxilliped with only 2 setae.

Legs 1 - 4 (P1 - P4) similar in both sexes, with triarticulated rami (Fig. 3). Spine formula 2.3.3.3; setal formula of third exopodites of P1 - P4: 5.4.4.4; setal formula of third endopodites of P1 - P4: 4.4.4.2. P1 with inner marginal seta of basipodite reaching to middle of third article of endopodite and terminal spine of third article of endopodite almost twice as long as article. P1 - P4 without seta on inner margin of first article of exopodite, with seta on outer margin of endopodite of distal article; P4 with third article of endopodite 1.9 times longer than broad; length of inner spine about 0.9 of terminal article; ratio of lengths of outer/inner spine about 1.6; couplers of P4 without spines; caudal side of coxopodite of P4 armed with row of spines near distal margin and one row of longer spines near basal edge. None of first articles of exopodites of P1 - P4 bearing a seta on inner margin.

P5 (Fig. 3) with first article quite narrow, with short seta. Short spine on second article almost in distal position.

P6 of female consisting of two very small spinules and small seta, P5 of male (Fig. 4) of two spines and one seta, all larger than in female.

Genital segment of female broadly cone-shaped, with seminal receptacle typically shaped like a butterfly (Fig. 4). Segments of abdomen mostly telescoped giving a short appearance relative to genital segment. Posterior hyaline margins of urosomites (except anal somite) not serrated. Distal margin of segment 4 (segment 5 in male) of abdomen ventrally with row of spines, dorsally (on both sides of anal operculum) only in male; females sometimes having few short spinules instead (Fig. 4). Anal operculum without any spinules posteriorly in both sexes.

Female furcal rami 2.7 (2.5-3.0) times longer than broad, male furcal rami 2.5 (1.9-2.7) times longer than broad. Inner surfaces typically smooth. However, four of Lobau-specimens with few transverse spinules on inner margin (example in Fig. 4), two of them only on one (the right) ramus. Marginal seta mean length 32 µm and 28 µm (female and male, resp.), inserting at about two thirds from base of furcal ramus. Origin of marginal seta of male flanked by three or four triangular spinules. Inner terminal seta about 2.35 times longer than outer terminal seta (female). Length of terminal setae 67/347/529/158 µm (outer to inner, mean of available values) in female, 58/315/479/154 µm in male (mean). Dorsal setae mean 68 µm (female) and 56 µm (male).

4. Discussion

According to its P5, this species is attributed to the genus *Acanthocyclops* (Kiefer 1927). However, Kiefer (1957) remarked on deviations from the usual *Acanthocyclops*-patterns (as encountered in *A. venustus* (Norman & Scott 1906), *A. vernalis* (Fischer 1853), *A. robustus* (Sars 1863) and *A. gmeineri* Pospisil 1989, representatives of which were used as comparative material for this investigation). These deviations were the setation of the swimming legs (no inner seta on the first article of the exopodites, only one seta on middle articles of all endopodites) and the shape of the receptaculum seminis. He consequently established a subgenus, *Rhenocyclops* Kiefer 1957. On looking closer, one can find additional unusual features. First, the spinule pattern of the basipodite of the antenna is quite strongly developed and has many small spinules not observed in the species compared (for *A. vernalis* and *A. ro-*

