

REDESCRIPTION OF *DIACYCLOPS DISJUNCTUS* (THALLWITZ, 1927)
FROM AUSTRIA, WITH REMARKS ON THE
DIACYCLOPS LANGUIDUS-GROUP IN EUROPE
(COPEPODA, CYCLOPOIDA, CYCLOPIDAE)

BY

FABIO STOCH^{1,3}) and PETER POSPISIL^{2,4})

¹) Museum of Natural History, Verona, Italy

²) Institute of Limnology, Austrian Academy of Sciences, A-5310 Mondsee, Austria

ABSTRACT

Diacyclops disjunctus (Thallwitz, 1927) is redescribed from interstitial groundwaters of the Danube riverine wetlands in Vienna, Austria. *D. disjunctus* co-exists in the study area with *D. languidus* (G. O. Sars, 1863), of which it has long been considered a subspecies. The two species can be differentiated on the basis of several morphological details of antennae, P4, and caudal rami. *D. disjunctus* is widely distributed in European surface waters as well as in groundwaters, but usually uncommon; it exhibits no troglomorphic traits and may be considered a stygophilous species. Finally, the *D. languidus*-group is redefined and its relationship with the *D. languidoidea*-group is discussed.

ZUSAMMENFASSUNG

Diacyclops disjunctus (Thallwitz, 1927) aus dem Grundwasser der Donauauen in Wien, Österreich, wird wiederbeschrieben. *D. disjunctus* tritt im Untersuchungsgebiet neben *D. languidus* (G. O. Sars, 1863) auf, als dessen Unterart er lange Zeit betrachtet wurde. Die zwei Arten können auf Basis mehrerer morphologischer Details der 2. Antenne, des P4 und der Kaudal-Rami (Furka) unterschieden werden. *D. disjunctus* ist in Europa in Oberflächen- und Grundwässern zwar weit verbreitet, aber normalerweise nicht häufig; er besitzt keine troglomorphen Merkmale und kann als stygophil betrachtet werden. Schließlich wird die *D. languidus*-Gruppe neu definiert und ihre Verwandtschaft zur *D. languidoidea*-Gruppe wird diskutiert.

INTRODUCTION

In recent papers, Pospisil & Stoch (1999) and Stoch (in press) stated that several poorly known or new taxa are included in the *Diacyclops languidoidea*-group;

³) Current address: Viale XXV Aprile 24, I-34015, Muggia (Trieste), Italy; e-mail: fabiocop@tin.it

⁴) Current address: Reichmannngasse 3/6, A-1160 Vienna, Austria; e-mail: peter.pospisil@netway.at

these taxa were usually reported as subspecies of *D. languidoides* (Lilljeborg, 1901). The same consideration applies to *D. languidus* (G. O. Sars, 1863) as well: some of its subspecies probably deserve specific status, while others are poorly described and their taxonomic status remains uncertain. Moreover, in most of the published taxonomic accounts dealing with *Diacyclops*, there is no description or illustration of the mouthparts as well as of several minute morphological details, very useful in distinguishing between closely related species (Stoch, in press). These arguments justify the detailed redescription of *D. disjunctus* (Thallwitz, 1927), recently discovered in the Lobau wetlands, Austria (Pospisil, 1994a) and an amended diagnosis of the *D. languidus*-group is given herein.

MATERIAL AND METHODS

Specimens were collected from groundwater piezometers with a diameter of 5 cm using a double-packer-sampler. The samples were filtered through a 100 μm plankton-net and stored in 4% formaldehyde. Copepods were extracted from the sample residue under a stereomicroscope; selected specimens were dissected in glycerine, and permanently mounted on slides in glycerine sealed with Caedax. A Zeiss Axioskop compound microscope fitted with a drawing tube was used to study the details at 1000 \times using an oil immersion lens.

The terminology related to the external morphology follows Huys & Boxshall (1991).

TAXONOMIC ACCOUNT

***Diacyclops languidus* (G. O. Sars, 1863)**

Synonymy. — *Diacyclops languidus* "F", Pospisil, 1994a: 93.

