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ON *REIDCYCLOPS*, NEW GENUS (CRUSTACEA, COPEPODA), WITH THE FIRST DESCRIPTION OF THE MALE OF *REIDCYCLOPS TRAJANI* (REID & STRAYER, 1994), NEW COMBINATION

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ABSTRACT

Reidcyclops n. gen. (Copepoda, Cyclopoida) is established to comprise three species, previously considered as members of the genus *Diacyclops: Reidcyclops dimorphus* (Reid & Strayer, 1994) n. comb., *R. imparilis* (Monchenko, 1985) n. comb., and *R. trajani* (Reid & Strayer, 1994) n. comb. (here designated as the type species). This genus is characterised by a 2-segmented fifth leg, and by the presence of sexual dimorphism in the swimming legs, as well as by other characteristics. In this paper the male of *R. trajani* is described for the first time from Macedonia. The taxonomic position of the new genus within the subfamily Cyclopinae is discussed.

INTRODUCTION

Petkovski (1954) gave a very short description and one plate of drawings of several female cyclopoid specimens from Macedonia, that he by mistake recognized as one species which Kiefer (1933) described, and later rediscovered (Kiefer, 1937), also from Macedonia: *Cyclops (Diacyclops) minutissimus*. Just Petkovski (1954) thought that it is better to place this species into the genus *Speocyclops*, although he noticed its isolated position within the genus. Later Petkovski (1971) corrected his error, when he redescribed the true *minutissimus* of Kiefer (and transferred it to the genus *Allocyclops*), but he left the specimens described in 1954 in the genus *Speocyclops*. These specimens were forgotten by several copepodologists (Kiefer, 1978; Dussart & Defaye, 1985; Lescher-Moutoue, 1986), until Monchenko (1985) called attention to their existence and transferred this species to the genus *Diacyclops*. In the same paper Monchenko described a new species from the Caucasus (*Diacyclops imparilis*) from a single male specimen, but he did not recognize their great similarity because the Macedonian species was known only from females. Reid & Strayer (1994) proposed a new name for the mysterious Macedonian female specimens, discovered by Petkovski (1954),

because of the great confusion that they provoked: *Diacyclops trajani*. In the same paper Reid & Strayer described a new species from the United States (from both females and males), which is also close to *D. trajani*. That species (*Diacyclops dimorphus*) possesses a very unusual feature within the genus: sexual dimorphism in the swimming legs. This strange feature (as well as some others) did not hinder them to place the new species into the genus *Diacyclops*, although they mentioned: "the diagnosis of *Diacyclops* is now so broad that it is effectively based on the fifth leg structure only".

The genus *Diacyclops* contains today more than 80 species and subspecies (Reid & Strayer, 1994; Monchenko & Vaupel Klein, 1999), and it is the largest genus of cyclopine copepods. Also, it is now one of the most problematic genera within the subfamily. Indeed its taxonomy was problematic from the beginning, when Kiefer (1927) described it, first as a subgenus of the genus *Cyclops*. Kiefer (1928) noticed two different groups of species within *Diacyclops*: the first including *D. bicuspidatus* (type species), *D. bisetosus*, *D. crassicaudis*, and some others; and the second including *D. languidus*, *D. languidoides*, *D. stygius*, etc. In the next few decades the genus *Diacyclops* was enlarged rapidly, mostly because of the great number of subterranean species. The range of its diagnosis was enlarged in parallel, although the diagnosis was very broad from the beginning. Also, the type species concept was almost forgotten, and some species described in the genus *Diacyclops* were closer to the type species of some other genera than to the type species of the genus *Diacyclops*. One good example of the recent misundenstanding of the genus *Diacyclops* range was given by Reid (1993a). She placed the species *Mesocyclops bernardi* Petkovski, 1986, which combines morphological features of the genera *Mesocyclops* and *Thermocyclops*, in the genus *Diacyclops*, because (among other things): "Reduction and variation in antennule article number is a common phenomenon in species of *Diacyclops*". Pesce (1996) "provisionally" placed the genus *Diacyclops* partly into two different groups of genera within the subfamily Cyclopinae, and even in three different places on his key for genera. This genus badly needs revision, but that would be a very large project. The much easier approach is to exclude everything that we are sure does not belong to this genus. The first brave step was made by Lescher-Moutoue (1976), who established the genus *Kieferiella*. Reid et al. (1999) transferred *Diacyclops virginianus*, which Reid (1993b) had described from the United States, to the newly established genus *Rheocyclops*. Reid & Ishida (in press) transferred *Diacyclops yezoensis* (Ito) to the newly proposed genus *Itocyclops*, after reexamination of extensive material from Japan, and also from the United States. The present paper is also on that course.