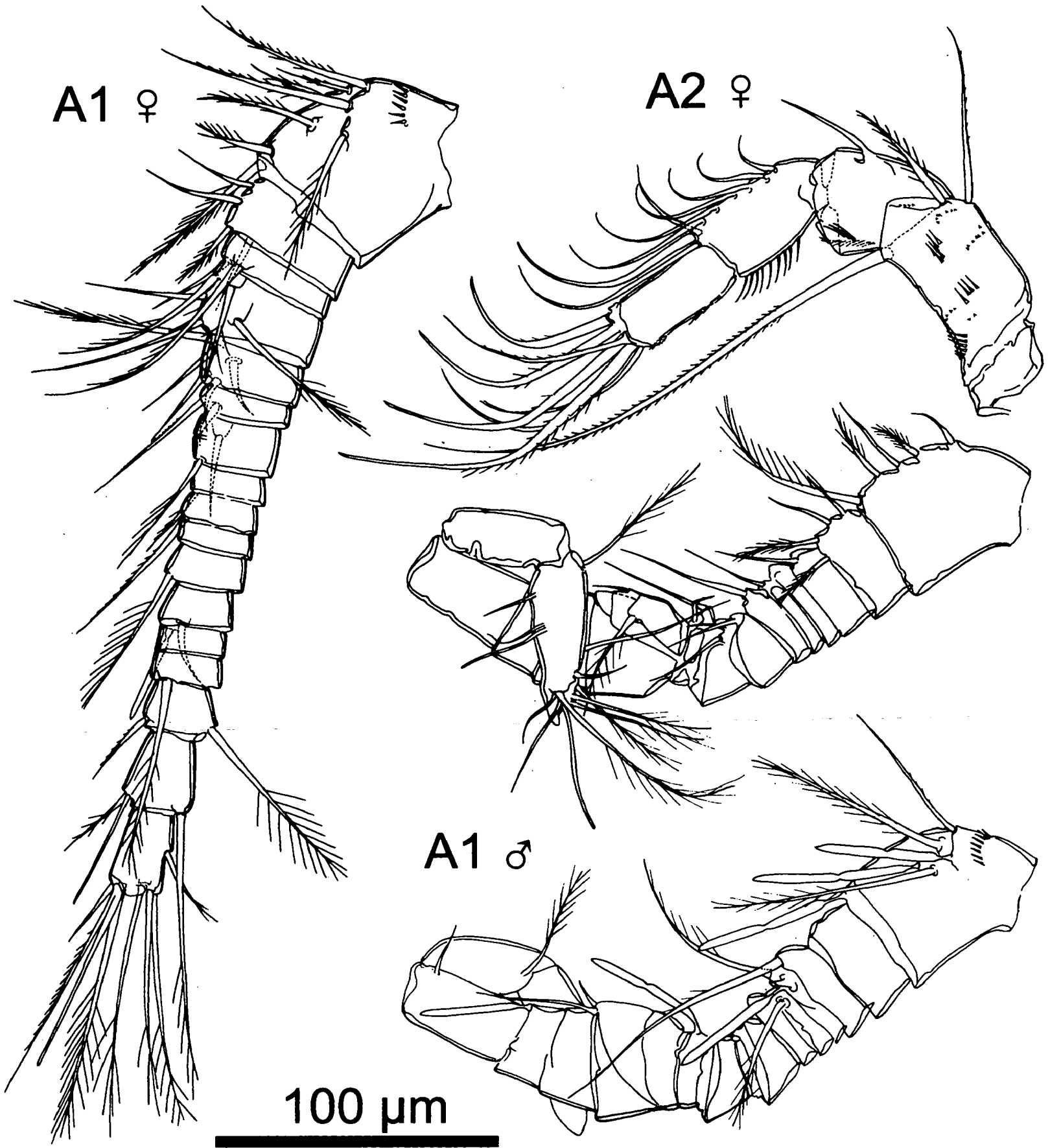


Fig. 1. *Acanthocyclops sensitivus* (Graeter & Chappuis, 1914), Lobau groundwater. (A1) antennule ; (A2) antenna of female and male.

Fig. 1. *Acanthocyclops sensitivus* (Graeter & Chappuis, 1914), Lobau nappe alluviale. (A1) antennule, (A2) antenne de la femelle. et du mâle.

