

REDESCRIPTION OF *TERATOCYCLOPS CUBENSIS* PLEȘA, 1981 (COPEPODA, CYCLOPOIDA, CYCLOPIDAE) FROM CUBA

BY

SANDA IEPURE^{1,3}) and DANIELLE DEFAYE^{2,4})

¹) Institutul de Speologie "Emil Racovitza", Clinicilor 5, Cluj, RO-3400, Romania

²) Muséum national d'Histoire naturelle, Département Milieux et Peuplements Aquatiques,
USM 403, 61, rue de Buffon, F-75005 Paris, France

ABSTRACT

Teratocyclops cubensis Pleșa, 1981 (Copepoda, Cyclopidae) is redescribed on the basis of specimens deposited in the collection of the Speleological Institute "Emil Racovitza", Cluj, Romania. The genus *Teratocyclops* Pleșa, 1981 is redefined, mainly characterized by the following characters of the female: the general habitus of the body, the 11-segmented antennule, the presence of the vestigial exopodite on the antenna, the segmentation of the swimming legs, the structure of the distal segment of the endopodite of leg P4 with 1 spine and 3 setae, and the proximal segment of leg 5 fused to the somite. The relationship to the closely related genera *Metacyclops* Kiefer, 1927, *Apocyclops* Lindberg, 1942, and *Goniocyclops* Kiefer, 1955 are discussed.

RÉSUMÉ

Teratocyclops cubensis Pleșa, 1981 (Copepoda, Cyclopidae) est redécrit à partir des spécimens déposés dans les collections de l'Institutul de Speologie "Emil Racovitza", de Cluj, Roumanie. Le genre *Teratocyclops* Pleșa, 1981 est redéfini. Il est principalement caractérisé par les traits suivants de la femelle: la forme générale du corps, l'antennule à 11 segments, la présence de l'exopodite vestigial sur l'antenne, la segmentation des pattes natatoires et l'ornementation du dernier segment de l'endopodite de P4 comprenant 1 soie et 3 épines, le segment proximal de P5 soudé au somite. Les affinités avec les genres voisins, notamment *Metacyclops* Kiefer, 1927, *Apocyclops* Lindberg, 1942 et *Goniocyclops* Kiefer, 1955 sont discutées.

INTRODUCTION

The genus *Teratocyclops* Pleșa, 1981 is a monospecific genus belonging to the copepod family Cyclopidae, subfamily Cyclopinae. *Teratocyclops cubensis* Pleșa,

³) e-mail: siepure@hasdeu.ubbcluj.ro

⁴) e-mail: ddefaye@mnhn.fr

1981 has been discovered in subterranean lakes from three caves in the provinces Pinar del Rio, Caguanes, and Camaguei, respectively, on Cuba (Botoșăneanu, 1970; Pleșa, 1981, 1989). The author established the new genus according to the following morphological traits: general habitus of the body (wide cephalon, enlarged genital somite), swimming legs P1-4 with biarticulate rami, and structure of P5. Here, we re-examine and redescribe the morphological characters of the female and give some morphological details on the male; also, we provide supplementary characters in order to complete the first description.

MATERIAL AND METHODS

Our observations were made using the existing material, completely dissected (Pleșa, 1981) and deposited in the collection of the Speleological Institute "Emil Racovitza", Cluj, Romania. Ten females and three males were used to redescribe the species, the others being in bad condition. All specimens of *Teratocyclops cubensis* from the collection are considered to constitute the syntype-series. All drawings were made from whole specimens in glycerol, using a compound microscope. We have used the terminology proposed by Dussart & Defaye (1995).

The material observed herein was collected during the first Cuban-Romanian biospeological expedition in 1969. From the total of 30 samples, one is epigean, 4 are from interstitial marine water, 4 from hyporheic habitats, 4 from wells, and 17 from caves. One new genus, three species, and one subspecies were described from hyporheic waters and caves (Pleșa, 1981).

The specimens described here were collected in association with two other copepod species in only one of the caves (Cueva del Aqua, province Pinar del Rio). These species are *Macrocyclus albidus* (Jurine, 1920) and *Mesocyclops (Thermocyclops) orghidani* Pleșa, 1981, now often considered as a species incertae sedis (Dussart & Defaye, 1985), and in need of a redescription as well.

TAXONOMY

CYCLOPIDAE Rafinesque, 1815

CYCLOPINAE sensu Dana, 1853

Teratocyclops Pleșa, 1981

***Teratocyclops cubensis* Pleșa, 1981 (figs. 1-5)**

Material examined. — Cueva del Aqua (Province Camaguei), site 12 (St. 30a), phreatic lake, temp. 22°C, leg. L. Botoșăneanu, 25.iv.1969; Cueva del Tunel (Province Caguanes), site 16 (St.

35a), lake, temp. 22.6°C, leg. L. Botoșăneanu, 29.iv.1969; Cueva del Aqua (Province Pinar del Rio), site 31 (St. 44b) phreatic lake, temp. 23°C, pH 8, leg. Șt. Negrea, 3.vi.1969.

Description of female. — Length excluding furcal setae: 478-695 μm (mean: 590 μm). Cyclopoid of small size, globose in its anterior part, largest width (135-208 μm , mean = 187 μm) at the posterior part of the cephalothorax in dorsal view (fig. 1A, B). Following somites narrowing, the somite bearing P5 the narrowest (fig. 1C).