We have found for the first time the male of *Diacyclops trajani* Reid & Strayer, 1994, and after its detailed examination we found out that it is impossible to maintain this species within the scope of the genus *Diacyclops*. So, we propose to establish a new genus for that species, and also for two other similar species: *Diacyclops imparilis* Monchenko, 1985 and *Diacyclops dimorphus* Reid & Strayer, 1994.

MATERIALS AND METHODS

A sample was collected from several wells in Oresani village, near the town of Skopje, Macedonia (SE Europe), on May 6, 1978, by Dr. Trajan K. Petkovski, and kindly loaned to us. The material was preserved by adding several drops of 36% formaldehyde, and remained in that preservative twenty years. Copepods were separated with a Wild M5 stereomicroscope and transferred to 70% ethyl alcohol. Specimens were dissected in a mixture of equal parts of distilled water and glycerol, with fine entomological needles (No. 000). Dissected appendages were placed on a slide, in the same mixture of distilled water and glycerol, and covered with a coverslip. For larger parts (abdomen, etc.) two human hairs were mounted between slide and coverslip, so the parts could not be crushed. By moving the coverslip carefully by hand, the whole animal or a particular appendage was placed in different positions, making possible the observation of morphological details. During the examination the water slowly evaporated, and after some time the appendages remained in pure glycerol.

All drawings have been prepared using a drawing attachment (tube) on a Leica DMLS microscope, with C-PLAN achromatic objectives. Dissected appendages were preserved in com-

mercial polyvinyl-lactophenol, or in Faure's medium which was prepared following the traditional procedure, recently discussed by Stock & Vaupel Klein (1996). Non-dissected specimens, after examination, were again preserved in 70% ethyl alcohol. In that sample the following species were found:

1. *Diacyclops crassicaudis* (Sars, 1863): 17 males and 5 females (3 ovigerous);
2. *Diacyclops zschokkei* (Graeter, 1910): 1 male and 5 females;
3. *Reidcyclops trajani* (Reid & Strayer, 1994) n. comb.: 1 male;
4. *Attheyella (s.str.) crassa* (Sars, 1863): 1 male.

The male specimen of *Reidcyclops trajani* was dissected, mounted in polyvinyl-lactophenol, and deposited in the Zoological Museum Amsterdam. All the other specimens are deposited in the author's working collection in Italy. In the description, diagnosis, and figure legends no abbreviations were used.

SYSTEMATIC DESCRIPTIONS

Order Cyclopoida Sars, 1886
Family Cyclopidae Burmeister, 1834
Subfamily Cyclopinae Dana, 1853
Genus *Reidcyclops* n. g.

DIAGNOSIS. - Cyclopidae, Cyclopinae. Small species, body length ranging from 0.24 to 0.75 mm. Genital double-somite very large, with anterior half expanded, and tapering posteriorly. Furcal rami short (about 1.7 times longer than wide), with innermost apical seta half length of outermost, and with dorsal seta considerably longer than outermost apical seta. Female antennula 11-segmented, shorter than cephalothorax. Antenna 4-segmented, without seta representing exopodite. Maxilliped 4-segmented, with reduced total number of setae (6 or 7). Sexual dimorphism present in swimming legs. Exopodites and endopodites of all swimming legs 2-segmented in female, while in male exopodite of fourth swimming leg (in some species also of third leg) 3-segmented. Second endopodite segment of fourth swimming leg with 3 inner setae, 2 apical spines (inner spine about twice longer than outer one), and 1 outer seta. Fifth leg 2-segmented, inserted ventrally. Proximal segment more than 2 times broader than long, attached to somite along its total width, with 1 seta on outer distal corner. Distal segment 1.5 to 2 times longer than broad, with 2 apical (almost equal) setae. These setae considerably longer than segment.