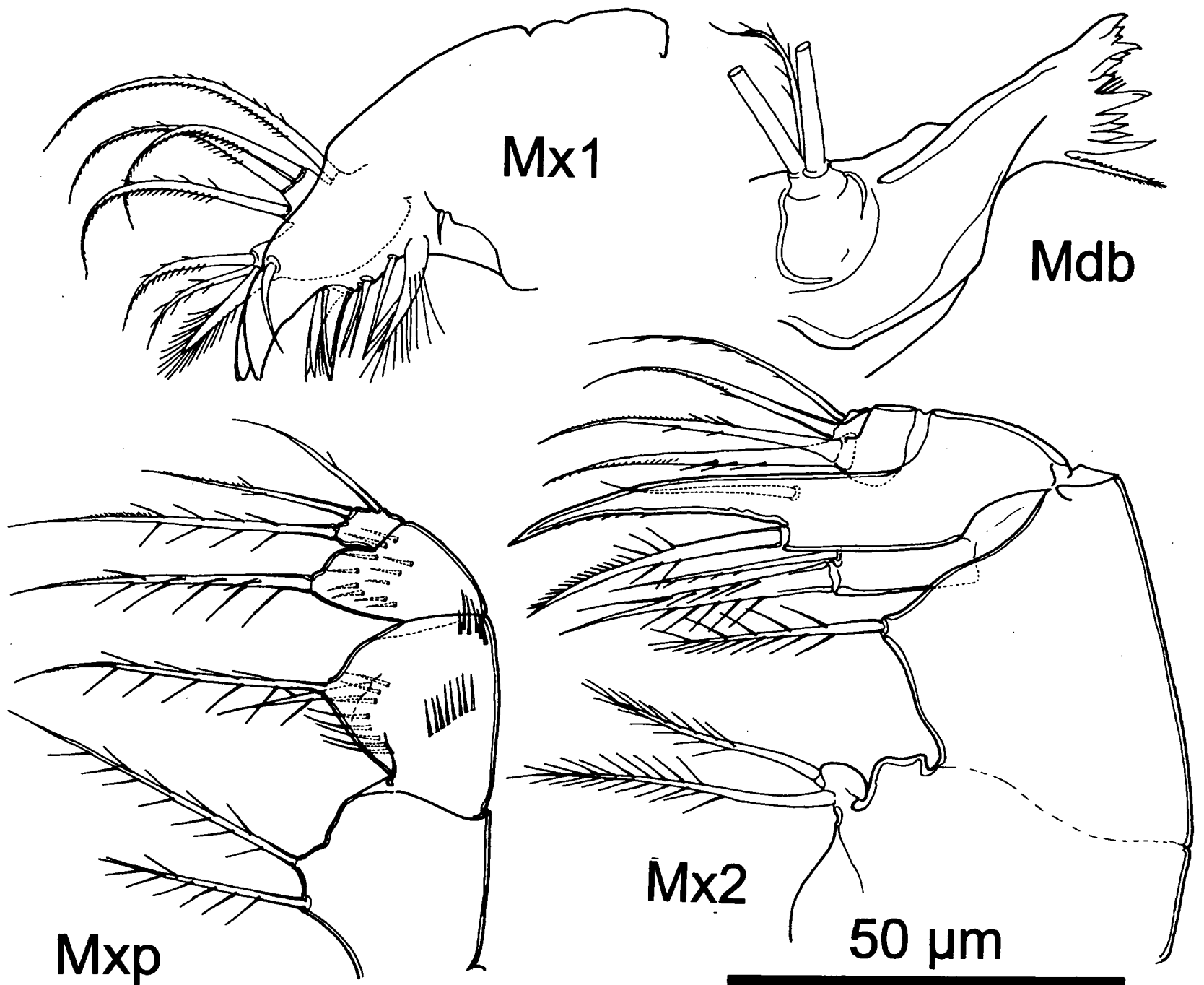


Fig. 2. *Acanthocyclops sensitivus* (Graeter & Chappuis, 1914), female, Lobau groundwater. (Mdb) mandible ; (Mx1) maxillule ; (Mx2) maxilla ; (Mxp) maxilliped.

