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Revision of the *horvathi* group and description of a new species of *Cylindroiulus* (Diplopoda: Julidae)

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All nominal species of the *horvathi* group of species within *Cylindroiulus* (*Crenatoiulus*) are reviewed. In conclusion, 2 valid species are maintained: *Cylindroiulus horvathi* (Verhoeff, 1897), and *C. abaligetanus* Verhoeff, 1901. One new species is added to the group, *Cylindroiulus cambio* sp. n., which is described from Rostov-on-Don, Russia. *Cylindroiulus vitosae* Strasser, 1962 and *C. ponticus* Golovatch, 1978 are synonymized with *C. horvathi*. Descriptive notes on the species are given, and the geographical distribution of the group members is discussed.

KEYWORDS: *Cylindroiulus*, Julidae, Diplopoda, Hungary, Bulgaria, Russia, Croatia.

Introduction and chronology

In 1897 Verhoeff named a new species of *Iulus* after Géza Horváth, director of the Zoological Department of the Hungarian National Museum at that time. The description was based on several female specimens originating from Kronstadt (now Brasov, Romania), it was very short, and no figures were provided. In the same year, Verhoeff together with the Hungarian coleopterist Ernő Csiki (= Dietl) collected some cylindroiuline specimens (including males) on the Sváb Hill (= Schwabenberg) near to Budapest, and described them as *Julus Dietli*. The description was more detailed and included the gonopods, but again no figures were provided; Verhoeff described *J. dietli* on 16 March 1898. The possibility of this species being *J. horvathi* was only mentioned because the latter lacked males, but 5 months later, on 28 August Verhoeff added a note to his original paper, and the two were published together (Verhoeff, 1898: 334). Here he already considered *J. dietli* as *J. horvathi*. This comment is repeated in 1899 (Verhoeff, 1899) with the first (poor) drawing of the gonopods, and in 1900 he reported males collected from the type locality (Kronstadt) amongst others. Since then, the synonomy of *J. dietli* with *Cylindroiulus horvathi* has been widely accepted (Verhoeff, 1905; Attems, 1927; Strasser, 1962).

The next 'species' to be described was *Cylindroiulus abaligetanus* Verhoeff, 1901 from southern Hungary, near to Abaliget, a small village in the Mecsek Mts; some short notes were given but no drawings. The gonopods appeared to be very similar to those of *C. horvathi*, and the main difference between the species was the shape of the telson.

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In 1903, Attems described two new species belonging to this group; *Cylindroiulus deubeli* from Kronstadt (= Brasov, now Romania) and *C. hyperopherus* from northern Croatia. As the localities already suggest, the new species were consequently taken into consideration as synonyms of *C. horvathi* and *C. abaligetanus*, respectively (Verhoeff, 1905). The possibility of the first had already been mentioned by Attems (1903), but due to the absence of adequate figures of the gonopods of *C. horvathi*, he could not resolve the problem. Verhoeff (1905), referring to his earlier drawing (Verhoeff, 1899), corrected Attems, and clearly stated both synonymies. Subsequent authors—except Loksa (1965) for *C. hyperopherus* and Strasser (1962, 1975) for *C. deubeli*—adopted it uniformly (Attems, 1927, 1949, 1959; Strasser, 1971a, 1973). *Cylindroiulus vitosae* was described by Strasser (1962) from Mt. Vitosa near Sofia, Bulgaria, and placed among *C. horvathi* and *C. deubeli*. Apart from some more localities from Bulgaria (Strasser, 1966, 1969; Golovatch and Kondeva, 1992) *C. vitosae* was subsequently only recorded from Dobrudzha, Romania (Tabacaru, 1966).

Cylindroiulus ponticus was described by Golovatch (1978) from the Crimea, and placed in the same group on the basis of gonopod structure although the crenulation of the metazonital limbus was reported to be missing.

In conclusion, 4 species emerge clearly from the literature: *Cylindroiulus horvathi* (Verhoeff, 1897) (= *C. dietli* Verhoeff, 1898), *C. abaligetanus* Verhoeff, 1901, *C. vitosae* Strasser, 1962 and *C. ponticus* Golovatch, 1978. In addition to these four, Verhoeff (1905), Attems (1927, 1949) and Loksa (1956) agree that *C. deubeli* Attems, 1903 is a synonym of *C. horvathi*, and Verhoeff (1905), Attems (1949, 1959) and Strasser (1971b, 1973, 1975) agree that *C. hyperopherus* Attems, 1903 is a synonym of *C. abaligetanus*. As a starting point for our revisional work, we accepted this situation.