Material examined. — 6 ♀♀ (years 1991-1993) from groundwater observation wells D3, D9, and D15; 2 ♂♂, 2 ♀♀ (years 1996-1998) from Eberschuetzwasser (surface waters); 4 ♂♂, 13 ♀♀ from wells of site C; all the sampling stations are located in the "Lobau" riverine wetland, Danube basin, Vienna, Austria (Pospisil, 1994a, b). Material from several localities in Finland, Germany, Spain, Italy, and former Yugoslavia was examined for comparison.

Remarks. — The correct name for this species, as remarked by Stoch (in press), should be *D. langvidus* and not *D. languidus*; this is clearly stated in the original description by Sars (1863: 249) as well as in Sars' monograph (1918: 50). However, the incorrect subsequent spelling *languidus* is in prevailing use, and is to be preserved following the rules of the International Code of Zoological Nomenclature (4th ed., article 33.3).

D. languidus, illustrated by Dussart (1969), Monchenko (1974), and Einsle (1993), is widely distributed in Europe. All the Asian records are to be treated with caution (Stoch, unpubl.); furthermore, the citations from North America (Ishida, 1992; Leblanc et al., 1981) are to be referred to other taxa (Stoch & Reid, unpubl.). For these reasons, we suspect that the alleged circumboreal distribution of *D. languidus* may be due to a weak taxonomic practice.

D. languidus is an epigeal species, common in lakes, ponds, swamps, and meadows; in the study area it inhabits surface waters and may be found in groundwaters as a stygoxene.

***Diacyclops disjunctus* (Thallwitz, 1927) (figs. 1-4)**

Synonymy. — *Diacyclops languidus* "E", Pospisil, 1994a: 91. Complete synonymy reported in Dussart & Defaye (1985), Monchenko (1974), and Einsle (1993).

Material examined. — 44 ♀♀ and 55 ♂♂ were collected between May 1991 and April 1993 from groundwater observation wells T3, D3, D4, D5, D9, D10, D15, and D17 in the Lobau riverine wetland, Danubian basin, Vienna, Austria (for precise locations, see Pospisil, 1994a, b).

Description of female. — Length, excluding caudal setae, 391-663 μm (average 484 μm , $N = 44$ specimens). Habitus as in fig. 1a. Hyaline fringes of posterior margins of urosomites not crenulate; urosomites with dorsal and ventral sides smooth. Genital double somite as in fig. 1d, broadest in anterior half, tapering posteriorly, approximately as long as wide. Seminal receptacle with broader anterior part, posterior expansion little produced. Anal somite with lateral rows of spinules on distal margin (fig. 1c), bearing two sensilla on dorsal surface; anal operculum broad, slightly convex, and weakly sclerotized.

Caudal ramus about 2.5 times as long as wide (fig. 1c), average length 43 μm , without ornamentation. Anterolateral caudal seta as long as width of caudal ramus (average length 16 μm); terminal accessory seta of about the same length as postero-lateral seta, their average lengths 30 and 31 μm , respectively; average values of lengths of outer and inner terminal setae 156 and 261 μm ; dorsal seta slightly longer (122%) than caudal ramus (average length 53 μm).

Antennule (fig. 1e) 16-segmented, segments 7-9 incompletely divided; segment 1 with a short comb of spinules, surfaces of the other segments smooth; segment 11 with 1 aesthetasc. Segments (with numbers of setae and aesthetascs in brackets): 1 [8], 2 [4], 3 [8], 4 [4], 5 [2], 6 [2], 7 [1], 8 [1], 9 [0], 10 [1], 11 [1+1 aesthetasc], 12 [0], 13 [1], 14 [2], 15 [3], 16 [8].

Antenna (fig. 2a): coxa unarmed; basis with simple spinulation pattern, as in fig. 2d; exopodal seta present. Endopod segment 1 with 1 seta, segment 2 with 7 setae, segment 3 with 7 distal setae.

