REDISCOVERY AND REDESCRIPTION OF *AUSTRIOCYCLOPS VINDOBONAE* KIEFER, 1964 (COPEPODA, CYCLOPOIDA) WITH REMARKS ON THE SUBFAMILY EUCYCLOPINAE KIEFER

BY

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ABSTRACT

Since the publication of the description of *Austriocyclops vindobonae* Kiefer, 1964, all known material was represented by a single female collected in a groundwater well in Vienna (Austria), characterized by a strong reduction of leg 5. The recent discovery of several specimens of *A. vindobonae* in phreatic waters in Vienna allows a redescription of the female and the first description of the male. The rudimentary fifth leg consists of one or two setae and resembles that of some Cyclopinae genera; however, the presence of tube-like, plumed aesthetascs on the male antennula and the spine pattern of the basipod of the antenna reveal that the genus *Austriocyclops* belongs to the subfamily Eucyclopinae. The inadequacy of using the fifth leg in the definition of this subfamily is discussed, and new characteristics for definition (shape and location of aesthetascs on male antennule and ornamentation pattern of antenna basipod) are proposed.

ZUSAMMENFASSUNG

Seit der Erstbeschreibung von *Austriocyclops vindobonae* Kiefer, 1964 bestand das gesamte bekannte Material aus einem einzigen Weibchen aus einem Grundwasserbrunnen in Wien (Österreich), welches sich durch eine starke Reduktion des fünften Beinpaares auszeichnete. Die jüngste Entdeckung mehrerer Exemplare von *A. vindobonae* im Wiener Grundwasser ermöglicht eine Neubeschreibung des Weibchens und die Erstbeschreibung des Männchens. Das rudimentäre fünfte Beinpaar besteht aus einer oder zwei Borsten und ähnelt jenem einiger Gattungen der Cyclopinae. Allerdings zeigt das Vorhandensein schlauchförmiger, beborsteter Aesthetasken auf der Antennula des Männchens und das Dörnchenmuster am Basipoditen der Antenna, daß die Gattung *Austriocyclops* der Unterfamilie Eucyclopinae angehört. Die mangelnde Eignung des fünften Beinpaares zur Definition dieser Unterfamilie wird diskutiert und neue Merkmale (Form und Lage der Aesthetasken auf der Antennula des Männchens sowie das Dörnchenmuster des Basipoditen der Antenna) werden vorgeschlagen.

INTRODUCTION

The description of the genus *Austriocylops* and of its unique species *A. vindobonae* Kiefer, 1964, based on a single female collected in a groundwater well in Kagran (Vienna, Austria), gave rise to some taxonomic problems. The holotype is characterized by a strong reduction of the taxonomically important leg 5, which is represented by a single, short seta. For this reason, the genus was placed in the subfamily Cyclopinae in subsequent papers (see Dussart & Defaye, 1985 and the references cited therein). Since Kiefer's (1964) description, *A. vindobonae* has not been found again despite sampling efforts made by Danielopol and Pospisil in the Kagran well where it first turned up (Einsle, 1993).

During recent research on the groundwater fauna in Vienna, several new specimens of *A. vindobonae* were discovered. A taxonomic analysis of this material, as well as a re-examination of the holotype deposited in Kiefer's collection in the museum of Karlsruhe, led to the discovery of several new taxonomic features, which suggest a close relationship of *Austriocyclops* with the subfamily Eucyclopinae.

In this paper we supply a new description of the female, the first description of the male and discuss the problems of using the rudimentary fifth leg in the definition of the subfamily Eucyclopinae.

SAMPLING SITES AND MATERIAL

Material examined (collection localities: fig. 1). — Holotype (female) from a well in Kagran, Vienna, Austria, 5 June 1961, leg. J. Vornatscher (slides nos 7338 and 7339, Kiefer's collection, Staatliches Museum f. Naturkunde, Karlsruhe, Germany). The following specimens (leg. P. Pospisil) are deposited in Pospisil's collection in Vienna: 5 females, 2 males, 19 July 1988, Lobau forest wetland in Vienna, Austria (nos 461, 462, 526, 529a, b, 556, 557 and 527, 555); 1 female, 1 male, 18 January 1992, Lobau (nos 552a, b, c, 551a, b, c); 1 female, 26 October 1992, Lobau (no. 551a, b, c). 1 female, Norton pump near Traismauer, Lower Austria, 20 July 1991 (slides nos 169, 170 and 171); Lobau specimens from groundwater multi-level monitoring well A89, 1 to 7 m below the surface (Pospisil, 1994a, b). Only one of the male specimens (no. 551) has undamaged antennules. The holotype and newly collected material are mounted on slides in glycerine.