Material and methods

As many specimens as possible, including type materials, were studied from a wide range of localities from the following institutions: Hungarian Natural History Museum, Budapest (TMB), Country Museum Somogy, Kaposvár, Hungary (CMSK), Naturhistorisches Museum, Wien (NMW), Museum für Naturkunde der Humboldt-Universität, Berlin (MNHB), Zoologische Institut und Zoologisches Museum, Hamburg (ZIZMH), Zoological Museum of the Moscow State University, Moscow (ZMMU), and Institutul de Speologie 'Emil Racovita', Bucuresti (ISERB). A light microscope was used for the analysis of the whole animals. Dimensions, segment numbers and ocelli were determined for both males and females where available. Full descriptions were made of coloration, setation, metazonital striation, limbus and secondary sexual characters. Permanent slide mounts of male and female genitalia, gnathochilarium, antennae and midbody legpairs of selected specimens were made. For scanning electron microscopy a Jeol JSM 840 was used in the Zoological Museum, University of Copenhagen.

Characterization of the *horvathi* group

Although the species in question have never been explicitly grouped together before, their general external similarity and almost identical gonopods have caused various authors to deal with them as such from the beginning (Attems, 1903; Verhoeff, 1905). Attems (1927) was first to recognize their common characters and

he established the subgenus *Crenatoiulus* for the species described at that time: *C. horvathi* (= *C. dietli*, = *C. deubeli*), *C. hyperopherus*, *C. abaligetanus*. At the same time he removed *C. horvathi* from the subgenus *Aneuloboiulus* where it had been preliminarily placed by Verhoeff (1899). The species described by Strasser (1962) and Golovatch (1978) (*C. vitosae* and *C. ponticus*, respectively) obviously became members of the *horvathi*-group. Other species have also been described in the subgenus *Crenatoiulus* but they differ in gonopod structure, and they are not included in this analysis.

General description of the group

Animals small (♂♂ 8–12 mm long, 0·66–1·0 mm in maximum vertical diameter, ♀♀ 9–14 mm long, 0·7–1·28 mm in maximum vertical diameter) with little variation in size between species. Coloration usually very similar, being generally pale yellowish with traces of darker typical julid pattern on head, first 6 segments, preanal segment and anal valves, with or without a darker mid-dorsal line. Legs pale yellow, somewhat lighter than the body colour.

Head bearing rather short antennae. Eyes reduced and ocelli rather jumbled so that it is difficult to distinguish the rows. Gnathochilarium of typical julid arrangement. Metazonital striation quite clear, with 10–18 striae in the dorsal quarter. As the subgenus name implies all species have a crenulate limbus; number of crenulations varying from 3 to 6 between the striae. Telson usually projecting beyond anal valves and with 2 setae at the tip. Anal valves themselves bearing 3 pairs of setae.

First leg pair of male a simple hook usually lacking tarsal spines, penis behind 2nd legpair bifurcate, with short, tubular membranous apices.

Gonopods (Figs 2, 3, 9–11 and 19–22) very similar in form within the group. Pro- and mesomerite subequal in length and rugose at the apices. Promerite with a large mesal flange and a smaller lobe-like lateral flange thus 'enveloping' the mesomerite. Mesomerite parallel-sided at the base and broadest subapically, steeply tapering to the tip. Flagellum of normal length. Paracoxal process present usually somewhat angular in outline, with well scleritised ventral margin and poorly sclerotised posterior margin with a tendency to be membranous. Overall shape of the opisthomerite is characteristic although details vary between species. Apex of opisthomerite indented, separating brachite from solenomerite.

Female vulvae (Figs 4 and 18) are of usual *Cylindroiulus* shape with 3–4 setae on each valve of the bursa. Operculum slightly longer than bursa, with 2–3 setae on the frontal side. Paired receptacles are almost spherical and may or may not have appendices (variation occurs within 1 individual).

Results

By studying both the literature and the specimens to hand two major patterns became evident. First, as suggested previously by various authors (Verhoeff, 1905, etc.) there appear to be no differences between *C. abaligetanus* and *C. hyperopherus*. Those outlined by Loksa (1965), i.e. the shape of the 1st pair of legs in the male, the structure of the paracoxal process and the spikes at the tip of the opisthomerite do not reveal any more variation than can be seen within the specimens of *C. horvathi*.

Secondly, also in agreement with Verhoeff (1905), there are no appreciable differences between *C. horvathi* and *C. deubeli*. In addition, examination of the specimens of *C. vitosae* reveal an identical telson and gonopod shape which does not differ from that of *C. horvathi* either. Strasser (1962) tabulated differences between

these latter 3 species but none of the characters is reliable, in particular the shape and length of the mesomerite relative to the promerite is variable and can be altered in the course of slide preparation. There is considerable variation in these characters between authors, slide preparations and specimens as well. Fresh mounts of gonopods from the type series show these discrepancies clearly. Loksa (1956) also illustrated such variation of the tip of the opisthomerite in 3 specimens from the same locality in the Velence Mountains, Hungary.