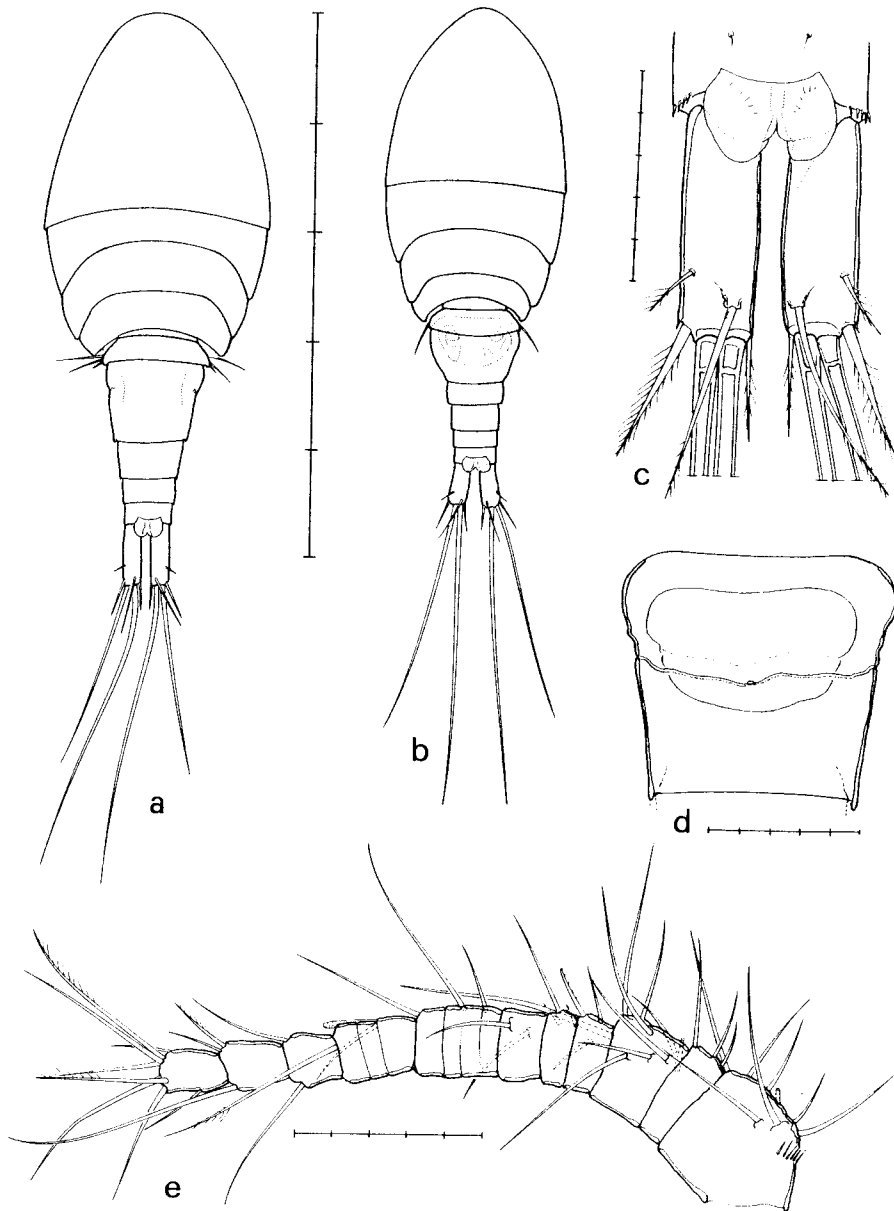


Fig. 1. *Diacyclops disjunctus* (Thalwitzer, 1927), a, c-e, ♀; b, ♂. a, habitus of female, dorsal view; b, habitus of male, dorsal view; c, caudal rami, dorsal view; d, genital double somite and seminal receptacle, ventral view; e, antennule. Scale bars: a-b = 500 μm ; c-e = 50 μm .