Austriocyclops lives in groundwater only marginally influenced by surface waters and showing stable temperature conditions. It never turned up in superficial sediments with strong fluctuations of temperature (with a seasonal range between 1 and 20°C) despite intensive investigations at various locations along the Danube (Danielopol, 1983). In the Lobau habitats, the groundwater fauna frequently faces hypoxic conditions, especially during the warm season (Pospisil, 1994a, b).

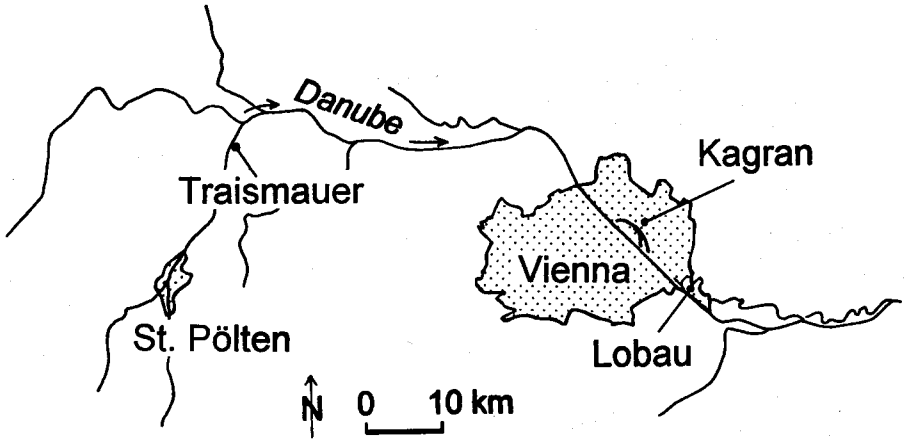

Fig. 1. Collection localities of *Austriocyclops vindobonae* Kiefer, 1964, in Austria.

Description. — Length of females (excluding caudal setae): 644-712 μm (fig. 2: habitus); length of males: 542-661 μm.

Antennule of the female (fig. 2) of 10 or 11 articles. In the Lobau specimens, the antennule consists of 10 articles with the 6th article half divided, while the specimen from Traismauer and the holotype have this article completely divided. Article 1 with a row of spinules; articles 8, 10 and 11 each with very long, ribbon-like, hyaline, unplumed setae which are supposed to be aesthetascs.

Only one male (slide no. 551) has undamaged antennules (fig. 2), consisting of 16 articles. Six tube- or trunk-like, plumed and thick setae on articles 1 (2 setae), 2, 3, 4 and 5 are aesthetascs; article 16 equipped with hyaline membrane.

Antenna (fig. 2) 4-segmented, with armature of the basipod well developed in both sexes; exopod present. Ornamentation pattern showing the two oblique rows of spinules on the basal part of the frontal side typical of the subfamily Eucyclopinae (Fiers & Van de Velde, 1984); pattern of the caudal side as in *Eucyclops*, with additional rows of spinules.

Mandible, maxilla, maxillula, maxilliped (with 3 setae on basal article) as in fig. 3.

Legs 1-4 similar in both sexes, with each ramus of three articles (P4 female: fig. 3; P1-4 male: figs. 4, 5). Spine formula 3.4.4.3; third article of exopods with 5 setae; setal formula of endopod 3 of P1-P4: 4.4.4.2. P1 with spines of outer ramus remarkably long and slender; basipod with inner marginal seta reaching the end of article 3. Article 3 of endopod of P3 with terminal spine longer than the article itself.