Genital double-somite enlarged, wider than the somite bearing P5, about 1.2 times wider than long and longer than the three following urosomites together. A constriction at each side of this somite marks the location of P6 covering the gonopores, and is situated at about 40% from the anterior edge of the somite. In ventral view, seminal receptacle well visible through the hyaline cuticle: anterior part slightly flattened, occupying half the space to the proximal margin of the somite, with anterior edge hardly concave and lateral parts rounded; posterior part of large size, the posterior margin, concave in its median part, almost reaching the distal edge of the somite; suture cord straight. Copulatory duct of wide cross section connecting the seminal receptacle to the copulatory pore situated just posteriorly to the suture cord (see Defaye et al., 2003 for terminology) (fig. 1E).

The two following urosomites of about the same width and length, 0.6 times the larger width of the genital somite, both without ornamentation at their distal margin. Anal somite a little longer, bearing a row of tiny spines ventrally. Anal operculum concave (fig. 1C).

Furcal rami slightly divergent, about 1.78-2.54 μm (mean: 2.17 μm), 1.8 times longer than broad, with the usual 6 setae (fig. 1D). Furcal setae: median external seta inserted at the middle of the caudal ramus, rather dorsally, being the shortest of the furcal setae, shorter than the externalmost and the internalmost setae; internalmost seta 1.6 to 1.7 times longer than the externalmost seta and more robust; dorsal seta inserted rather internally, long, 1.5 times longer than the caudal rami, about 1.1 times longer than the internalmost and 1.8 times longer than the externalmost seta. No spinule inserted at the base of the median external and the externalmost setae. Terminal median furcal setae long, with a true geniculation, allowing the setae to fold completely dorsally without breaking (fig. 1D, arrow).

Antennule 11-segmented, characterized by long setae, especially on segments 1, 3, 8; setation from proximalmost to distalmost segments (number of setae in parentheses; a, aesthetasc; s, spine): 1 (8), 2 (3), 3 (5), 4 (1s), 5 (1 + 1s), 6 (2), 7 (3), 8 (2 + 1a), 9 (2), 10 (2 + 1a) and 11 (7 + 1a). Segmental fusion patterns of the antennule as I-V, VI-VII, VIII-XI, XII-XIII, XIV, XV-XVI, XVII-XX, XXI-XXIII, XXIV, XXV, XXVI-XXVIII (fig. 3C, D).

Antenna 4-segmented, composed of the basipodite and an endopodite of 3 segments (fig. 2A). Basipodite with 2 internal plumose setae, inserted antero-distally

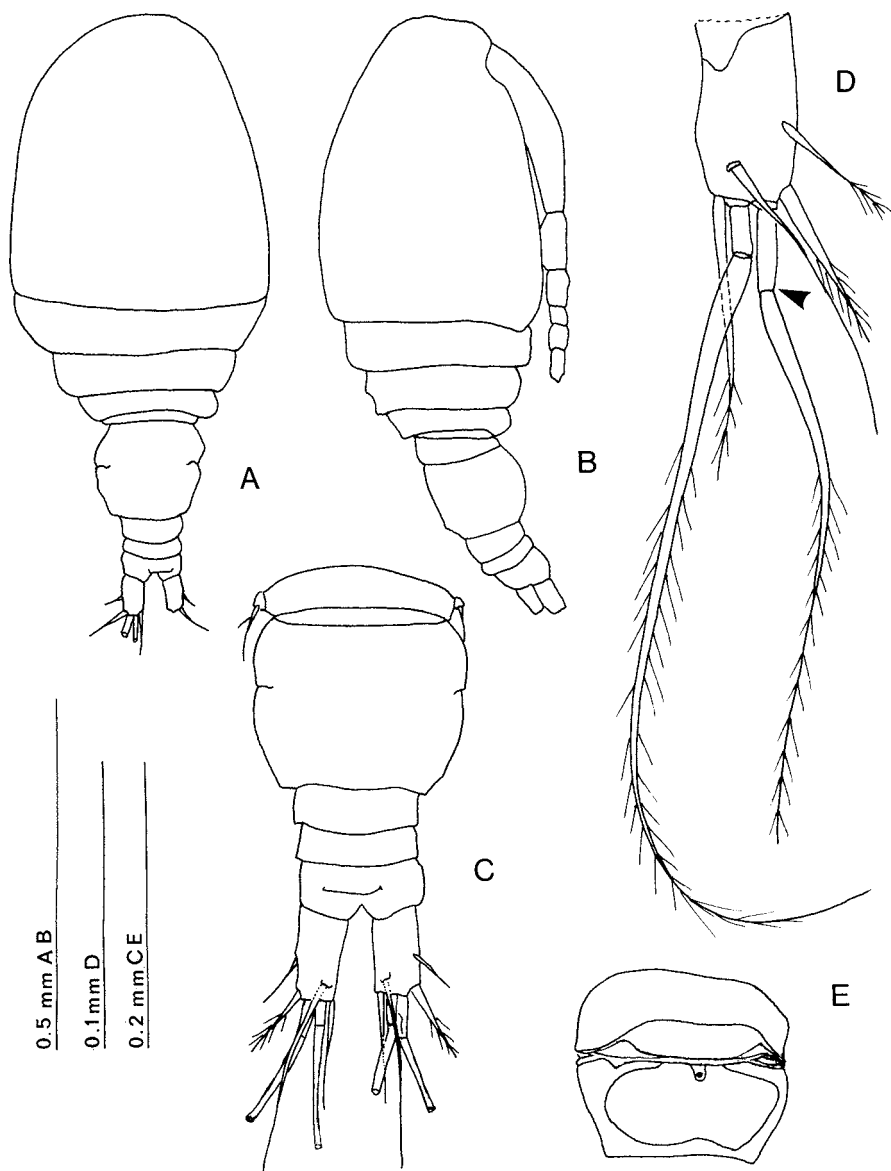


Fig. 1. *Teratocyclops cubensis* Pleša, 1981, female. A, habitus, dorsal side; B, habitus, lateral view; C, urosome; D, furcal rami and setae; E, genital double-somite with, by transparency, view of the seminal receptacle.

and bearing externally the long exopodal seta inserted distally. No spinule ornamentation observed on the frontal and caudal faces of the basipodite. A tiny row of spinule ornamentation is visible on the outer sides of the basipodite. Endopodite bearing on its successive segments 1, 8, and 7 setae, respectively; all three segments ornamented with a row of hairs on the outer margin.