Fig. 2. *Acanthocyclops sensitivus* (Graeter & Chappuis, 1914), femelle, Lobau nappe alluviale. (Mdb) mandibule ; (Mx1) maxillule ; (Mx2) maxille, (Mxp) maxillipède.

bustus corroborated by Fiers & Van de Velde 1984). Instead, Fiers & Van de Velde (op. cit.) report similar spinules in several species of *Cyclops* O. F. Müller 1785. Another feature is the seta on the article 2 of the antenna (i. e. article 1 of the endopodite), which inserts rather close to the distal part of the article (in the other investigated *Acanthocyclops*-species it inserts not far from the middle of the article). In addition, the basipodite of the maxilliped has only two setae as compared to the other *Acanthocyclops*-species mentioned above (which have three setae). Moreover, in the latter case, both setae are of similar strength, while on the other

species there is one "main" seta and two distinctively smaller ones. The length of the aesthetasc of the antennule of the female probably is a deviating trait of minor taxonomic value. This aesthetasc is longer only in *Acanthocyclops rhenanus* Kiefer 1936, where it reaches beyond the border of the article 10, equivalent of the article 15 in *A. sensitivus*. The other *Acanthocyclops* and *Cyclops* have shorter aesthetascs.

Living exclusively in groundwater, *A. sensitivus* exhibits only one trait which could be considered troglomorphic sensu Christiansen (1992) : the long aesthetasc on the antennule of the female. Other aspects,