Couplers of P4 (figs. 3, 5) with a row of setae; caudal side of coxopod of P4 armed with a row of spinules near the distal margin and two other smaller

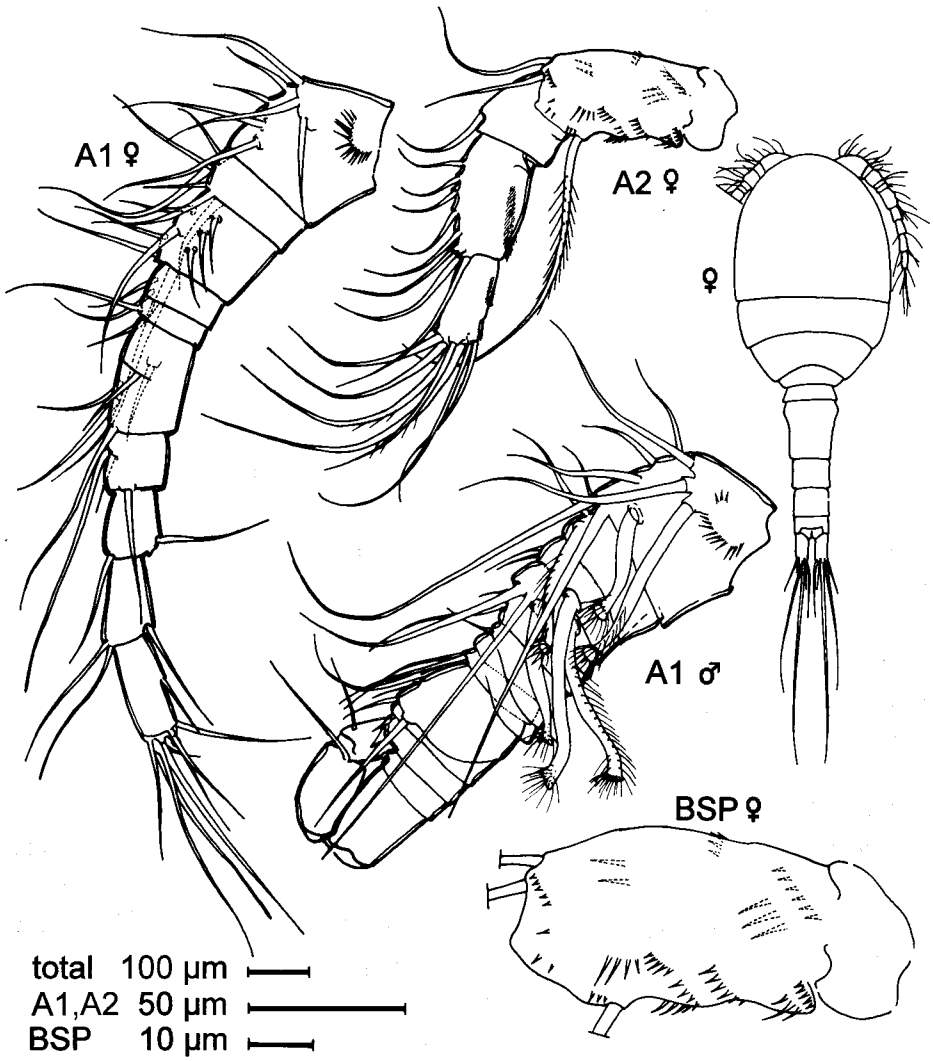

Fig. 2. *Austriocyclops vindobonae* Kiefer, 1964, Lobau groundwater. Habitus of female (dorsal view); antennula (A1, ventral view); antenna (A2, caudal view); basipod of antenna (Bsp).

rows of spinules near the basal edge. Article 3 of endopod of P4 1.61-2.06 times longer than broad in the female, 1.83-2.11 times in the male; inner terminal spine about 1.5 times longer than the outer and 0.86-1.00 times as long as the article in both sexes. Inner setae of article 3 slightly longer than terminal spines.

P5 (fig. 6) similar in both sexes, but variable even on the same specimen, composed of one or two short, sometimes spiniform setae; the articles of this leg are completely fused with the thoracic somite.