ETYMOLOGY. - The genus in named after Dr. Janet W. Reid, in honour of her outstanding contribution to the taxonomy of Cyclopinae (and especially to the species included in the new genus); prefixed to the genus name *Cyclops*. Gender masculine.

TYPE SPECIES. - *Diacyclops trajani* Reid & Strayer, 1994

ADDITIONAL SPECIES. - *Reidcyclops dimorphus* (Reid & Strayer, 1994) n. comb., and *Reidcyclops imparilis* (Monchenko, 1985) n. comb.

Reidcyclops trajani (Reid & Strayer, 1994) n. comb.
Figs. 1-16

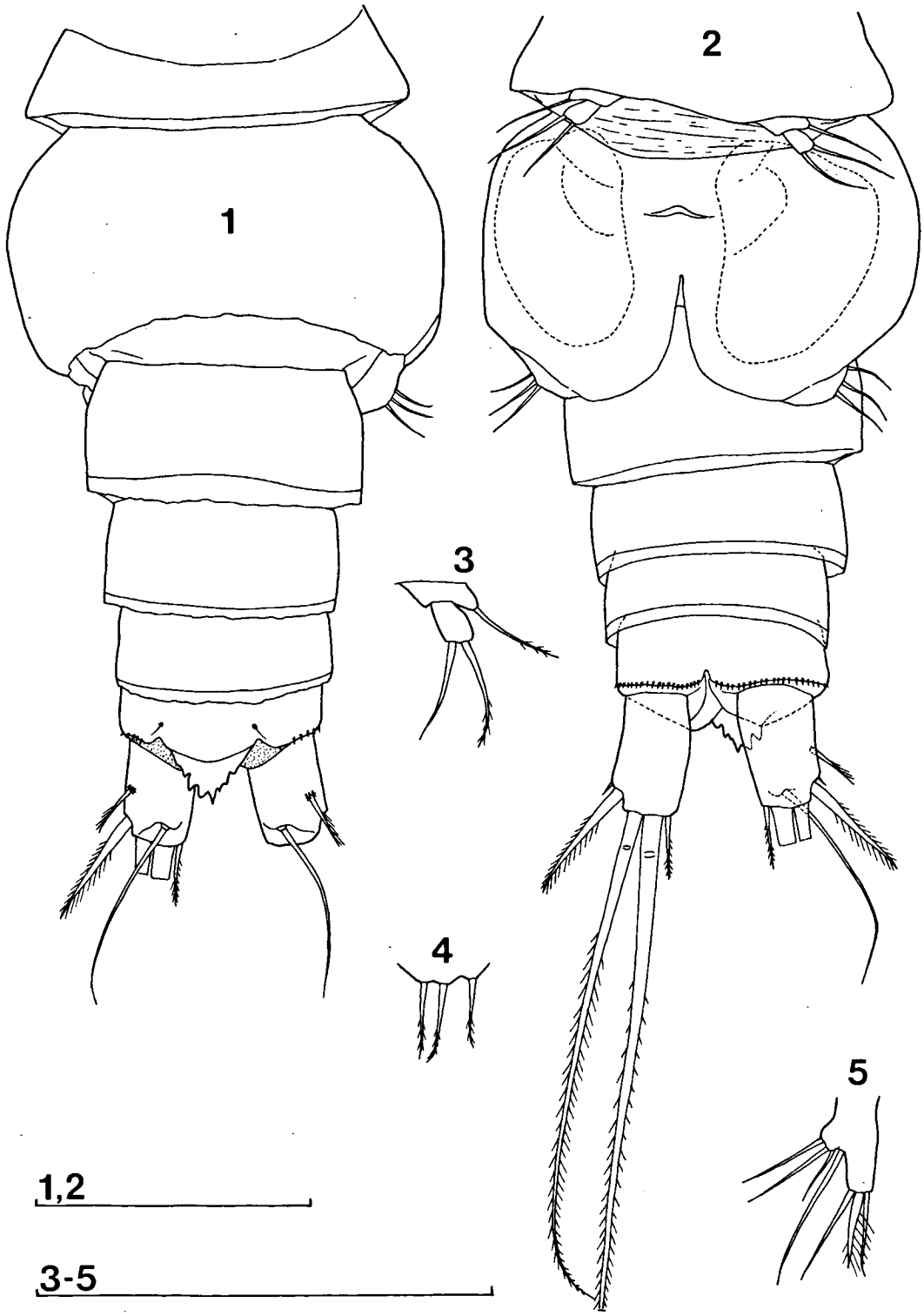
SYNONYMY

Speocyclops minutissimus (Kiefer): Petkovski, 1954: 22, figs. 29-33; Petkovski, 1971: 106.
Diacyclops minutissimus sensu Petovski: Monchenko, 1985: 24.
Diacyclops trajani nom. nov.: Reid & Strayer, 1994: 257.
Diacyclops trajani (Petkovski): Pesce, 1996: 192.
Non: *Cyclops (Diacyclops) minutissimus* n.sp.: Kiefer, 1933: 278, figs. 1-3.
Non: *'Diacyclops' minutissimus* Kiefer: Kiefer, 1937: 17, figs. 5-7.
Non: *Allocyclops minutissimus* (Kiefer): Petkovski, 1971: 106, figs. 67-69; Kiefer, 1978: 215; Dussart & Defaye, 1985: 146; Lescher-Moutoué, 1986: 309.
Non: *Allocyclops (s.str.) minutissimus* (Kiefer): Karanovic, in press.

MATERIAL

MACEDONIA. - ZMA Co. 204433 (Skopje, Oresani village, one ♂, Coll. T.K. Petkovski, 6-V-1978).

DESCRIPTION OF THE MALE. - Body length, excluding furcal setae, 0.75 mm. Habitus compact, dorsoventrally compressed. Body colourless,



Figs. 1-5. *Reidcyclops trajani* (Reid & Strayer, 1994) n. comb., male (0.75 mm): 1, urosome, dorsal view. 2, urosome, ventral view. 3, fifth leg. 4, sixth leg. 5, maxillular palp (scales = 0.1 mm).