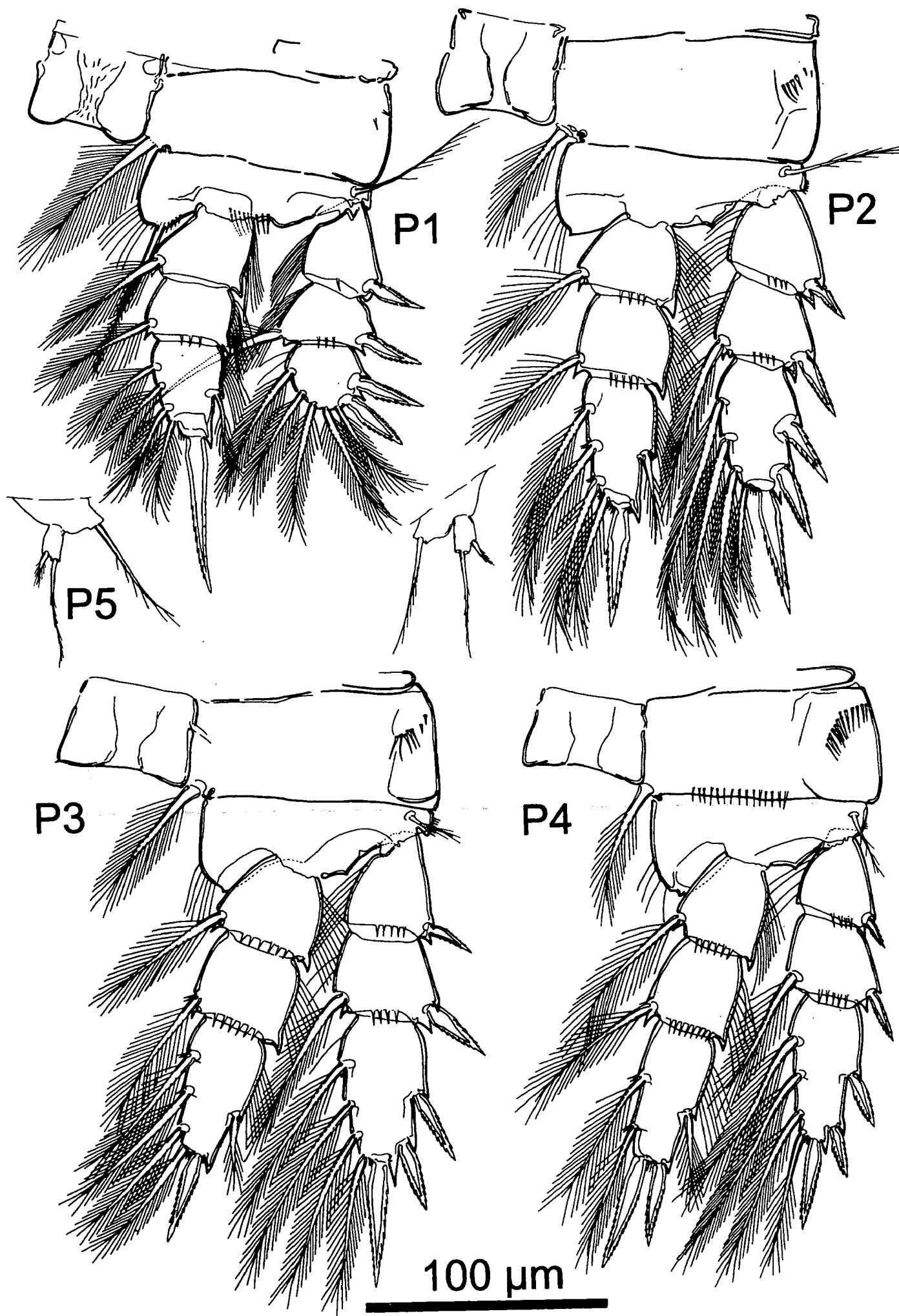


Fig. 3. *Acanthocyclops sensitivus* (Graeter & Chappuis, 1914), female, Lobau groundwater. (P1, P2, P3, P4) legs 1 to 4, caudal view ; (P5) leg 5.

Fig. 3. *Acanthocyclops sensitivus* (Graeter & Chappuis, 1914), femelle, Lobau nappe alluviale. (P1 à P4) pattes natatoires (vue caudale) ; (P5) 5^{ème} patte.