Examination of *C. ponticus* showed that the limbus is crenulate and that the shape of the penis, described as mushroom-like in the original diagnosis, does not differ from that of *horvathi* (Figs 6 and 7). In addition, the posterior gonopods fall within the range of the variation seen in this species.

In summary, agreement is found for the synonymy of *C. hyperopherus* and *C. abaligetanus* and also for *C. deubeli* with *C. horvathi*. In addition *C. vitosae* and *C. ponticus* are also here synonymized with *C. horvathi*.

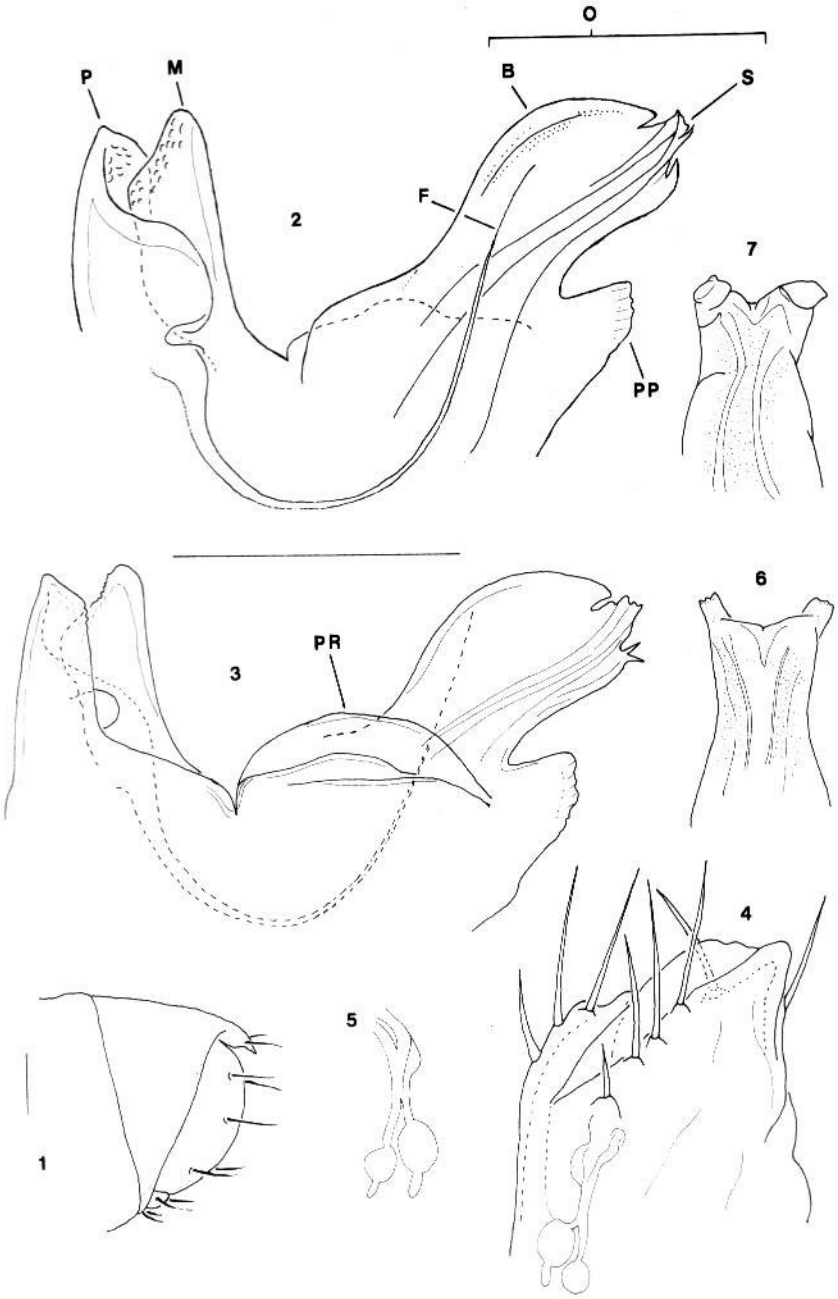
One further specimen of the group referred to by Read (1992), from Rostov-on-Don, is considered here to be sufficiently different from congeners in telson shape (lacking all projection) and in gonopod structure to be described as a new species.