Labrum typical of the genus (fig. 2e). Mandible (fig. 2c): coxa without spinules, gnathobase with 5 stout teeth, a comb of spinules and 1 spinulose seta; mandibular palp represented by 1 short and 2 long plumose setae. Maxillule (fig. 2b) compris-

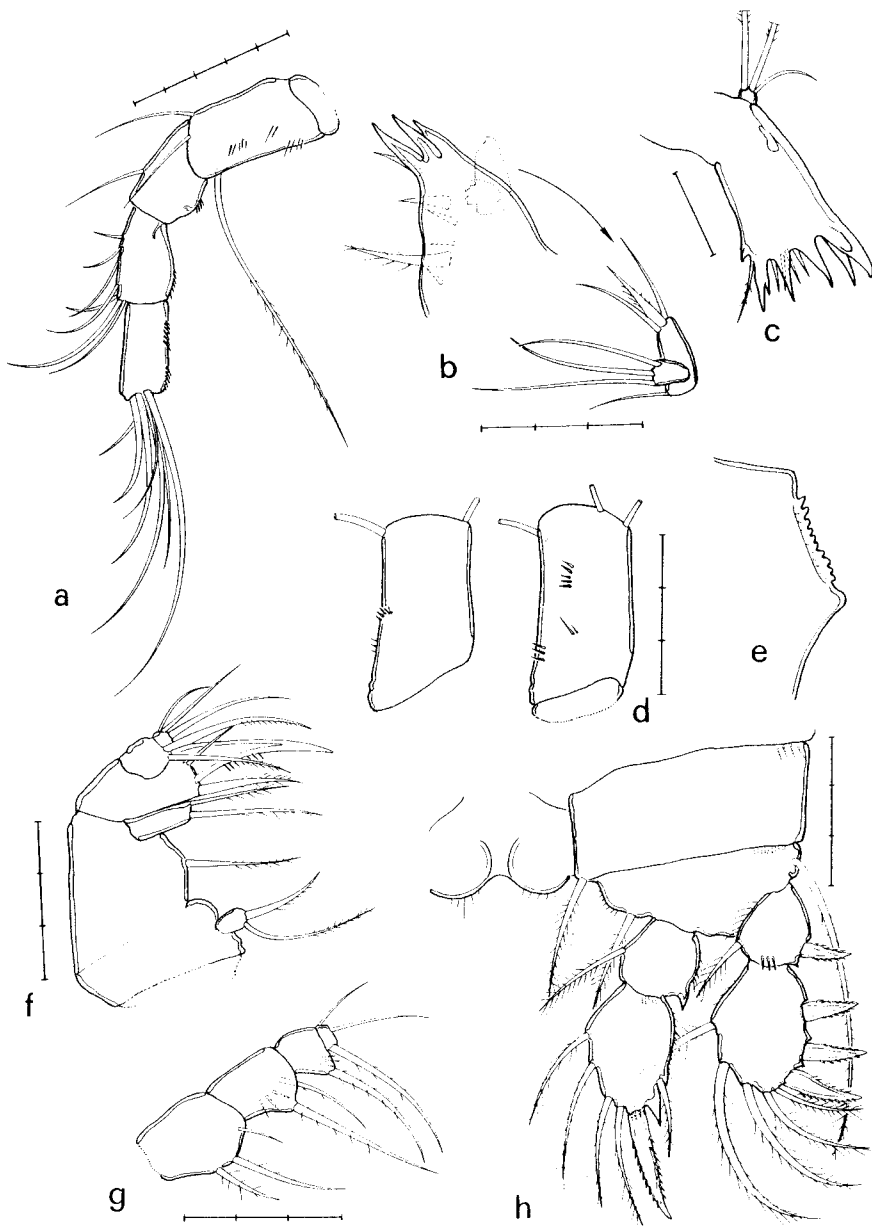


Fig. 2. *Diacyclops disjunctus* (Thalwitzer, 1927), ♀. a, antenna; b, maxillule and maxillary palp; c, mandible; d, antennary basis with spinule pattern on frontal (left) and caudal (right) sides; e, labrum; f, maxilla; g, maxilliped; h, P1, posterior view. Scale bars: c = 10 μ m; b, d-h: 30 μ m; a = 50 μ m.