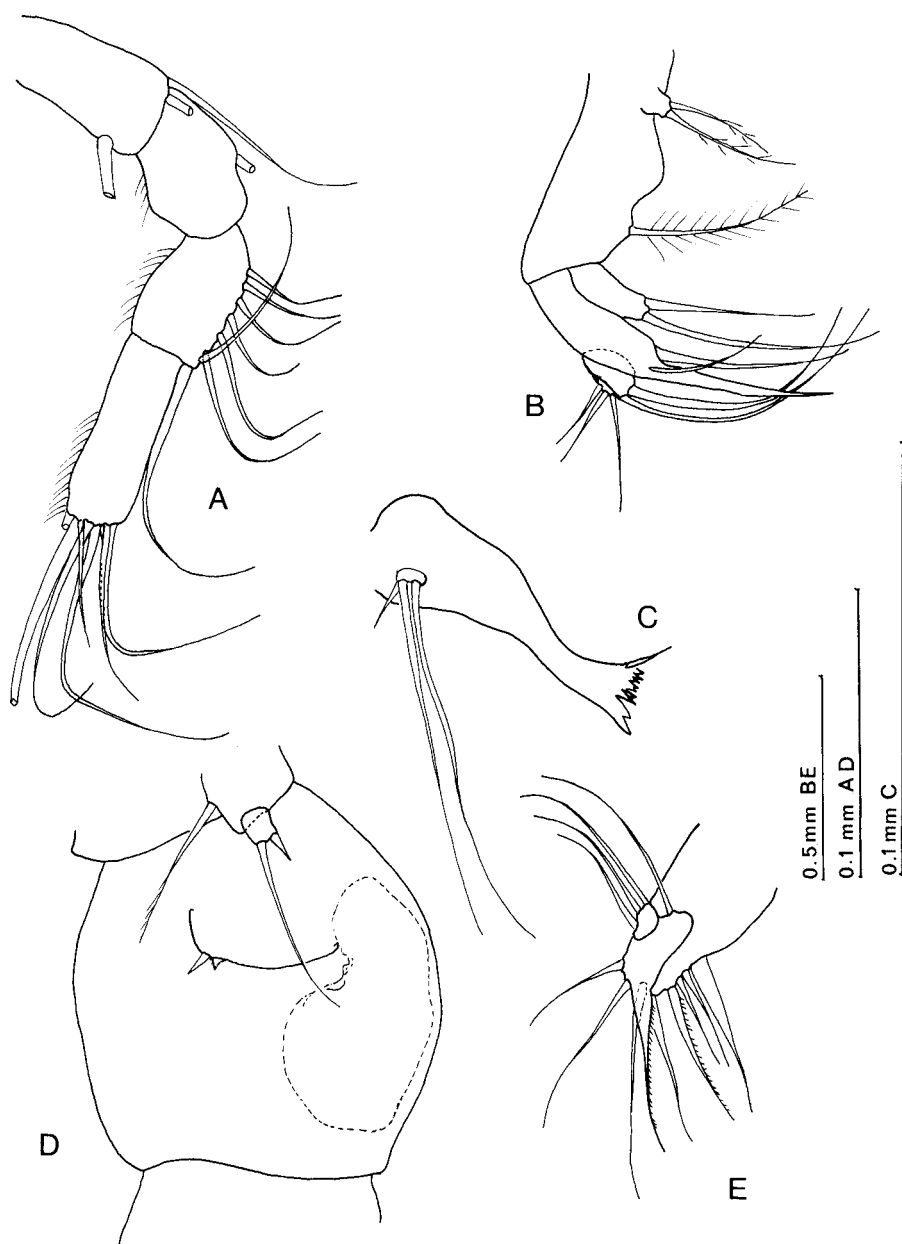


Fig. 2. *Teratocyclops cubensis* Pleșa, 1981, female. A, antenna; B, maxilla; C, mandible; D, P5, P6 and genital double-somite, lateral view, seminal receptacle drawn in dotted line; E, terminal part of maxillule.