and nauplius eye absent. Surface of dorsal shield covering cephalothorax, as well as 3 free pedigerous somites, lacking ornamentation (Fig. 10). Body widest at second pedigerous somite. More or less sclerotized joint (as pseudosomite) present between prosome and urosome, as well as between fifth pedigerous somite and genital somite (Figs. 2 and 10). Genital somite about 1.8 times broader than long, with 2 ventral lobes produced posteriorly to middle of second abdominal somite, and with 2 large kidney-like spermatophores (Fig. 2). Second, third, and fourth abdominal somites with hind margins smooth ventrally and wavy (not serrated) dorsally (Fig. 1). Anal somite short, ornamented with pair of sensillae, and with row of spinules along posterior margin. Anal operculum triangular, roughly and irregularly serrated, reaching considerably beyond limit of anal somite (Fig. 1). Anal sinus smooth. Furcal rami slightly divergent, about 1.7 times longer than wide, and with space between them less than width of 1 furcal ramus (Fig. 2). Lateral seta inserted dorsolaterally, just at midlength of ramus. Dorsal seta about 1.5 times longer than ramus, smooth. Outermost apical seta very stout, subterminal, and about twice longer than innermost apical seta. Two middle apical setae well-developed; inner seta about 1.4 times longer than outer one. Furcal rami without ornamentation, except 3 small spinules at base of lateral seta (Fig. 1). Rostrum large, evenly rounded, but not reaching beyond end of antennula first segment (Fig. 10).

Antennula 15- segmented, geniculate, with slender aesthetasc only on eighth segment, and with setal formula as follows: 8.4.1.2.2.2.0. 1.2.2.1.0.1.1.8 (Fig. 12). Proximal seta on ninth, as well as seta on eleventh segments very stout and short (maybe spiniform). All setae smooth.

Antenna 4-segmented, without seta representing exopodite, and with setal formula as follows: 2.1.8.6 (Fig. 13). No ornamentation visible on surface of basipodite.

Labrum with small teeth on posterior margin, but without any other ornamentation (Fig. 11). Cutting edge flat.