Description of the species in the *horvathi* group

Cylindroiulus horvathi (Verhoeff, 1897)
(Figs 1–7)

Iulus (*Cylindroiulus*) *Horvathi* Verhoeff, 1897: 467.
Julus (*Cylindroiulus*) *Dietli* Verhoeff, 1898: 333 (synonymized by Verhoeff, 1898).
Cylindroiulus Horvathi: Verhoeff, 1899: figs 74, 82.
Cylindroiulus deubeli Attems, 1903: 138, fig. 76 (synonymized by Verhoeff, 1905).
Cylindroiulus horvathi: Loksa, 1956: 389, fig. 4.
Cylindroiulus (*Crenatoiulus*) *vitosae* Strasser, 1962: 458, figs 27–32. **New synonymy**.
Cylindroiulus deubeli and *horvathi*: Strasser, 1962: 459–460.
Cylindroiulus vitosae: Tabacaru, 1966: 173.
Cylindroiulus ponticus Golovatch, 1978: 456, figs 4–10. **New synonymy**.

Material examined. 1♂, 2♀♀ (ZIZMH: labelled as '*Julus horvathi* Verh. ex typis'), Romania: 'Siebenbürgen', 1. January 1899; 1♀ (NHMW: XXIII.15, 'Type'), Romania: 'Kronstadt', 1897, Adensamer don.; 2♂♂, 5♀♀ (NHMW: XXVII.5, 'Type'), Hungary: 'Mittelungarn', 1897, leg. K. W. Verhoeff; 1♂, 2♀♀ (NHMW), Hungary: 'Pest', 8 January 1908, leg. & det. K. W. Verhoeff; 1♂, 2♀♀, 1 juv. (MNHB: ZMB 2667), Hungary: 'Mecsekgebirge', leg. & det. K. W. Verhoeff; 1♂ (MNHB: ZMB 3353), Romania: 'Kronstadt', leg. & det. K. W. Verhoeff; 1♀ (MNHB: ZMB 3976), 'Ungarn', leg. & det. K. W. Verhoeff; 7♂♂, 7♀♀, 1 juv., Hungary: County Csongrád, Mindszent, Nagyhalom, DS 35, 3 May 1985; 50♂♂, 17♀♀, 2 juvs (2♂♂, 2♀♀: ZMUC, 2♂♂, 2♀♀: ZMMU) same locality, 12 June 1985; 8♂♂, 12♀♀, 2 juvs, same locality, 4 October 1985, leg. E. Hornung; 3♂♂, 3♀♀, 1 juv., County Fejér, Gyúró, Etyeki Hills, 3 April 1988, leg. Z. Korsós; 1♂, Balatonfüred, Koloska valley, *Fraxino-Quercetum Melicetosum uniflorae*, 31 October 1988, leg. N. Szederkényi; 1♀, Budapest, Farkasrét, CT 46, graveyard, 5 June 1989, leg. Z. Korsós; 1♀, Balatonudvari, Dongó meadow, 16 May 1990, leg. Z. Korsós & Sz. Róka (all TMB); 1♂, 1♀ (MNHB: labelled as *Cylindroiulus dietli*, syntypes, ZMB 2280), Hungary: 'Mittelungarn', 1898, leg. & det. K. W. Verhoeff; 3♀♀ (TMB 1115/1897: labelled as *Julus Dietli*, det. J. Daday), Hungary: Budapest, 1897, leg. E. Csiki; 2♂♂,



FIGS 1–7. *Cylindroiulus horvathi* (Verhoeff, 1897). (1–5) Material from Gyúró, Hungary (TMB), (1) telson (♂); (2) left gonopods, mesal view; B, brachite; F, flagellum; M, mesomerite; O, opisthomerite; P, promerite; PP, Paracoxal process; S, solenomerite; (3) right gonopods, lateral view; PR, Paracoxal rim; (4) entire vulva, latero-caudal view; (5) receptaculum seminis (same specimen). (6–7) Penis, (6) specimen from Ghimpati forest, Romania; (7) animal from Perevalnoye, Crimea. Scale 0·2 mm.

16♀♀ (NHMW: labelled as *Cylindroiulus deubeli*, type?), Romania: 'Kronstadt, Schneckenberg, Fuchsbank', 16 September 1900, leg. Deubel; 2♂♂ (labelled as *Cylindroiulus vitosae* by I. Tabacaru), Romania: Ghimpati Forest, 20 May 1972; 1♀ (ZMMU: labelled as *Cylindroiulus vitosae*, det. S. I. Golovatch, 1989), Bulgaria: Vitosha Mt., Zheleznitsa, pasture, under stones, 2 April 1986, leg. E. Kondeva; 3♂♂, 12♀♀, 2 juvs (ZMMU: paratypes of *Cylindroiulus ponticus*), Ukraine: Crimea, near Perevalnoye, forest litter, 8 July 1975, leg. S. I. Golovatch.

Total material. 88♂♂, 89♀♀, 9 juvs.