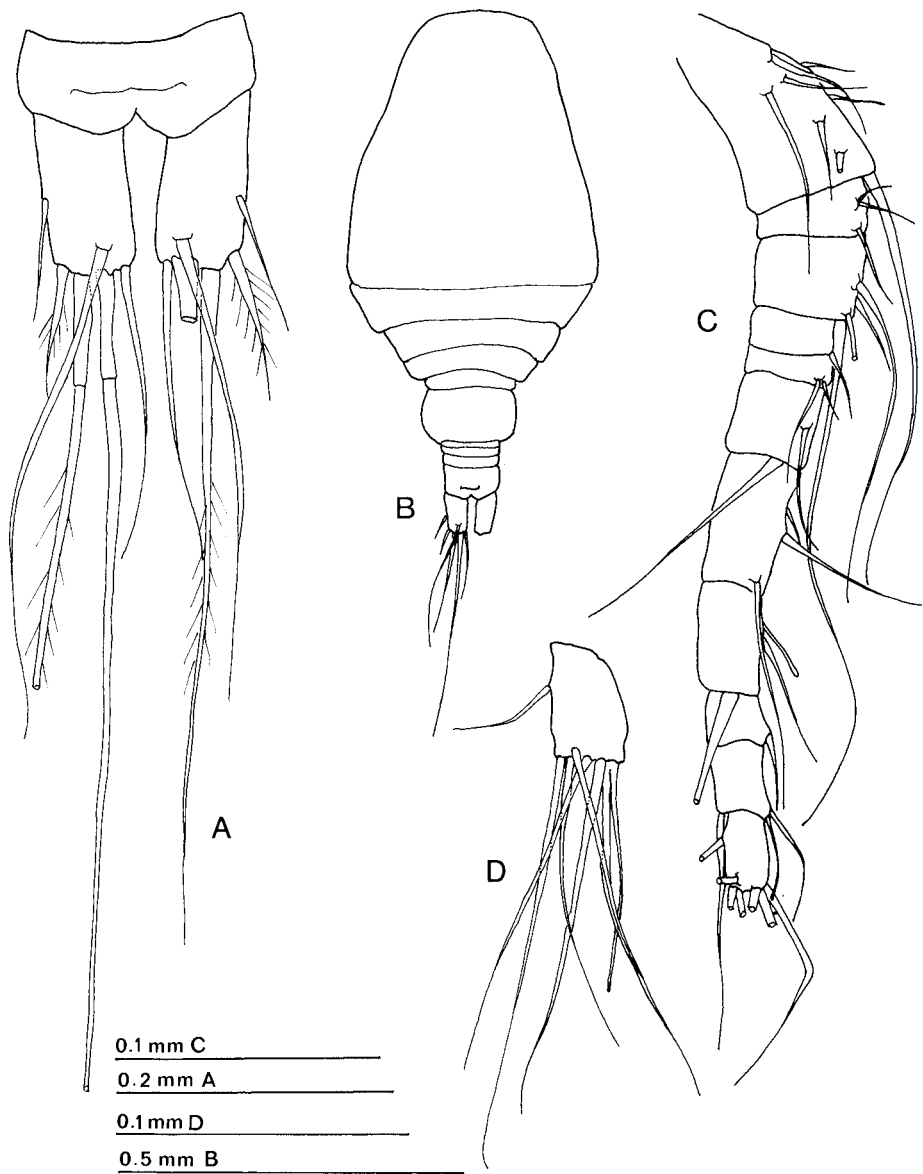


Fig. 3. *Teratocyclops cubensis* Pleša, 1981. A, anal somite and furcal rami with setae, male; B, habitus, male; C, antennule, female; D, last segment of female antennule.

Mandible of the usual structure, composed of a well developed gnathobase and a palp represented by two long setae and a smaller seta (fig. 2C).

Maxillule classically consisting of a strong praecoxa ending in rather elongate spines and a 2-segmented palp (fig. 2E). Palp bearing three short spines distally;

its distal part, representing the endopodite, with three long setae and an outer spiniform seta.

Maxilla composed theoretically of 5 segments, precoxopodite, coxopodite, basipodite, and bi-segmented endopodite, the distal segment (second endopodite segment very difficult to distinguish) with 3 setae. Limit between precoxopodite and coxopodite indistinct. Precoxal endite with two long spinulose setae. Proximal endite of coxopodite with a long, strong spinulose seta, distal endite ending by two long, slender, bent spines; basipodite bearing a long spine and ending in a long, curved claw with an accessory shorter one, inserted at its base. First segment of endopodite carrying 2 setae, the longest setae of the maxilla (fig. 2B).

Maxilliped consisting of 4 segments: syncoxa with 3 setae, basipodite with 2 setae and a row of tiny spines on the outer margin; endopodite bi-segmented, bearing 1 and 2 setae, respectively.

Swimming legs P1-P4 with biarticulate rami (fig. 4A, B, C, D). Seta and spine formula of distal segments of exopodites 5.5.5.5 and 3.4.4.3, respectively. Spines slender and sometimes with curved extremity. Intercoxal plates of P1-P4 with distal margin straight and without any ornamentation. Setae inserted at the internal angle of the coxopodites very long, reaching at least the distal margin of the first segment of the endopodite. Basipodite of P1 with 1 spine on the inner margin, longer than the first segment of the endopodite. No ornamentation observed on coxopodites and basipodites.

Segment 1 of endopodite P1 with a tuft of tiny spines on distal part and long hairs on inner margin. First segment of endopodite of P4 with a row of tiny spines, endopodite 2 ending in a setiform spine, 2 times longer than the segment; seta of the basipodite inserted internally and very long, reaching half way the second segment of the exopodite.

Spine and seta formula as follows (spines in Roman numerals, setae in Arabic numerals, * setiform spine):

	Coxopodite	Basipodite	Exopodite	Endopodite
P1	0-1	1-I	I-1; III-2-3	0-1; 1-I, 1-3
P2	0-1	1-0	I-1; III-I, 1-4	0-1; 1-I, 1-4
P3	0-1	1-0	I-1; III-I*, 1-4	0-1; 1-I*, 1-4
P4	0-1	1-0	I-0; II-I, 1-4	0-1; 1-I*-2

P5: proximal segment of P5 completely fused with the somite, the remaining seta directly inserted on the somite; distal (free) segment with 2 unequal setae clearly separated, the external seta 9 times longer than the internal one (fig. 2D). P6 little visible, located dorso-laterally, only two small external spines to be discerned.