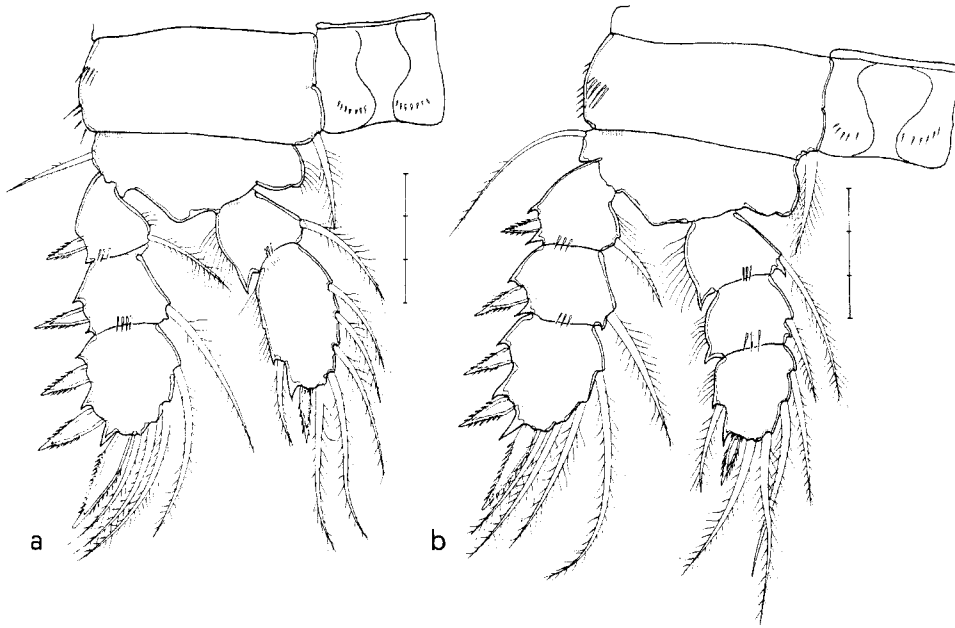


Fig. 3. *Diacyclops disjunctus* (Thalwitzer, 1927), ♀. a, P2, posterior view; b, P3, posterior view. Scale bars: 30 μ m.

ing praecoxa and maxillary palp; praecoxa with a short proximal spine; praecoxal endite typical of the genus *Diacyclops*; surface of palp segment 1 (derived from coxa and basis) smooth; palp segment 2 (endopod) bearing 3 setae; exopodal seta present. Maxillary syncoxa (fig. 2f) typical of subfamily, bearing 3 endites; basis with 1 claw and 2 setae; endopod segment 1 bearing 2 setae, segment 2 with 3 setae. Maxilliped (fig. 2g) 4-segmented as usual in the family; second endopodal segment with 1 spinulose seta and 2 short naked setae.

Swimming legs: P1 exopod 2-segmented, P2-P4 exopods 3-segmented (figs. 2h, 3a-b, 4c); P1-P2 endopods 2-segmented, P3-P4 endopods 3-segmented; pores as in the above-mentioned figures. Distal segments of exopods 1-4 with 3,3,3,3 spines and 5,4,4,4 setae, respectively. Intercoxal sclerites ornamented with spinules and setules. P4 (fig. 4c): coxa with spinulation pattern as in figure; basis inner margin with a distinct notch and a sclerified tooth; third endopodal segment 0.94-1.28 times longer than wide (average value 1.14); inner terminal spine 0.59-0.84 times longer than segment (average value 0.71), approximately as long as outer terminal spine. P5 (fig. 4a): protopodal segment with 1 outer plumose seta and 1 pore; exopodal segment more than twice as long as wide, armed with 1 seta and 1 inner spine shorter than segment. P6 (fig. 4b) bearing 2 short spinous processes and 1 seta.