Diagnosis. Differs from the 2 other group members in the pointed downward directed telson projection and in the conformation of the posterior gonopods (high and strong paracoxal rim on the lateral side, solenomerite longer than tip of brachite and separated by a small indentation).

Descriptive notes. Length 8–10 mm (♂♂), 9–14 mm (♀♀), maximum vertical diameter 0·76–0·8 mm (♂♂), 0·88–1·25 mm (♀♀), number of podous segments 31–36 (♂♂), 34–43 (♀♀).

Colour. Pale yellow brown with head and anal valves slightly darker. Usually without darker mid-dorsal stripe.

Telson. With down turned dorsal projection ending in hyaline point (Fig. 1).

Male gonopods (Figs 2 and 3). Paracoxal rim high and domed. Paracoxal process clearly present, with slightly indented posterior margin. Opisthomerite broadest subapically, with solenomerite ending in projection beyond that of brachite. With variable number of small spikes (sometimes lacking) appearing as continuations of the posterior margin of opisthomerite.

Remarks. The '*Julus Dietli*' specimens in the Hungarian Natural History Museum, originated from the type locality and labelled by museum curator J. Daday as early as 1897, are most likely to be a part of the type series. Re-examination of other types of *C. dietli* (labelled as such) from the Berlin Museum confirmed that they were indeed identical with *C. horvathi*.

The presumed type of *C. deubeli* (according to the type locality: 'Kronstadt, Schneckenberg, Fuchsbank', J. Gruber in litt.) and the type of *C. ponticus* proved also to be indistinguishable from *C. horvathi*. The original diagrams of *C. vitosae* (Strasser, 1962: figs 27–32) strongly resemble the specimens of *C. horvathi* except for the penis. Dissection of specimens from Romania (Fig. 6) indicates that the penis shows no deviation from that of the rest of the group.

A dark brown mid-dorsal line is usually absent. The animals from the Crimea and from Romania formerly identified as *C. ponticus* and *C. vitosae*, respectively, were found to have a dorsal stripe, although the latter species was originally described by Strasser as lacking such markings.

Distribution and biology. By incorporating records of *C. vitosae* the distribution of *C. horvathi* has been expanded considerably (Fig. 8). It has been found from Poland through the eastern Carpathian area (Jawlowski, 1936) to Hungary, Romania and Bulgaria. New Hungarian records suggest that *C. horvathi* may be widespread but sporadic throughout the country. No records are available for Czechoslovakia or Yugoslavia (Lang, 1954; Strasser, 1971a). The inclusion of *C. ponticus* as well has extended the range still further to the Crimea, however, there are considered to be records from the Ukraine (Stojalowska and Starega, 1974) which would form a link between the Crimea, Bulgaria and Poland. *Cylindroiulus horvathi* seems to be a xerophilous species (Stojalowska and Bielak-Olesky, 1970; Golovatch, in litt.) inhabiting dry grasslands and steppe vegetation.

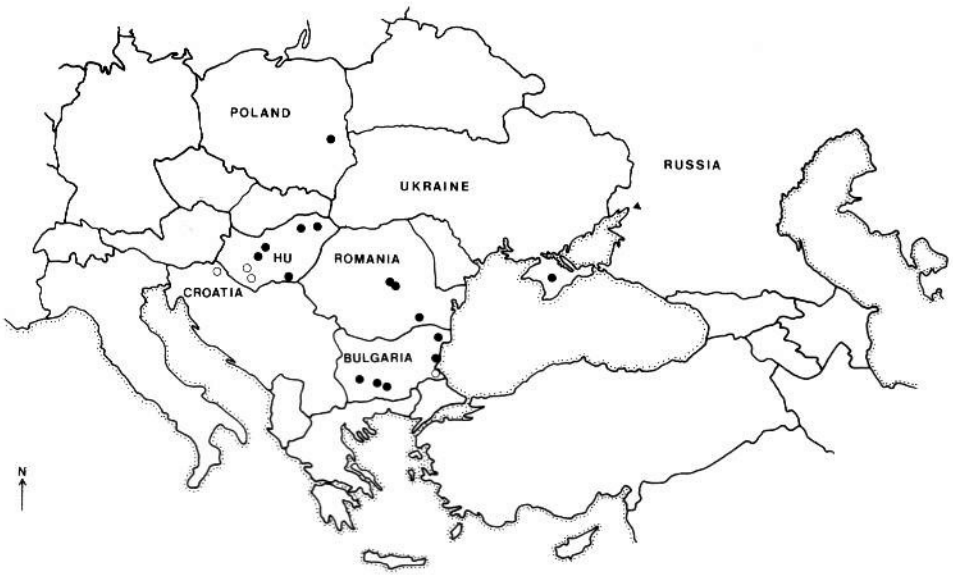


FIG. 8. Distribution of the species of the *Cylindroiulus horvathi*-group. ●: *C. horvathi*, ○: *C. abaligetanus*, ▲: *C. cambio* sp. n. HU: Hungary.