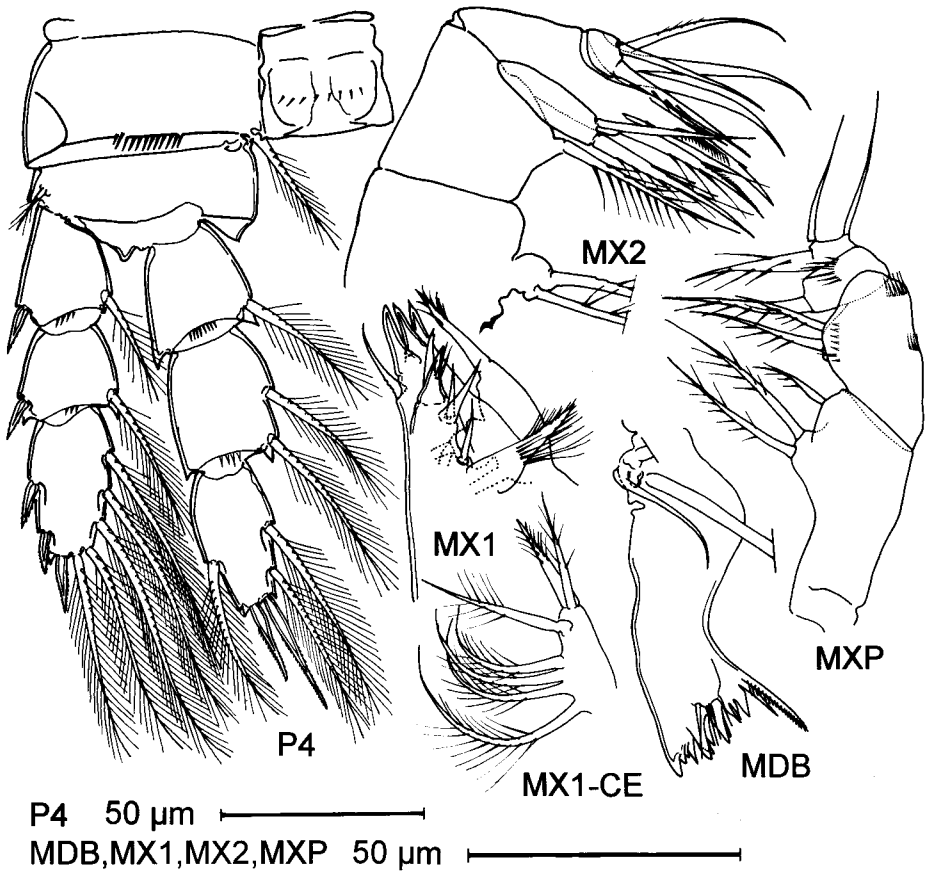

Fig. 3. *Austriocyclops vindobonae* Kiefer, 1964, female, Lobau groundwater. Mandible (Mdb); maxillula (Mx1), coxal endite (Mx1-ce) drawn from different specimen; maxilla (Mx2); maxilliped (Mxp); leg 4 (P4, caudal view).

P6 of female (fig. 4) consisting of 3 small, spine-like stumps, the inner one longer than the others. P6 of male (fig. 4) armed with 3 small spines or setae, the outer one plumed.

Genital segment longer than broad in the female (fig. 6), slightly broadened anteriorly; genital segment of the male (fig. 6) as long as broad. Receptaculum seminis (fig. 6) with narrow anterior and posterior expansions. Posterior hyaline margins of urosomites (except anal somite) weakly serrated. Anal operculum posteriorly bordered with rows of setae.

Furcal rami (fig. 6) short, 1.67-1.69 times longer than broad in the female (squeezed slides; a ratio of 2.2 was measured on the unsqueezed female specimen no. 552), average value 1.73 (squeezed), 1.43-1.96 times in the male (squeezed); inner margins smooth. Lateral setae inserted at posterior one-fifth of ramus