Description of male. — Length: 514-524 μm (mean: 519 μm). Largest width 361-392 μm (376.5 μm). Shape of the anterior part of the body similar to that

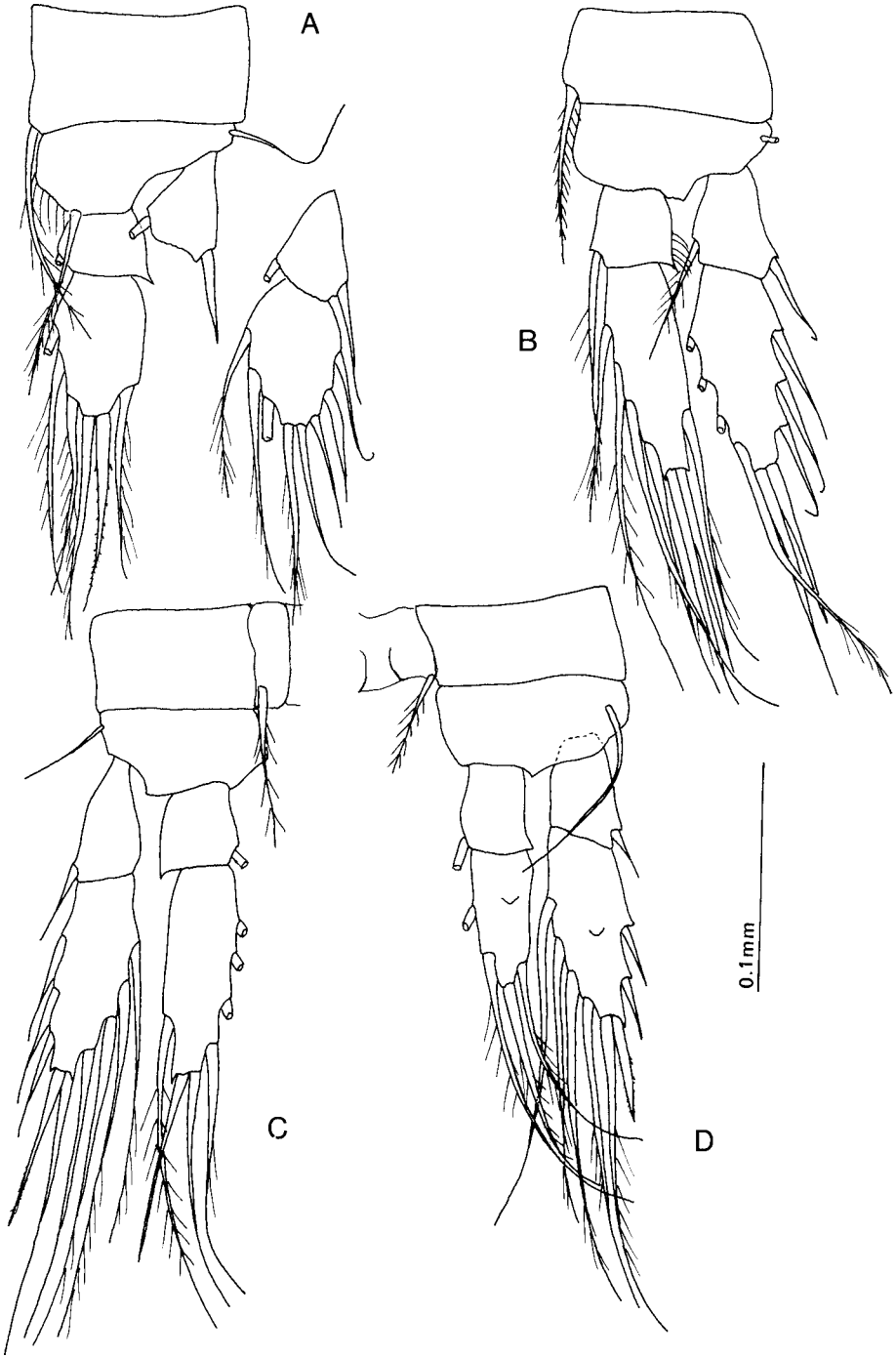


Fig. 4. *Teratocyclops cubensis* Pleša, 1981, female, swimming legs. A, P1; B, P2; C, P3; D, P5.

of female (fig. 3B). Urosome of 5 somites, the genital somite the largest, as broad as Th5, 1.55 times wider than long, three following urosomites of same size, very short (fig. 3A, 5D). Anal somite longer than these last 3 urosomites together and without particular ornamentation, anal operculum with a very slight median incision (fig. 3A). Antennule 15-segmented, with segments 4 and 5 hard to distinguish. Aesthetascs were observed on the following segments: 1 (1a), 4 (1a), 6 (1a), and 14 (1a) (not figured, damaged). Antenna and buccal appendages without significant differences from the female. Swimming legs P1-P4 with biarticulate rami (fig. 5A, B, C). Setation of swimming legs P1-4 identical to that in the female, without sexual dimorphism. P5 similar to that of female, but external seta of the distal free segment relatively longer than in female. P6 particularly well developed, constituted by a ventral conical expansion of the external lateral margin of the genital somite, like a true somite (but there is no distinct suture line visible between the somite and the plate) and bearing two long, slender spines of unequal length, the internal the longest, reaching the proximal edge of the anal somite (fig. 5D).

DISCUSSION

Teratocyclops cubensis is, at present, known only from Cuban subterranean habitats. From a series of characters such as the general shape and the segmentation of the body, the particular structure of the P5, the swimming legs P1-4 all bi-segmented, and the armature of the endopodite of P4, Pleșa (1981) established the new genus *Teratocyclops*. After re-examination of the morphological characters of females and males, and after having taken into account the details of the buccal appendages, the presence of the exopodal seta on the antenna, the setation pattern of the antennule, the spine and seta formula of P1-P4, and the shape of the female seminal receptacle, we herein confirm the validity of the genus *Teratocyclops*.