Cylindroiulus abaligetanus Verhoeff, 1901
(Figs 9–18)

Cylindroiulus abaligetanus Verhoeff, 1901: 235.
Cylindroiulus hyperopherus Attems, 1903: 139, figs 85–88 (synonymized by Verhoeff, 1905).
Cylindroiulus abaligetanus and *hyperopherus*: Loksa, 1965: 218–221.
Cylindroiulus abaligetanus: Strasser, 1973: 442–443.

Material examined. 1♂, 1♀ (MNHB: syntype, ZMB 2538, slide prep. No. 1916), Hungary: Abaliget, 1901, leg. & det. K. W. Verhoeff; 2♂♂ (ZIZMH), Hungary, 11 September 1911, leg. & det. K. W. Verhoeff; 2♂♂, 7♀♀, 3 juvs (NHMW), Croatia: Zelesnica, 13 October 1900 (labelled as *Cylindroiulus hyperopherus*, type?); 1♂, 7♀♀ (NHMW), Croatia: Sleme (?), 15 October 1901 (labelled as *Cylindroiulus hyperopherus*); 3♀♀ (CMSK), Hungary: County Somogy, Boronka Nature Reserve, Hosszúvíz, XM 85, pitfall trap, 25 May–20 June 1990, leg. L. Ábrahám; 2♂♂, 8♀♀ (ZIZMH), Turkey: Yalova (9/548); 2♂♂, 1♀ (ZIZMH), Polenezkö (15/548) (det. H. Lohmander as *C. hyperopherus* n. subsp.).

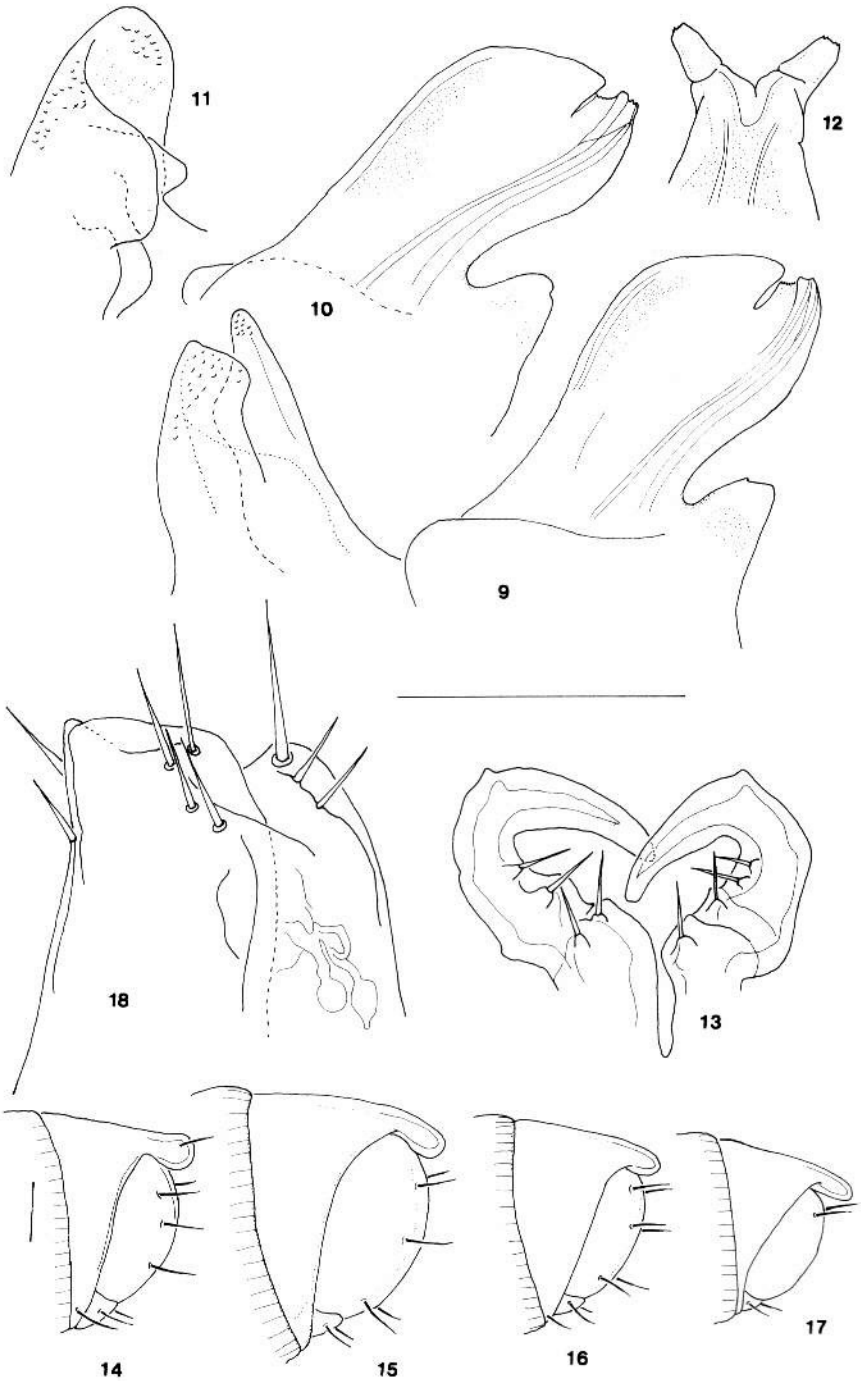
Total material. 10♂♂, 27♀♀, 3 juvs.