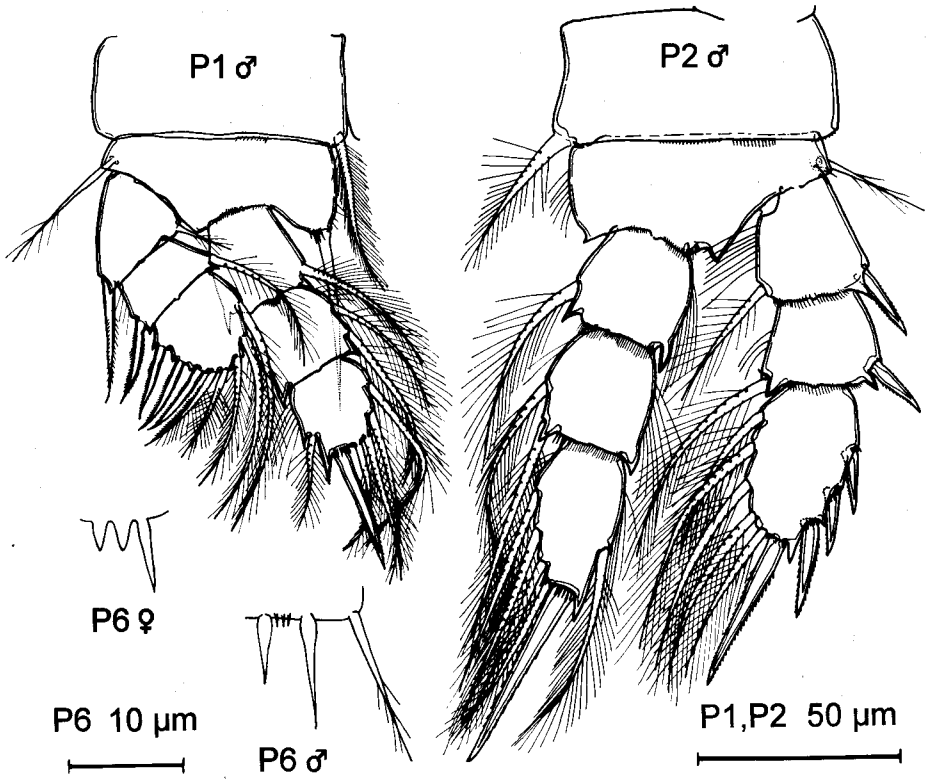

Fig. 4. *Austriocyclops vindobonae* Kiefer, 1964, Lobau groundwater. Swimming legs 1-2 of male (P1, P2: frontal view), leg 6 (P6).

bordered anteriorly by a dorsoventral row of spinules. Dorsal seta approximately as long as caudal ramus in the female, slightly longer (1.2 times the length of caudal ramus) in the male. Lengths of terminal setae 61/235/305/126 µm (outer to inner one, average of available values) in the female, 58/225/320/120 µm in the male. Ratio between inner terminal seta and outer one approximately 2 : 1 in both sexes.

DISCUSSION

According to the definition of the subfamilies of Cyclopidae by Kiefer (1927), *Austriocyclops* should be a member of the Cyclopinae. In fact, four genera of this subfamily include at least some species with leg 5 completely fused with the somite: *Bryocyclops* and *Speocyclops*, which differ from *Austriocyclops* by their harpacticoid body shape and associated morphological details, as well as *Allocyclops* and *Yansacyclops*. The latter genus from South America (Reid, 1988) shares some characters with *Austriocyclops*, including cyclopoid body