Some other genera of the family Cyclopidae share with *Teratocyclops* the following morphological characters of the P5 and the antennule: on P5, the proximal segment having the proximal segment completely fused with the somite and represented by a long seta, and the distal (free) segment ending with 2 setae or spines; the female antennule 10- or 11-segmented. These genera are: *Metacyclops* Kiefer, 1927 sensu Lindberg, 1961, *Muscocyclops* Kiefer, 1937, *Apocyclops* Lindberg, 1942, *Menzeliella* Lindberg, 1954, *Goniocyclops* Kiefer, 1955, *Cochlacocyclops* Kiefer, 1955, *Hesperocyclops* Herbst, 1984, *Fimbricyclops* Reid, 1993, and *Rheocyclops* Reid & Strayer, 1999 (in Reid et al., 1999).

Among these genera, seven have the same biarticulate structure of the swimming legs: *Fimbricyclops*, *Muscocyclops*, *Apocyclops*, *Menzeliella*, *Metacyclops*, *Goniocyclops* and *Cochlacocyclops*. *Hesperocyclops* has the endopodite of P4 uni-segmented (Herbst, 1984; Rocha & Bjornberg, 1987) and *Rheocyclops* has P1 to

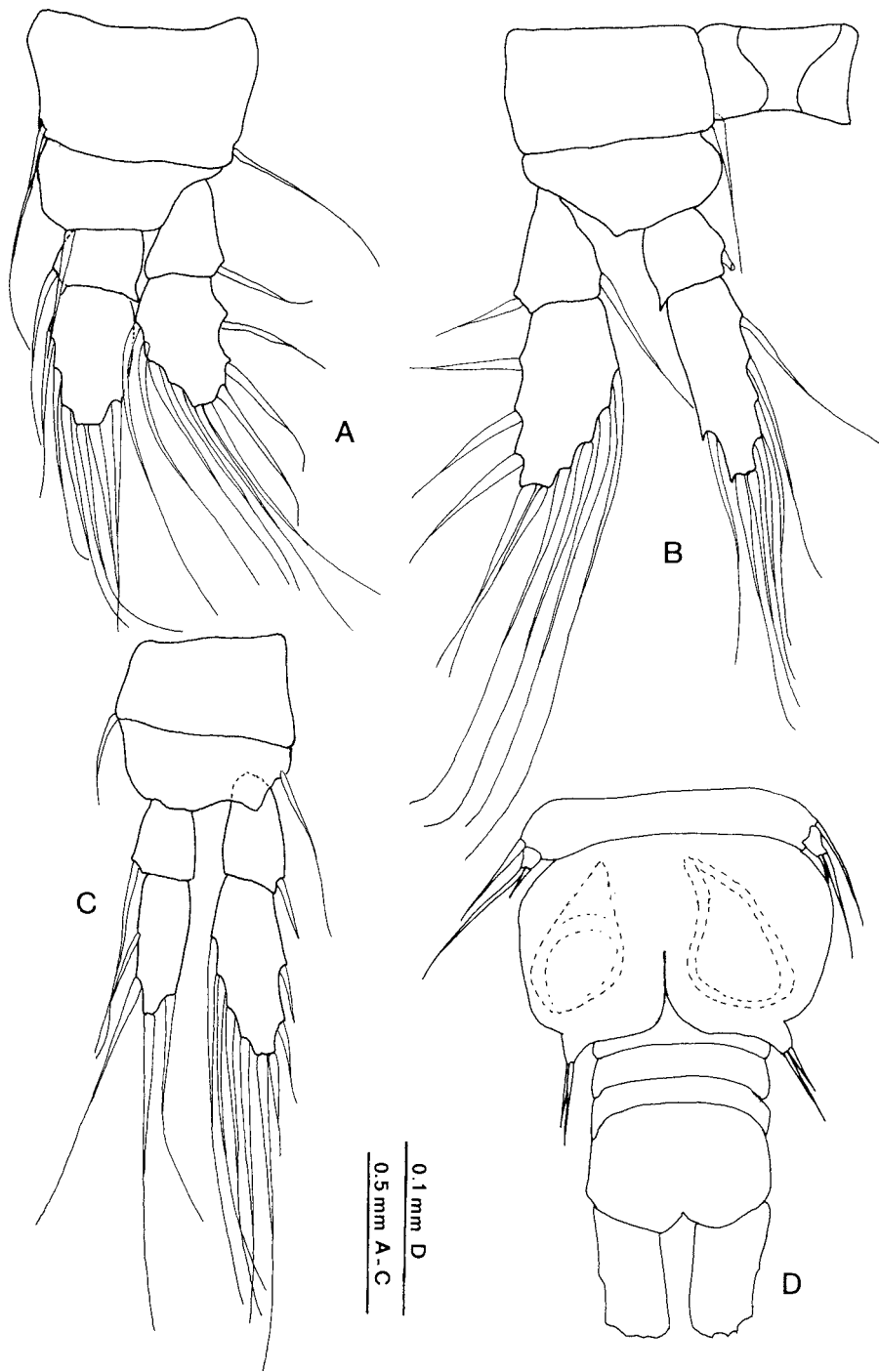


Fig. 5. *Teratocyclops cubensis* Pleša, 1981, male. A, P1; B, P3; C, P3; D, urosome, P5, and P6.

P4 basically tri-segmented, with some species with bi-segmented rami (Reid et al., 1999).