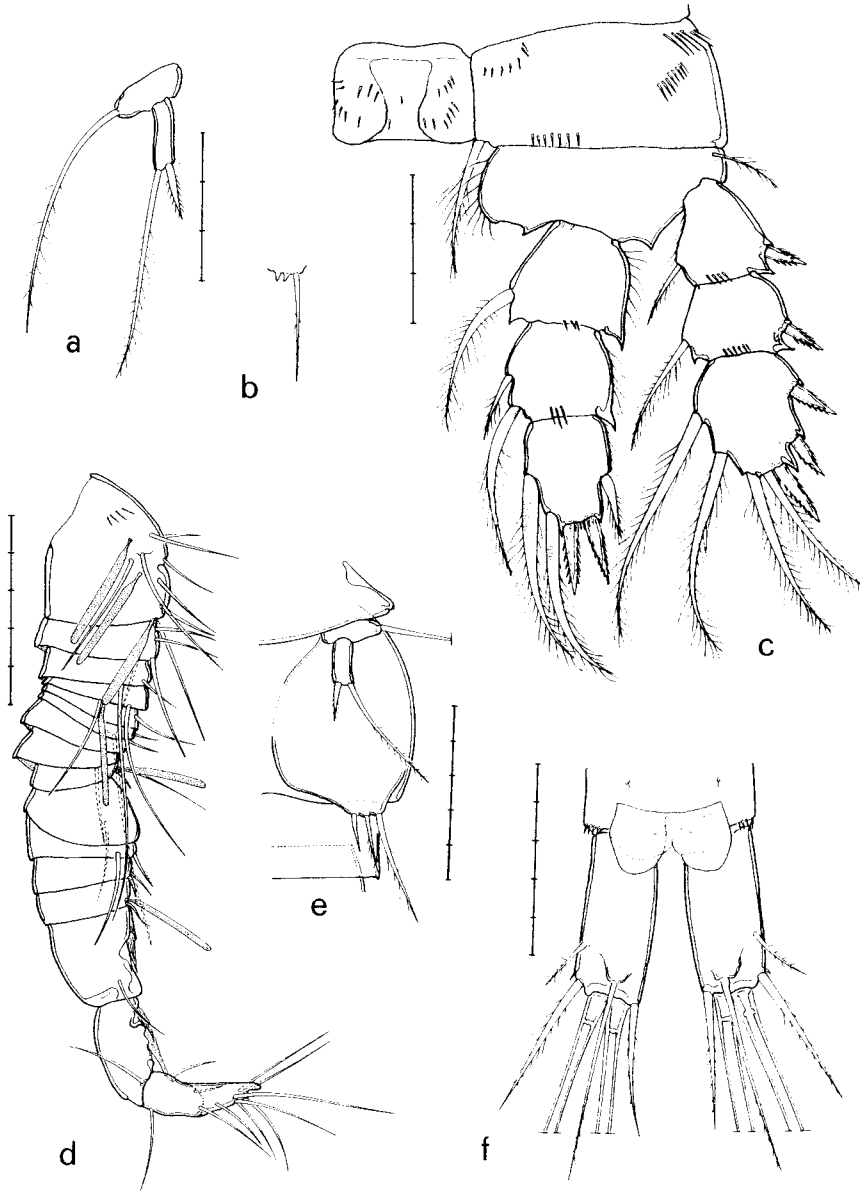


Fig. 4. *Diacyclops disjunctus* (Thalwitzer, 1927), a-c, ♀; d-f, ♂. a, P5; b, P6; c, P4, posterior view; d, antennule; e, genital somite, P5 and P6, ventral view; f, caudal rami, dorsal view. Scale bars: a-c = 30 μm ; d-f = 50 μm .

Description of male. — Length, excluding caudal setae, about 440 μm (357-561 μm , $N = 54$). Hyaline fringes of posterior margins of urosomites smooth. Caudal ramus about 1.8 times longer than wide (fig. 4f), average length 31 μm . Proportions of lengths of setae much as in female.

Antennule (fig. 4d) digeniculate, 17-segmented; neocopepodan distal geniculation between segments 14 and 15; segments 16 and 17 indistinctly divided. Segments 1, 4, 9, and 13 bearing aesthetascs, typical of the subfamily and the genus (Pospisil & Stoch, 1997, 1999). Segments (with numbers of setae and aesthetascs in brackets): 1 [8 + 3 aesthetascs], 2 [3], 3 [2], 4 [2 + 1 aesthetasc], 5 [1], 6 [2], 7 [1], 8 [1], 9 [2 + 1 aesthetasc], 10 [1], 11 [2], 12 [2], 13 [1 + 1 aesthetasc], 14 [1], 15 [1], 16 [5], 17 [7].

Antenna and other appendages as in female. P6 (fig. 4e) forming opercular plate and bearing 3 slender setae.