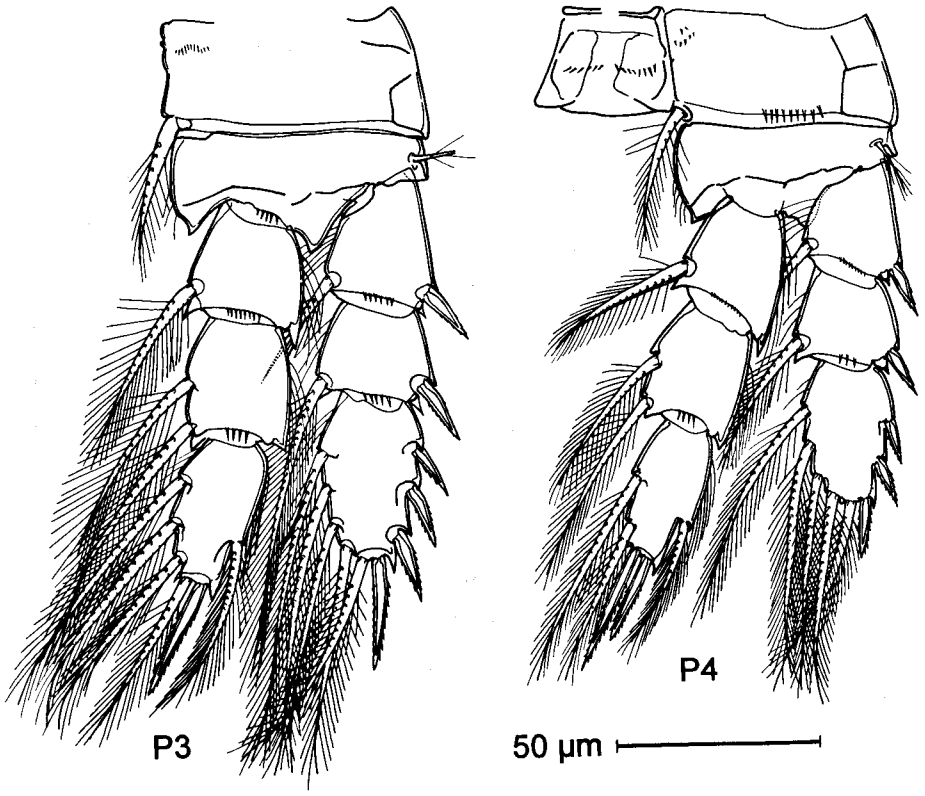

Fig. 5. *Austriocyclops vindobonae* Kiefer, 1964, Lobau groundwater. Swimming legs 3-4 of male (P3, P4: caudal view).

form, shape of receptaculum seminis, setal formula of exopods of P1-P4 and presence of a row of spinules on the furca. However, it differs by the biarticulated swimming legs, the patterns of aesthetascs on both male and female antennules, and the antennal basipod probably with a poor spinulation pattern.

Notwithstanding the fact that the conservative nature of P5 morphology has been stressed by Reid (1988) and Monchenko (1986), this latter author demonstrated that species with a similar P5 may show large differences in other respects. Moreover, the variability of the P5 (consisting of one or two setae) of *Austriocyclops* does not provide any taxonomically useful information for assessment of the phylogenetic relationships of this genus within the family Cyclopidae. So we have to search for additional traits which can be contemplated together with traditional ones. The shape of the aesthetascs of the antennules, especially in the male, and the ornamentation pattern of the basipod of the antenna (the phylogenetic interest of which was stressed by Fiers & Van de Velde, 1984) seem to