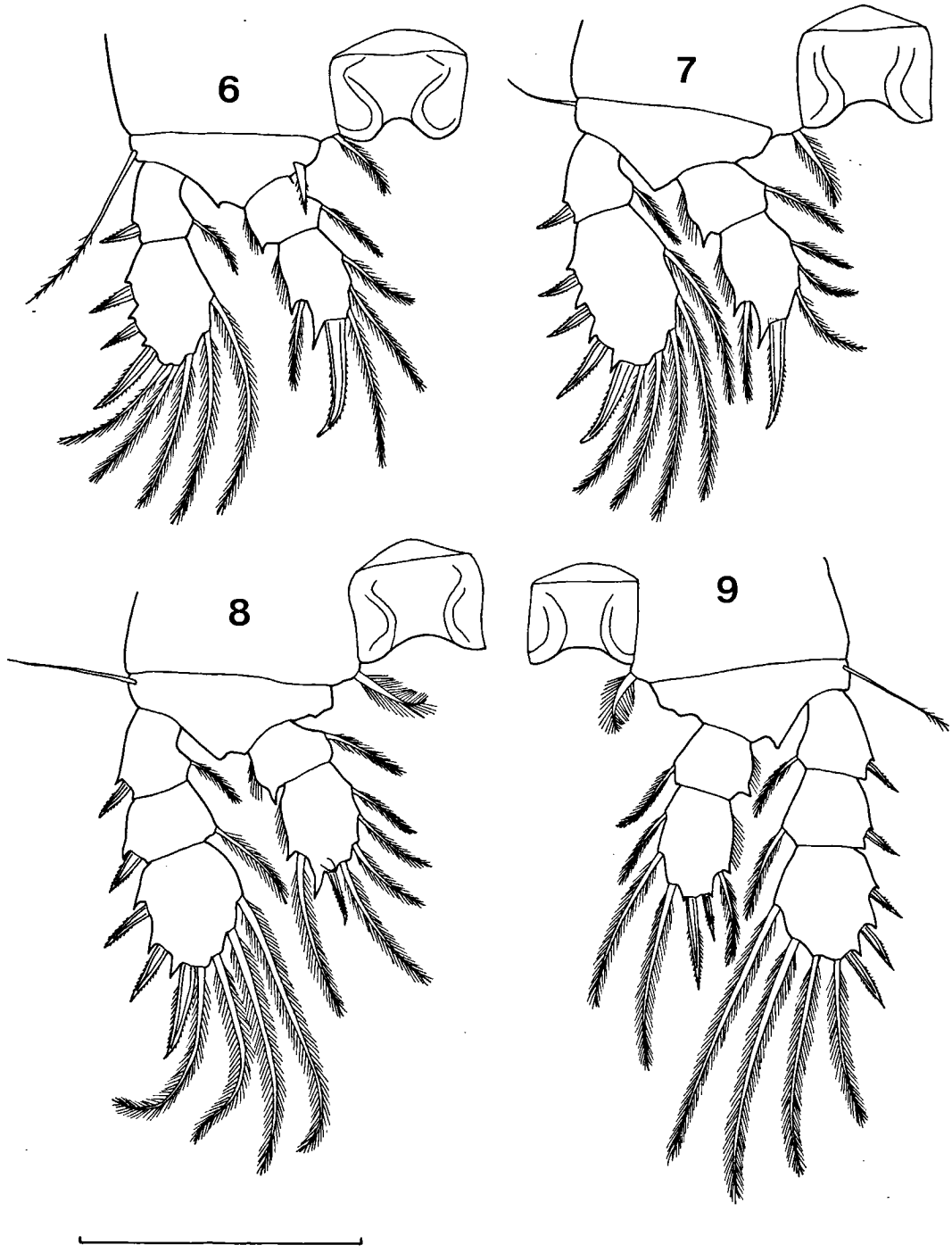
Mandibula with very strong teeth on distal end of coxa, and without any trace of mandibular palp (Fig. 15).

Maxillula comprised of stout praecoxa and 1-segmented palp. Palp bearing 3 apical setae and 4 lateral ones. Only middle apical seta plumose (Fig. 5).

Maxilla 4-segmented, praecoxa and coxa completely fused, forming syncoxa (Fig. 14). Proximal endite of praecoxa bearing only 1 plumose seta; distal endite small, unarmed. Proximal endite of coxa with 1 plumose seta; distal endite highly mobile and bearing 1 plumose and 1 smooth setae. Basis drawn out into claw, with few spinules on inner margin and 2 setae. First endopodite segment armed with 2, second with 3 setae (Fig. 14).

Maxilliped 4-segmented, without any visible surface ornamentation, and with setal formula as follows: 2.1.1.2 (Fig. 16).