Teratocyclops shares with *Fimbricyclops* the same setal formula of the exopodites (5.5.5.5) but not the spine formula (3.3.3.3 in *Fimbricyclops*). It clearly differs from *Fimbricyclops*, which is characterized by the absence of the antennal exopodal seta, the structure of the mandible that has a palp reduced to a single remnant seta, which is very unusual in the Cyclopinae; the distal segment of P5 is particularly reduced in the single known species of *Fimbricyclops*, *F. jimhensoni* Reid, 1993 (cf. Reid, 1993; Reid et al., 1999).

Members of *Muscocyclops* differ from *Teratocyclops* by the spine formula 2.3.3.2, the seta formula 5.4.4.4 of the exopodites of P1 to P4, and by other morphological characteristics: the shape of the seminal receptacle transversely elongate and narrow, lacking a posterior expansion; the anal operculum enlarged; the P1 basipodite lacking a seta on its medial expansion; P6 absent in the female and consisting of 2 short setae in the male; the medio-terminal seta of the free distal segment of P5 being setiform, and the remnant seta of the first segment inserted far from the free segment (Rocha & Bjornberg, 1987).

Apocyclops, first described by Lindberg (1942), has a short internal spine on the free segment of P5, less than two times the length of the segment, smooth or serrate, and inserted far from the other seta. This spine might be considered lateral rather than terminal, which is at variance with the other genera (Reid, 1993; Pesce et al., 1996; Defaye & Dussart, 1988). This genus has been discussed by various authors: Pleșa (1981) considered it a subgenus of *Metacyclops*. It is now in the course of being revised (Coelho Botelho, in prep.) and its validity must be considered to be clearly established. *Teratocyclops* differs from it by the structure and armature of the free segment of P5, the shape of the seminal receptacle, and the number of spines and setae on Enp2P4: 4 in *Teratocyclops* instead of 6 in *Apocyclops*. The rich ornamentation of the intercoxal plates of P1 to P4 is an important feature of the genus *Apocyclops* that has not been observed in *Teratocyclops*.

Menzeliella has been created (Lindberg, 1954) for *Cyclops staheli* Chappuis, 1917 from Surinam. In spite of a redescription by Kiefer (1928) from the type material, the species remains incompletely diagnosed. Some characters deserve to be noted, as the spine formula of the exopodites of P1 to P4: 3.4.4.3 (corrected by Kiefer, 1928: the same as in *Teratocyclops*), the lateral caudal seta inserted at the posterodorsal third of the caudal ramus, the anterior and posterior parts of the seminal receptacle narrow and symmetrical, the Enp2P4 bearing 6 ornaments (3 internal and 1 external setae, and 2 terminal spines). Kiefer (1928) mentioned that the posterior margins of the urosomites were not toothed. All these traits indicate that there is no close relationship between *Menzeliella* and *Teratocyclops*.

Our observations of the *Teratocyclops* specimens evidenced important morphological similarities with three other genera of the subfamily Cyclopinae: *Metacyclops*, *Goniocyclops* and *Cochlacocyclops*. *Cochlacocyclops* is only known from one female collected in Madagascar. Described by Kiefer (1955), it has never been found again and its description lacks some characters, as the general shape and segmentation of the body, the setation of the antennule, the presence of an exopodal seta on the antenna, the detailed armature of the legs, as well as the buccal appendages and the furcal structure. Yet, the present information permits to show some valid generic differences with *Teratocyclops*: the spine formula of the exopodites of P1-P4: 3.3.3.2, and the shape of the seminal receptacle, being of the “*Metacyclops* type”, with a globose posterior part.

Teratocyclops and *Metacyclops* share many characters, as already mentioned. The genus *Metacyclops* is currently composed of about 55 species (Dussart & Defaye, 1985). This large genus includes species that can appear as very close to *Teratocyclops* if one considers the variability of some characters in *Metacyclops*: the antennule is 9 to 13-segmented; the spine formula of the exopodites of the bi-segmented P1 to P4 is 3.4.4.3 or 3.3.3.3; the exopodal seta is present but this character has not been described for all species, and the same situation pertains to the presence of the internal spine on the basipodite of P1. The free segment of P5 usually presents a narrow or serrate internal spine, no longer than two times the segment length (Reid, 1987, 1991; Reid et al., 1990; Defaye, 1992). There is no developed anal operculum, like in *Teratocyclops*. The two permanent characters that we can consider to definitively separate the two genera, if we except the structure of P5, are the armature of Enp2P4, which comprises 4 elements in *Teratocyclops* and 6 in *Metacyclops*, and the structure of the seminal receptacle. A revision of the genus *Metacyclops* would probably contribute more elements to assess these differences.

Goniocyclops is very close to *Teratocyclops*, as already mentioned by Pleša (1981), differing mainly by the spine and seta formula of the exopodites of P1 to P4, and the shape of the seminal receptacle, with a reduced posterior part in *Goniocyclops*.

As a conclusion, the genus *Teratocyclops* Pleša, 1981 is clearly distinct of the other genera of the Cyclopinae that appear to be closely similar and is confirmed here as a valid genus for which we propose the following, amended diagnosis:

***Teratocyclops* Pleša, 1981**

Diagnosis (amended). — Small species, body length between 514 and 695 μm . Female genital double-somite broader than long, with gonopores located dorso-laterally; seminal receptacle of large size, with a small, flat anterior part and a

posterior part occupying almost the whole space, up to the distal margin of the somite. Furcal rami about 1.8 times longer than broad, with median terminal furcal setae having the capacity to fold. Female antennule 11-segmented. Male antennule 15-segmented. Swimming legs all with 2-segmented exopodites and endopodites, without any sexual dimorphism. P5 consisting of a seta inserted on the somite (remnant of the proximal segment) and a distinct segment ending in two unequal setae, the smallest internal. P6 reduced to a spine in the female, quite developed in the male, in which it consists of two setae, inserted on a segment-like expansion.