Remarks. — *D. disjunctus* can easily be differentiated from *D. languidus* on the basis of the following characters: smaller size; ornamentation of antenna; inner margin of basis of P4 with less pronounced notch and teeth; different shape of third endopodal segment of P4, with shorter spines and longer inner setae; shorter caudal rami. This unique combination of features also allows a distinction from *D. belgicus* Kiefer, 1936 (considered a good species by Stoch, 1998), which lacks the exopodal seta on the antennary basis.

Distribution and habitat. — *D. disjunctus* was found in river bed sediments and in groundwater habitats closely located to old arms of the Danube river; it was never collected in the surface waters of the study area (Pospisil, 1994). *D. disjunctus* was found to co-exist with *D. languidus* in wells D3, D9, and D15.

D. disjunctus was originally described by Thallwitz (1927) from mosses collected from the shore of a pond in Germany; it is widely distributed in Europe (France, Sweden, Germany, Austria, Czech Republic, Poland, Ukraine), both in surface waters and in groundwaters (Monchenko, 1974; Šterba, 1955). The citation from Spain (Kiefer, 1937), based on a single male, is not reliable: the re-examination of the slide in Kiefer collection revealed that the terminal accessory caudal seta of the specimen is about 2 times longer than the postero-lateral seta, and the terminal spines of the third endopodal segment of P4 are long and slender; no other morphological details could be observed. Therefore, the specimen belongs to another, indeterminable species of the *D. languidus*- or *D. languidoides*-group. The records from Japan (Ito, 1954, 1964 and references cited therein) probably should be referred to another species as well; the figures published by Ito (1954) show a different shape of the third endopodal segment of P4, with longer spines. Unfortunately, the material from the Ito collection must be considered lost (Ishida, pers. comm.), preventing the taxonomic status of those specimens to be established.

Although widely distributed, the species is not common and displays a scattered geographical pattern. *D. disjunctus* does not exhibit troglomorphic traits, and may be considered a stygophilous species in groundwaters.

DISCUSSION

The *Diacyclops languidus*-group, already established by Kiefer (1926), followed by Thallwitz (1927), may be redefined as follows:

Antennule 16-segmented in the female, 17-segmented in male; segmentation pattern of P1-P4 (exopods/endopods) 2/2, 3/2, 3/3, 3/3; distal segments of exopods of P1-P4 with 3,3,3,3 spines and 5,4,4,4 setae, respectively.

The group includes the following European taxa: *D. languidus*, *D. disjunctus*, and *D. belgicus*. The taxonomic status of *D. languidus linneanus* (Lindberg, 1949) and *D. languidus deminutus* Šterba, 1955 remains uncertain; following Šterba (1955), *D. languidus deminutus* from the Czech Republic does not belong to *D. languidus* and seems to be very closely related to *D. disjunctus*. *D. languidus distinctus* Šterba, 1955 reported by Dussart & Defaye (1985: 86) does not exist; it was probably a typographical error and should be included as *D. languidus disjunctus* (not *distinctus*) in the synonymy of *D. disjunctus*. At least two undescribed species are present in Italy (Stoch, unpubl.) and other closely related, new species are to be described from North America (Stoch & Reid, unpubl.); finally, the representatives of this group from Japan (Ito, 1954, 1964) and Lake Baikal (Mazepova, 1978) should be redescribed.

The differentiation of the *D. languidus*-group from the *D. languidoides*-group (see Pospisil & Stoch, 1999) is based essentially on the segmentation pattern of the female antennule: 16-segmented in the *D. languidus*-group, 11-segmented in the *D. languidoides*-group (segments 7-8-9 and 11-12-13 being fused together here); the males consequently cannot be attributed to either of the two groups on their own characters. Nevertheless, in *D. disjunctus* some of the segments of the female antennule are incompletely divided (see fig. 1e); the same consideration applies also to the specimen described by Ishida (1992) from Alaska, recently re-examined by Stoch & Reid (unpubl.). For this reason, we suspect that the distinction of the two species groups, although useful, may be fictitious. A careful redescription of all the taxa included in these two groups is needed to establish if the 11-segmented antennule of the *D. languidoides*-group is a synapomorphy for that group as a whole or is due to convergence and/or parallel evolution of the individual species now accommodated in that group.

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