All swimming legs with smooth coxae, and 1 plumose seta on their inner distal corner (Fig. 6, 7, 8 and 9). Couplers (intercoxal sclerites) without surface ornamentation. Basis of each swimming leg with epipodite seta on outer margin, especially well developed on first leg (Fig. 6). Basis of first leg also with short stout spine on distomedial corner. Corresponding corner on other swimming legs without spine, just with small and obtuse process. All swimming legs with 2-segmented endopodites. Exopodites of first and second swimming legs also 2-segmented, while exopodites of third and fourth swimming legs 3-segmented. First exopodite segment of all legs, as well as second exopodite segment of third and fourth legs, each with inner short seta and outer stout spine. Distalmost exopodite segments with spine formula 3.4.3.3, and setal formula 5.5.4.4. First endopodite segment of all legs bearing 1 seta on inner-distal corner. Second endopodite segment of first swimming leg with 3 inner setae, 1 large curved apical spine, and 1 outer seta (Fig. 6). Same segment of second leg very similar, only inner setae and apical spine somewhat shorter (Fig. 7). Second endopodite segment of third leg with 4 inner setae, 1 small curved apical spine, and 1 outer seta (Fig. 8). On base of apical spine there is small cuticular bulge. Second endopodite segment of fourth swimming leg with 3 inner setae, 2 apical spines (inner spine about twice longer than outer one), and 1 outer seta (Fig. 9); this segment about 1.5 times longer than broad. Outer margins of endopodites of all swimming legs ornamented with rows of long pinnules.



Figs. 6-9. *Reidcyclops trajani* (Reid & Strayer, 1994) n. comb., male (0.75 mm): 6, first swimming leg. 7, second swimming leg. 8, third swimming leg. 9, fourth swimming leg (scale = 0.1 mm).

Also, all setae (except epipodite setae on second and third legs) plumose.

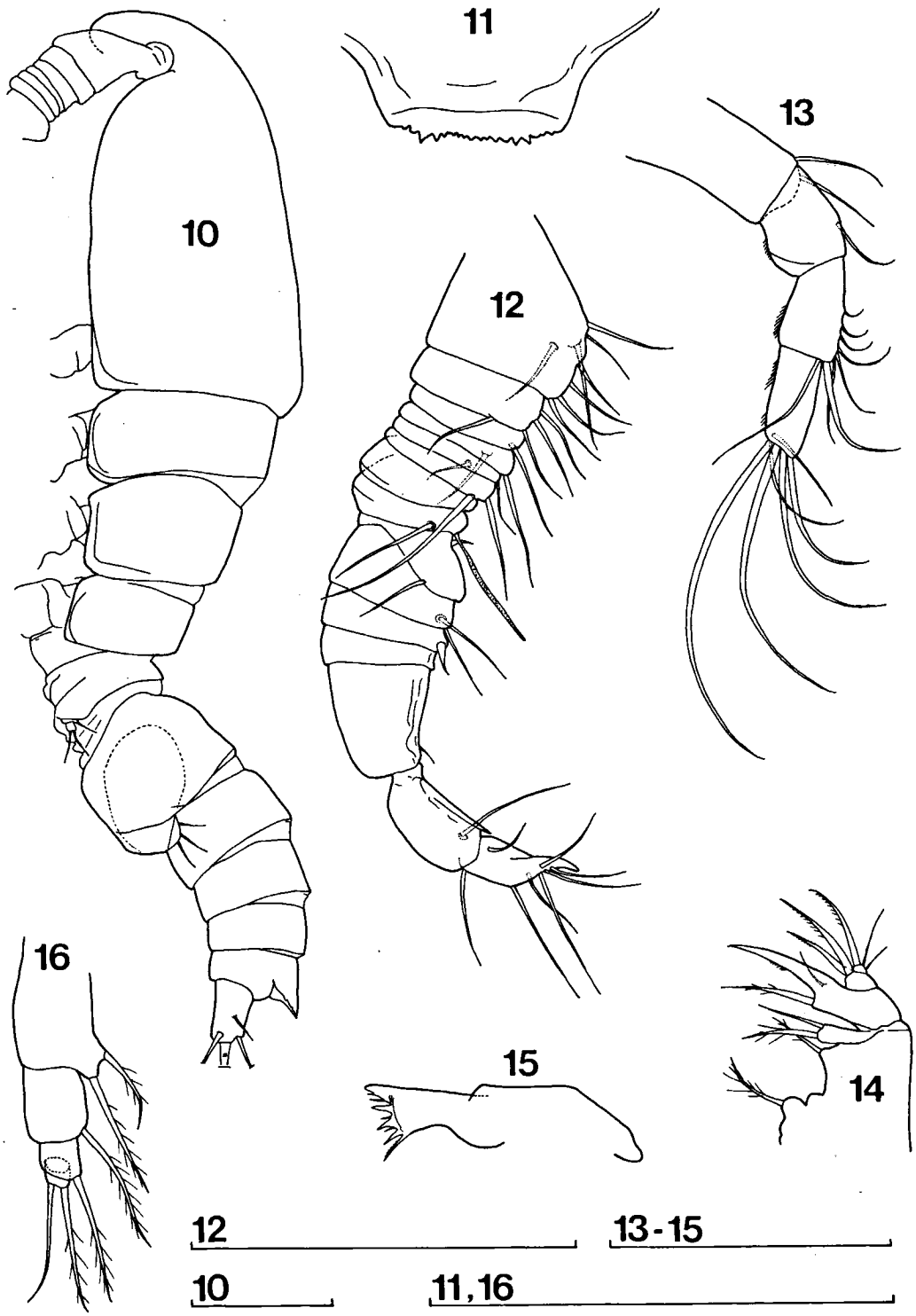
Fifth leg 2-segmented, inserted ventrally (Fig. 2). Proximal segment about 2.5 times broader than long, with 1 seta on outer distal corner. Distal segment about 1.5 times longer than broad, with 2 apical subequal setae, almost 2.5 times longer than segment (Fig. 3). Inner apical seta smooth; outer apical seta, as well as seta on proximal segment, bearing only a few short pinnules.