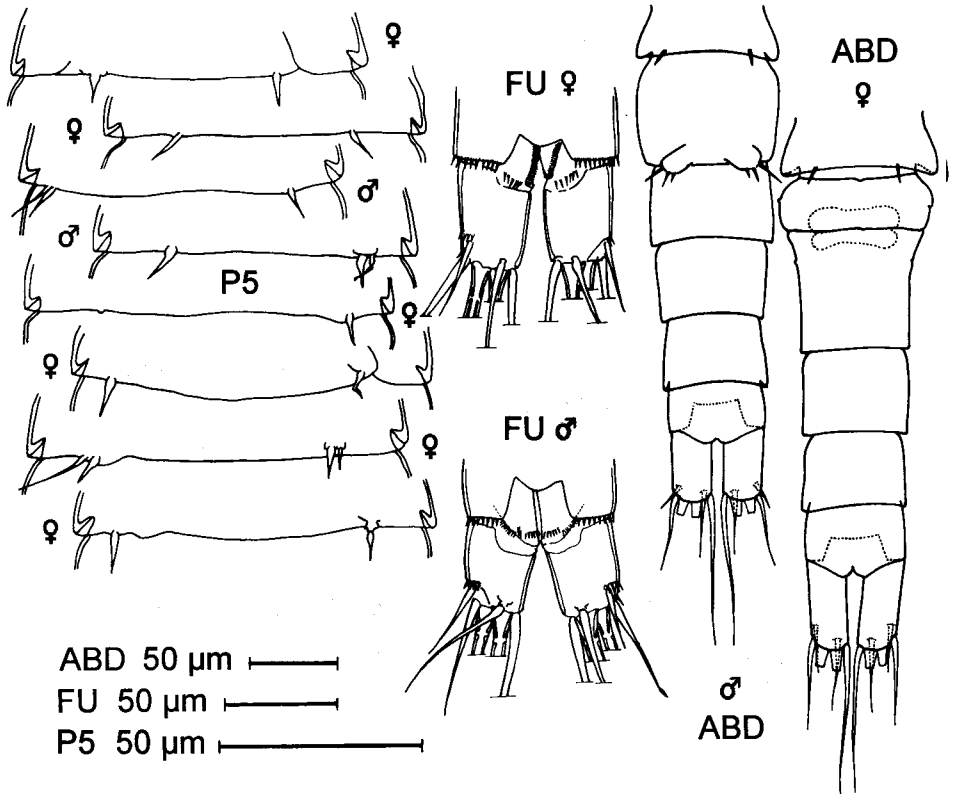

Fig. 6. *Austriocyclops vindobonae* Kiefer, 1964, Lobau groundwater. Rudimentary fifth legs (P5) of 8 specimens (ventral view); furcal rami (Fu); abdomen of male and female with genital segments and shape of receptaculum seminis (dotted line) (Abd).

be helpful, and suggest that the genus *Austriocyclops* belongs to the subfamily Eucyclopinae.

The antennule of the male is equipped with thick, tube- or trunk-like, plumed aesthetascs, indicating a close relationship between *Austriocyclops* and other Eucyclopinae genera, like *Eucyclops*, *Tropocyclops*, and *Ectocyclops*, which bear such modified setae on the same antennular articles (article 1 with 2 aesthetascs, and articles 2, 3, 4, and 5 each with one aesthetasc). The aesthetascs of many male Cyclopinae, on the other hand, appear on antennular articles 1 (3 aesthetascs), 4, 9, and 13 and have a different shape, i.e., they are club-like, stalked, hyaline, and smooth. The female antennule of *Austriocyclops* lacks the typical cyclopine-type aesthetascs as well. A comparison of the female antennular aesthetascs of some Eucyclopinae reveals a large variability: *Eucyclops* and *Tropocyclops* have spine-like structures, *Paracyclops*, has a filiform seta similar to, but much shorter than, that of *Austriocyclops*. *Macrocyclops*, possibly the

most primitive genus (Fiers & Van de Velde, 1984), bears aesthetascs somewhat resembling those of the Cyclopinae.

The armature of the antennal basipod of *Austriocyclops* shows the same pattern as that cited by Fiers & Van de Velde (1984) for Eucyclopinae: presence of two parallel rows of spinules on the caudal side, and several well developed, small rows of spinules and teeth on the frontal side. The ornamentation pattern of this species shows no reduction as in most cyclopine genera; the exopod is present as well, and this seems to be a general rule for Eucyclopinae.

Within the subfamily Eucyclopinae, *Austriocyclops* shares several morphological traits with the genus *Ochridacyclops*, especially with *O. brevicaudatus* Shen & Tai, 1964 from surface river waters of Southern China (Shen, 1979): the shape of abdomen and furcal rami in both sexes, the almost identical structure of legs 1 and 4, and the length-relationship of the articles of the female and male antennulae. However, *Austriocyclops* has an additional seta on the basal article of the maxilliped and a strongly reduced leg 5.

The subfamily Eucyclopinae was defined by Kiefer (1927) on the basis of the presence of three setae on the distal article of P5, and no attempts to emendate this poor definition (from today's point of view) were made after the redescription of *Eucyclops* (*Stygocyclops*) *teras* (Graeter, 1907) by Plesa (1971), with P5 bearing only two setae. A reduction of the number of articles and setae of P5 takes place within all but one Eucyclopinae genera. Only *Macrocyclops* has a biarticulated P5 with distal article bearing three setae; *Eucyclops*, *Afrocyclops*, *Tropocyclops*, *Paracyclops*, and *Ochridacyclops* have uniarticulated P5 with three setae, while *Stygocyclops* has an uniarticulated P5 with two setae; *Ectocyclops* has a strongly reduced P5, with the three setae implanted directly on the somite; finally, *Austriocyclops* shows an extreme reduction, with P5 consisting only of one or two setae.

Reid (1988) stated that the "demarcation of genera of cyclopoids must be based on balanced consideration of similarities in body form and all appendages ...". In fact it is inadequate to base higher taxonomic categories on rudimentary appendages like the fifth leg, which are commonly very simply shaped. The *Austriocyclops*-case illustrates the P5-problem more than any other. As a consequence, we suggest that new taxonomic traits (shape and location of aesthetascs on male antennule and ornamentation pattern of antennal basipod) must be taken into account in defining the subfamily Eucyclopinae.

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