Diagnosis. Very similar in general appearance to *C. horvathi* but with a blunt more or less straight telson projection. Gonopods with a low paracoxal rim and opisthomerite tip with solenomerite separated from indentation by a thin but broad membrane.

Descriptive notes. Length 8–12 mm (♂♂), 10–15 mm (♀♀); maximum vertical body diameter 0·8–1·0 mm (♂♂), 1·04–1·3 mm (♀♀); number of podous segments 31–37 (♂♂), 33–39 (♀♀).

Colour. Pale yellow white with darker mid-dorsal stripe.

Telson. With strong projection continuing along the line of the dorsal surface. Usually clubbed, with constriction at the base (Hungarian, Croatian and Bulgarian



FIGS 9–18. *Cylindroiulus abaligetanus* Verhoeff, 1901. (9–12) Individual from 'Ungarn', leg. & det. Verhoeff, 1901 (ZIZMH), (9) right gonopods, lateral view, (10) left opisthomerite, mesal view, (11) left promerite, latero-caudal view, (12) penis. (13–14) Syntypes from Abaliget, Hungary (MNHB), (13) male first legpair, oral view, (14) telson (♀). (15–17) Telson shapes, material from Yalova, Turkey (ZIZMH), (15) female, 43 podous segments, (16) female, 32 podous segments, (17) male, 34 podous segments. (18) Vulva from individual from Boronka, Hungary. Scale 0·2 mm.

specimens; Fig. 14) but in two samples from Turkey parallel-sided and elongate (Figs 15–17).

Male gonopods (Figs 9–11). Paracoxal rim poorly developed, low and flat. Paracoxal process basically similar to *C. horvathi*. Opisthomerite with broadest part closer to the apex. Tip of opisthomerite with longer indentation and with thin membrane between solenomerite and brachite. Solenomerite and brachite subequal in length.

Remarks. Examination of the type specimens of *C. hyperopherus* from Zelesnica reveal no true differences from the type specimens of *C. abaligetanus*. However, the fresh dissection of a male from a Verhoeff collection does require re-definition of the species concept as described above. For example the paracoxal process is obscured in the type as is the tip of the opisthomerite. The collection from Turkey (labelled by Lohmander as *C. hyperopherus* new subspecies) shows some variation in the shape of the telson which also is less bulbous than those of *C. abaligetanus* from Hungary. This is within the range of the known variation for telson shapes within certain species of the genus *Cylindroiulus* (Mauriès, 1964). The figures shown by Strasser (1973: figs 44 and 45) of *C. abaligetanus* from Bulgaria were suggested to represent possibly a different subspecies. Those observations are not upheld here although the gonopods illustrated by Strasser (not available for study) do resemble more closely the specimens from Turkey.

Distribution and biology. *Cylindroiulus abaligetanus* has a disjunct distribution (Fig. 8). The type locality in south west Hungary and the collection from Croatia (type of *C. hyperopherus*) form one group whilst the specimens from Turkey and the Bulgarian localities mentioned by Strasser (1973) form a separate group a considerable distance away. This species seems to be genuinely rare, and in spite of recent thorough searching in the type area only three females were found. Thus it is possible it may have a continuous but sparse distribution between the two groups of localities mentioned above.

Cylindroiulus cambio sp. n.

(Figs 19–23)

Material examined. 1♂ (ZMMU), Russia: Rostov-on-Don, Botanical Gardens, Rostov-on-Don University, field plot, 24 May 1977, leg. V. Minoransky.

Total material. 1♂.