ACKNOWLEDGEMENTS

We gratefully thank Dr. Corneliu Pleșa from Speleological Institute “Emil Racovitza”, Cluj, who permitted us to study additional material of *Teratocyclops cubensis*. We are also grateful to Prof. Dr. D. Danielopol for giving comments on the manuscript.

REFERENCES

- BOTOȘĂNEANU, L., 1970. L'expédition biospéologique à Cuba (mars-juin 1969) organisée par les Académies des Sciences de Cuba et de Roumanie: présentation sommaire des stations explorées pour le prélèvement d'échantillons de faune aquatique souterraine. Travaux Inst. Speol. “Emile Racovitza”, Bucarest, **9**: 81-95.
- CHAPPUIS, P. A., 1917. Zur Kenntnis der Copepodenfauna von Surinam. Zool. Anz., **49**: 220-224.
- DEFAYE, D., 1992. *Metacyclops hannensis* n. sp. (Crustacea, Copepoda, Cyclopoida), un cycloptide nouveau du Sénégal. Rev. Hydrobiol. trop., **25**: 145-151.
- DEFAYE, D., C. CUOC & R.-M. BARTHÉLÉMY, 2003. A new interpretation of the female genitalia in *Macrocyclus albidus* (Copepoda, Cyclopidae). Acta Zoologica, **84**: 25-31.
- DEFAYE, D. & B. H. DUSSART, 1988. Compléments à la faune des Crustacés Copépodes des eaux intérieures de Guyane française. Rev. Hydrobiol. trop., **21**: 109-125.
- DUSSART, B. H. & D. DEFAYE, 1985. Répertoire mondial des Crustacés Copépodes des eaux intérieures, **2**, Cyclopoïdes: 1-236. (C.N.R.S., Paris).
- — & — —, 1995. Introduction to Copepoda. Guides to the Identification of the Microinvertebrates of the Continental Waters of the World, **16**: 1-344. (Backhuys Publ., Leiden).
- HERBST, H. V., 1984. Amsterdam expeditions to the West Indian Islands, report 40: *Hesperocyclops improvisus* n. g., n. sp., ein neuer Cyclopoide (Crustacea, Copepoda) von den westindischen Inseln. Bijdragen tot de Dierkunde, Amsterdam, **54**: 66-72.
- KIEFER, F., 1928. Über Morphologie und Systematik der Süßwasser-Cyclopiden. Zool. Jahrb., (Syst.) **54**: 495-556.
- —, 1955. Neue Cyclopoida Gnathostoma (Crustacea Copepoda) aus Madagaskar. II. Cyclopinae. Zool. Anz., **154**: 222-232.
- LINDBERG, K., 1942. Cyclopides (Crustacés Copépodes) de l'Inde. XIV, XVIII. Rec. Indian Mus., Calcutta, **44**: 139-190.
- —, 1954. Un Cycloptide (Crustacé Copépode) troglobie de Madagascar. Hydrobiologia, **6**: 97-119.

- PESCE, G. L., P. DE LAURENTIIS & W. F. HUMPHREYS, 1996. Copepods from groundwaters of Western Australia. I. The genera *Metacyclops*, *Mesocyclops*, *Microcyclops* and *Apocyclops* (Crustacea: Copepoda: Cyclopidae). Records of the Western Australian Museum, **18**: 67-76.
- PLEȘA, C., 1981. Cyclopides (Crustacea, Copepoda) de Cuba. Résultats des Expéditions Biospéologiques Cubano-Roumaines à Cuba, **3**: 17-34.
- —, 1989. Cyclopides (Crustacea, Copepoda) de Cuba. Supplément (Biométrie). Miscell. speol. Romanica, **1**: 113-119.
- REID, J. W., 1987. The cyclopoid copepods of a wet campo marsh in central Brasil, Hydrobiologia, **153**: 121-138.
- —, 1991. The genus *Metacyclops* (Copepoda: Cyclopoida) present in North America: *Metacyclops cushae*, new species, from Louisiana. Journ. Crust. Biol., **11**: 639-646.
- —, 1993. *Fimbricyclops jimhensoni*, new genus, new species (Copepoda: Cyclopoida: Cyclopidae) from bromeliads in Puerto Rico. Journ. Crust. Biol., **13**: 383-392.
- REID, J. W., J. A. MOLINA AREVALO & M. FUKUSHIMA, 1990. *Metacyclops leptopus totaensis*, new subspecies (Crustacea: Copepoda) from Lago de Tota, Colombia. Proc. biol. Soc. Washington, **103**: 674-680.
- REID, J. W, D. L. STRAYER, J. V. MCARTHUR, S. E. STIBBE & J. J. LEWIS, 1999. *Rheocyclops*, a new genus of copepods from the southeastern and central U.S.A. (Copepoda: Cyclopoida: Cyclopidae). Journ. Crust. Biol., **19**: 384-396.
- ROCHA, C. E. F. & M. H. G. C. BJORNBERG, 1987. Copepods of the Jureia Ecological Reserve, State of Sao Paulo, Brazil. II. The genera *Hesperocyclops*, *Muscocyclops*, and *Bryocyclops* (Cyclopoida, Cyclopidae). Hydrobiologia, **153**: 97-107.
- ROUCH, R., 1994. Copepoda. In: C. JUBERTHIE & V. DECU (eds.), Encyclopædia biospeologica, **1**: 105-111. (Soc. Biospeol., Moulis/Bucarest).