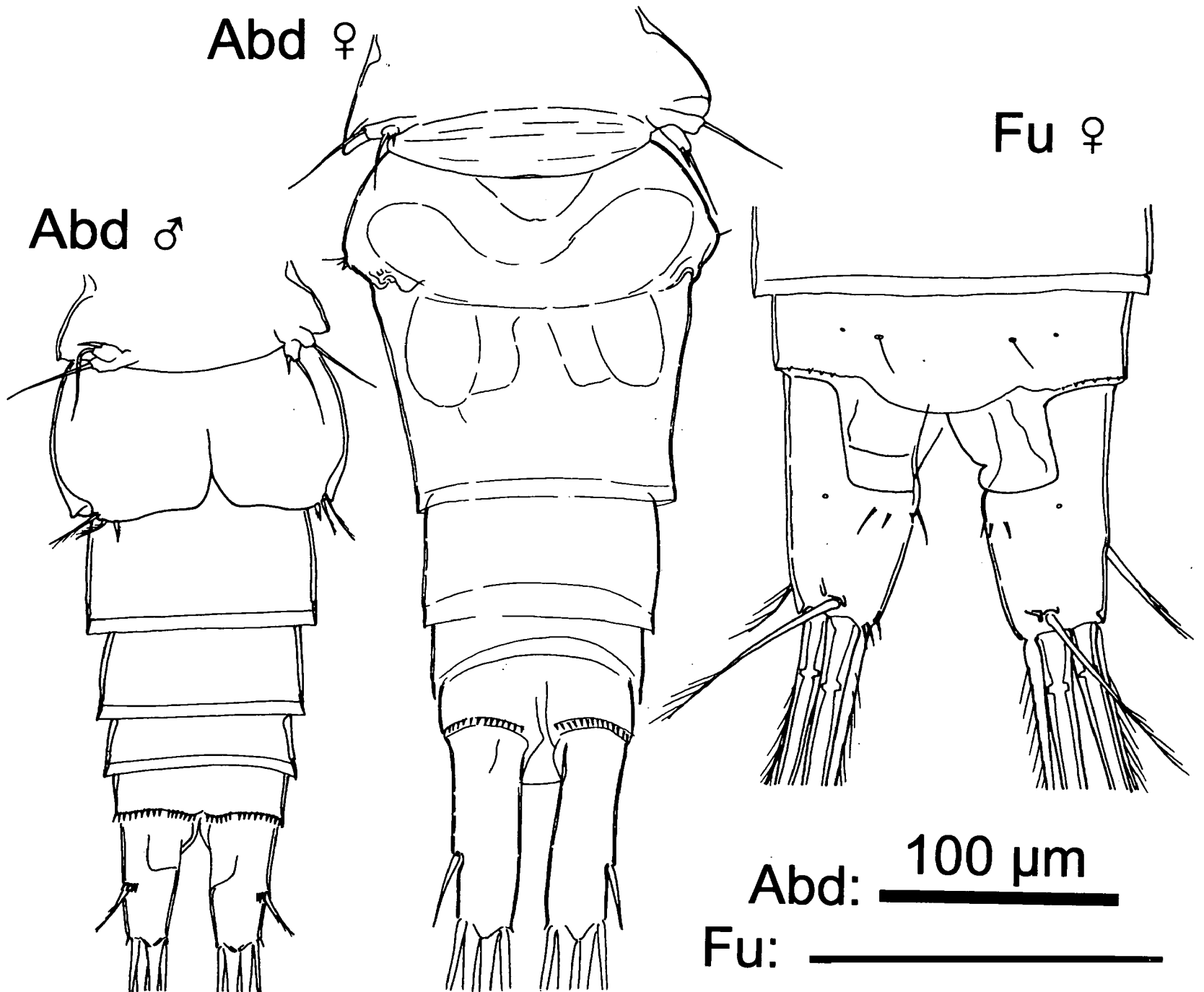


Fig. 4. *Acanthocyclops sensitivus* (Graeter & Chappuis, 1914), Lobau groundwater. (Abd) abdomen of female and male (ventral view) with last somite of cephalothorax bearing the rudimentary legs 5 and genital segments with legs 6 ; shape of seminal receptacle indicated in the female's genital segment ; (Fu) example of female furcal rami (dorsal view, compressed specimen on slide) with small spinules on inner margins.

Fig. 4. *Acanthocyclops sensitivus* (Graeter & Chappuis, 1914), Lobau nappe alluviale. (Abd) abdomen femelle et mâle (vue ventrale), avec le dernier somite du céphalothorax portant la 5^{ème} paire de pattes et les articles génitaux avec la 6^{ème} paire de pattes ; forme du réceptacle séminal indiquée sur le segment génital de la femelle ; (Fu) exemple de branches furcales d'une femelle (vue dorsale, légèrement déformé par pression de la lamelle microscopique) avec de minuscules spinules sur le bord intérieur.

such as the high number of articles of the antennule and the complex spine pattern of the basipodite of the antenna are quite contrary to expectations of how adaptations or evolutionary trends in the course of colonizing the subterranean environment should look (and frequently can be observed in the *Acanthocyclops-Diacyclops*-lineage within the Cyclopinae) (see discussion on morphology-environment relationships among cyclopoids by Reid 1991 and Reid & Strayer 1994). Another unusual aspect is its wide geographical

distribution and yet morphological stability. Even the North American sister species *Acanthocyclops parasensitivus* Reid 1998 is morphologically very close to *A. sensitivus*.

Thus, if not for the P5, it is doubtful if *A. sensitivus* would be attributed to its present genus. However, a change of its generic assignment is useful only within the framework of a revision of the whole subfamily of Cyclopinae.

Acanthocyclops sensitivus is a widely distributed cyclopoid in the groundwater of Europe (Einsle 1993). In Austria it was discovered in the Province of Vorarlberg by Pesta (cit. in Priesel-Dichtl 1959), in the Provinces of Tirol (Tilzer 1967) and Salzburg (Priesel-Dichtel 1959), and in Vienna (Kiefer 1964). I discovered it on two locations in the groundwater of the Province of Salzburg (Taugl Valley and Lengfelden), the Provinces of Upper Austria (Mondsee), Lower Austria (Kleinzell and Regelsbrunn, Pospisil, unpubl.) and Vienna (Lobau ; Pospisil 1994). However, it seldom occurs in significant numbers. In a study on the groundwater cyclopoids from the Lobau wetlands in Vienna, *A. sensitivus* accounted for 7 % of all specimens sampled (copepodids were not determined) and it was present in 6 of 43 samples (14 %) (Pospisil 1994). It therefore meets various definitions of rarity cited by Gaston (1994), among them the "quartile definition" of rarity proposed by Gaston himself. This definition describes rarity as the frequency distribution of species abundances or range sizes falling beyond a cut-off of 25 % (Gaston 1994).