Etymology. The species name commemorates an exchange between 1 new species and the 2 new synonyms of *C. horvathi.*

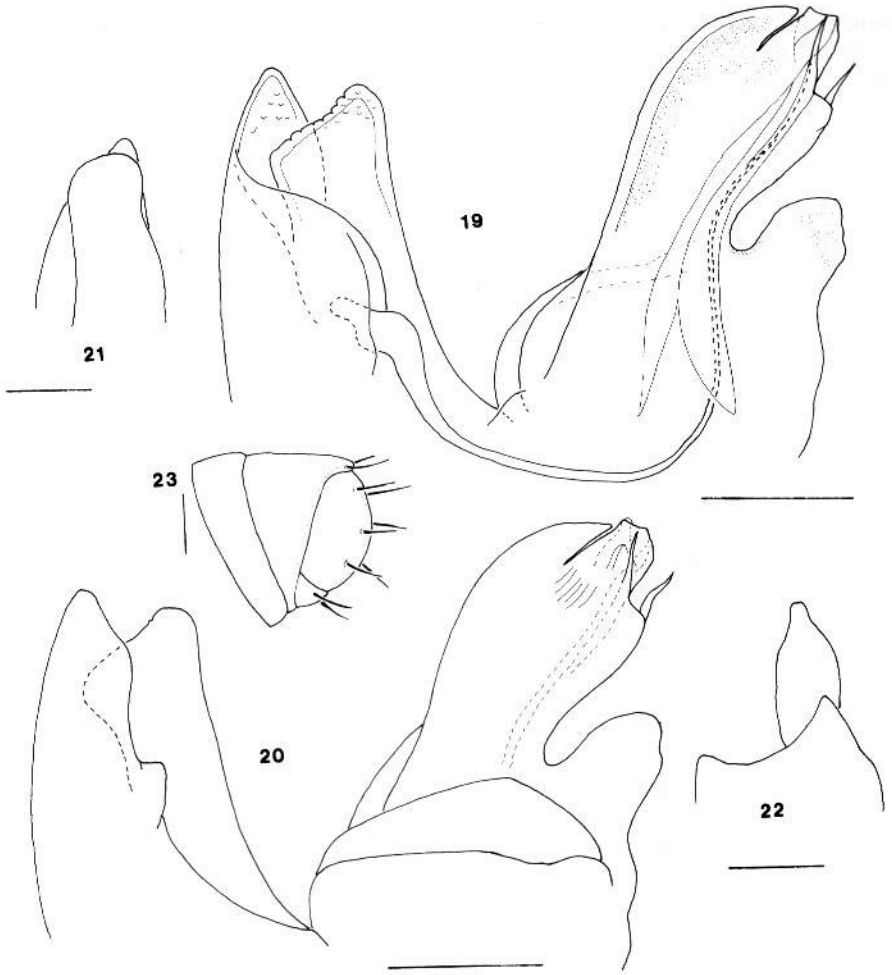
Diagnosis. A species of the group lacking a telson projection. Gonopods with a large, broad paracoxal process, opisthomerite wide, with large spines on posterior margin.

Description. Length 9·75 mm; maximum vertical diameter 0·66 mm; body segments 36 + 2.

Colour. Head and first six segments chocolate brown, with typical markings. Body segments darker brown at ozopore level and dorsally with a darker midbody line. Preanal ring and anal valves with dark marbling. Legs pale yellow.

Telson. Telson projection completely lacking (Fig. 23) but with two setae dorsally on preanal ring.

Male gonopods (Figs 19–22). Pro- and mesomerites typical of the species group, of similar length, with both mesal flange and lateral flap protecting the mesomerite. Flagellum of normal length. Paracoxal rim domed, paracoxal process long and



FIGS 19–23. *Cylindroiulus cambio* sp. n., holotype from Rostov-on-Don, (19) left gonopods, mesal view, (20) right gonopods, lateral view, (21) right gonopods, anterior view, (22) right gonopods, posterior view, (23) telson. Scale 0·1 mm.

parallel-sided with a triangular shaped tip. Opisthomerite broad, with steplike bulge on posterior margin bearing a large spine or seta. Extensive membranous area between sperm canal opening and large indentation which separates solenomerite and brachite.

Remarks. Despite there only being one individual it is clearly a different species due to the lack of telson projection. The gonopods, especially the opisthomerite, differ sufficiently from those of *C. horvathi* and *C. abaligetanus* to be certain of the specific status.

Distribution. The only individual found so far is from Rostov-on-Don (Fig. 8). The possibility exists that this has been introduced into the Botanical Gardens.

Concluding remarks

The three species belonging in this group are very similar in many respects. It is hoped that following this review it may be easier to identify these animals and that further samples can be obtained which will help in assessing the true geographical

distribution of these species. From the presence of a crenulate limbus they can all be placed in the subgenus *Crenatoiulus*, but this subgenus needs further work in order to clarify the relationships between all of its species which at the present time are confused.

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