Sixth leg consisting of small triangular plate bearing 3 almost equal setae (Fig. 4).

DISCUSSION

The systematics of the genera included in the subfamily Cyclopinae has been recently discussed by many authors (Dussart & Defaye, 1985; Reid, 1993c; 1999; Pesce, 1996; Ferrari, 1998; Rocha et al., 1998; Reid et al., 1999). Presently, as 60 years ago, the most important character at the generic level is the morphology of the fifth leg (although this is not the only character). Until now nine genera are known with a 2-segmented fifth leg: *Cyclops* Muller, 1776; *Mesocyclops* Sars, 1914; *Megacyclops* Kiefer, 1927; *Acanthocyclops* Kiefer, 1927; *Diacyclops* Kiefer, 1927; *Thermocyclops* Kiefer, 1927; *Mixocyclops* Kiefer, 1944; *Kieferiella* Lescher-Moutoue, 1976; and *Caspicyclops* Monchenko, 1986. From all these genera *Reidcyclops* n. g. is easy distinguishable by the presence of sexual dimorphism in the swimming legs. It is unknown whether there is sexual dimorphism in the swimming legs in the genus *Caspicyclops* Monchenko, 1986, because only females are known, but this genus differs from all other genera in the subfamily Cyclopinae by the harpacticoid body shape, the appearance of the furcal rami, and many other characteristics (Monchenko, 1986). The genera *Cyclops, Mesocyclops, Megacyclops, Thermocyclops,* and *Kieferiella,* beside the absence of sexual dimorphism in the swimming legs, differ from the genus *Reidcyclops* n. g. also by 3-segmented exopodites and endopodites of all swimming legs, by 17-segmented antennula (rarely with a reduced number of segments, but never as few as 11), and many other details. The genus *Mixocyclops* is very similar to the genus *Reidcyclops* n.g. in the 11-segmented antennulae, furcal rami shape, and 2-segmented exopodites and endopodites of all swimming legs, but it has only one seta on the inner side of the second endopodite segment of the fourth swimming leg, it has no sexual dimorphism in the swimming legs, and the distal segment of the fifth leg bears only one seta (Kiefer, 1944). The genus *Acanthocyclops* has very confused systematics (like the genus *Diacyclops*), but it clearly differs from the genus *Reidcyclops* n.g. by the presence of one very short subapical spine and one long apical seta on the distal segment of the fifth leg.