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References

- Bou C. & Rouch R. 1967. — Un nouveau champ de recherches sur la faune aquatique souterraine. *C. R. Acad. Sc. Paris*, 265 : 369-370.
- Christiansen K. 1992. — Biological processes in space and time : Cave life in the light of modern evolutionary theory. In : *The Natural History of Biospeleology*. Camacho, A. I. (ed.), Monografias del Museo Nacional de Ciencias Naturales, Madrid : 453-478.
- Danielopol D. L. & Niederreiter R. 1987. — A sampling device for groundwater organisms and oxygen measurement in multi-level monitoring wells. *Stygologia*, 3,3 : 252-263.
- Einsle U. 1993. — Crustacea, Copepoda : Calanoida und Cyclopoida. *Süßwasserfauna von Mitteleuropa* 8 (4-1) : 1-208 pp.
- Fiers F. & Van de Velde I. 1984. — Morphology of the antenna and its importance in the systematics of the Cyclopidae. *Crustaceana*, (suppl.) 7 : 182-199.
- Gaston K. J. 1994. — *Rarity*. Chapman & Hall, London etc., x + 305 p.
- Kiefer F. 1957. — Die Grundwasserfauna des Oberrheingebietes mit besonderer Berücksichtigung der Crustaceen. *Beitr. naturk. Forsch. SüdwDtl.*, 16 : 65-91.
- Kiefer F. 1964. — Zur Kenntnis der subterranean Copepoden (Crustacea) Österreichs. *Ann. Naturhist. Mus. Wien*, 67 : 477-485.
- Pesce G. L. 1996. — Towards a revision of Cyclopinae copepods (Crustacea, Copepoda). *Fragmenta entomologica, Roma*, 28 (2) : 189-200.
- Pospisil P. 1994. — Die Grundwassercyclopiden (Crustacea, Copepoda) der Lobau in Wien (Österreich) : faunistische, taxonomische und ökologische Untersuchungen. Ph. D. Thesis Univ. Wien, Austria : 222 p.
- Pospisil P. & Stoch F. 1997. — Rediscovery and redescription of *Austriocyclops vindobonae* Kiefer, 1964 (Copepoda, Cyclopoida) with remarks on the subfamily Eucyclopinae Kiefer. *Crustaceana*, 70 (8) : 901-910.
- Priesel-Dichtl G. 1959. — Die Grundwasserfauna im Salzburger Becken und im anschließenden Alpenvorland. *Arch. Hydrobiol.*, 55 : 281-370.
- Reid J. W. 1991. — Use of fine morphological structures in interpreting the taxonomy and ecology of continental cyclopoid copepods (Crustacea). *Anais do IV Encontro Brasileiro de Plâncton, Recife*, 4 : 261-282.
- Reid J. W. 1998. — How "cosmopolitan" are the continental cyclopoid copepods ? Comparison of the North American and Eurasian faunas, with description of *Acanthocyclops parasensitivus* sp.n. (Copepoda : Cyclopoida) from the U.S.A. *Zool. Anz.*, 236 : 109-118.
- Reid J. W. & Strayer D. L. 1994. — *Diacyclops dimorphus*, a new species of copepod from Florida, with comments on morphology of interstitial cyclopinae cyclopoids. *J. N. Am. Benthol. Soc.*, 13 (2) : 250-265.
- Tilzer M. 1967. — *Acanthocyclops (Rhenocyclops) sensitivus* (Graeter & Chappuis 1914) (Crustacea, Copepoda) aus dem hyporheischen Interstitial des Lech (Tirol). *Ber. Nat. Med. Ver. Innsbruck*, 55 : 175-177.