Reidcyclops n.g. was separated from the genus *Diacyclops,* and because of that it is very important to present the main differences between these two genera. However, the taxa now remaining in the genus *Diacyclops* do not form a harmonious entirety. Unfortunately a revision of the genus *Diacyclops* is beyond the scope of this paper. For now it is certain that two characteristics easily distinguish those two genera: the segmentation pattern of the exopodites and endopodites of the swimming legs, and the presence of sexual dimorphism in the genus *Reidcyclops.* Also, the distal segment of the fifth leg in the genus *Diacyclops* bears one subapical spine (which is remarkably longer than in the genus *Acanthocyclops*) and one apical seta, while in the genus *Reidcyclops* it bears two long setae. Indeed, Monchenko (1985) claimed that the fifth leg of *Reidcyclops imparilis* (Monchenko) n. comb. is like that in the genus *Diacyclops,* but we believe that the structure of the fifth leg of that species was misinterpreted. Inner apical (maybe slightly subapical) seta on distal segment of the fifth leg in *Reidcyclops trajani* (Reid & Strayer) n. comb. also a little bit resambles spine (Fig. 3), because it is not plumose, but it was very easy to discover that this is a seta by twisting when we moved the coverslip during the examination of material. Nevertheless, several species from Lake Baikal, that are now in the genus *Diacyclops,* have a very similar shape of the fifth leg (Mazepova, 1950; 1952; 1962; Alekseev & Arov, 1986). Those species are: *D. incolotaenia, D. jasnitskii, D. intermedius, D. spongicola,* and perhaps *D. eulitoralis.* They have a very specific shape of the antenna (different from *Diacyclops* as well as from *Reidcyclops* n.g.), and in our opinion they form a distinct genus, endemic in Baikal. That group of species differs from the genus *Reidcyclops* n.g., besides the sexual dimor-



Figs. 10-16. *Reidcyclops trajani* (Reid & Strayer, 1994) n. comb., male (0.75 mm): 10, habitus, lateral view. 11, labrum. 12, antennula. 13, antenna. 14, maxilla. 15, mandibula. 16, maxilliped (scales = 0.1 mm).

phism in the swimming legs and the shape of the antenna, also by the segmentation of the swimming legs, and by the shape of furcal rami.

Sexual dimorphism in the swimming legs was known in the subfamily Cyclopinae only in six genera: *Bryocyclops* Kiefer, 1927; *Graeteriella* Brehm, 1927; *Paleocyclops* Monchenko, 1972; *Hesperocyclops* Galassi & Pesce, 1992; *Rheocyclops* Reid et al., 1999; and *Itocyclops* Reid & Ishida, in press. It seems that this phenomenon originated independently in all these genera, as a consequence of oligomerization of the swimming legs, and that it is without phylogenetic importance (convergency). So, in some genera it is connected with endopodites, in some others with exopodites, and often in one genus dimorphism is connected with fourth swimming leg in some species, while in others also with the third swimming leg. After all, a similar situation is seen among the species of the genus *Reidcyclops* n.g. From all genera mentioned above, the genus *Reidcyclops* n.g. differs by its fifth leg structure. This appendage is in those genera either completely fused to the somite (*Bryocyclops, Paleocyclops*), or its proximal segment is fused, while the distal one is free (*Graeteriella, Hesperocyclops, Rheocyclops, Itocyclops*). In the newly established genus we included three species: *Reidcyclops trajani* (Reid & Strayer, 1994) n. comb.; *Reidcyclops dimorphus* (Reid & Strayer, 1994) n. comb.; and *Reidcyclops imparilis* (Monchenko, 1985) n. comb. Although *R. imparilis* was described only from the male, its great similarity to the male of *R. trajani* (described in this paper) shows that there is no room for doubt that these two taxa belong to the same genus. This species surely differs from *R. trajani* only by the absence of a seta on the first exopodite segment of the first swimming leg, and by the presence of four (instead of three) setae on the second endopodite segment of the second swimming leg (Monchenko, 1985). *Reidcyclops trajani* is known from Balkan Peninsula and *R. imparilis* from the Caucasus. *R. dimorphus* is known from North America (Florida), and differs from the other two species by the shape of the anal operculum, by the 2-segmented exopodite of the male's third swimming leg, the setal formula, and some other caracteristics (Reid & Strayer, 1994). All three species are stygobionts.

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