IDENTIFICATION KEY TO THE CAVERNICOLOUS DIPLOPODA OF ROMANIA

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Abstract. The authors analyze the families Trachysphaeridae, Trichopolydesmidae and the tribe Typhloiulini and provide an identification key for the cavernicolous Diplopoda recorded from the caves of Romania.

Key words: Diplopoda, identification key, Romanian caves.

1. INTRODUCTION

Among the four classes (Chilopoda Latreille, 1817, Symphyla Ryder, 1880, Pauropoda Lubbock, 1868 and Diplopoda De Blainville in Gervais, 1844) included in the subphylum Myriapoda Latreille, 1802, the Diplopoda represent the most numerous and the most diversified class. It is estimated that up to approximately 12,000 species of diplopods have been described until now.

At present, the subphylum Myriapoda is considered as a monophyletic group by some authors (see KOCH, 2003) but there are different opinions concerning the sister group: with Hexapoda (Mandibulata hypothesis, Tracheata or Atelocerata hypothesis, Uniramia hypothesis); with Pancrustacea (Pancrustacea or Tetraconata hypothesis); with Chelicerata (Paradoxopoda or Myriochelata hypothesis). Since 1893, Pocock has divided the Myriapoda into two lineages: 1. Progoneata (with the genital openings in the anterior part of the body) containing Symphyla + Pauropoda + Diplopoda; 2. Opisthogoneata containing Chilopoda which has the genital openings in the terminal part of the body just like Hexapoda. Initially, POCOCK had included Symphyla in the Opisthogoneata but in the same year he rectified his error (1893 – A correction).

Nevertheless, many authors (see DOHLE, 1980; KRAUS & KRAUS, 1996) consider Myriapoda as a paraphyletic group, arguing different phyletic relations for the four classes. Some authors regard Chilopoda (as part of the Opisthogoneata) as a sister group of Hexapoda, other authors (Snodgrass, Tiegs, Sharov) see Symphyla as the sister group of Hexapoda, while other authors (Kraus & Kraus – Labiophora hypothesis) see Progoneata as the sister group of Hexapoda.

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Concerning the class Diplopoda, there is a general agreement regarding its monophyly. The majority of authors considers Diplopoda as the sister group of the class Pauropoda, together forming the Dignatha Tiegs, 1947 or Collifera Boudreaux, 1979. The monophyly of Diplopoda is well supported by the following morphological characters:

– Only two pairs of mouthparts respectively the mandibles and the gnatochilarium formed by the merging of the maxillae.

– The presence of the diplosegments: the first segment (the collum) lacking legs, the segments 2, 3, 4 with only one pair of legs but beginning with segment five there are two pairs of legs (diplosegments).

– The short antennae have only 8 articles, the last antenomere bearing four (rarely more) sensorial cones.

The main divisions of the class Diplopoda, respectively Penicillata – Chilognatha, Pentazonia (Opisthandria) – Helmintomorpha (Proterandria) within Chilognatha and Colobognatha – Eugnatha within Helminthomorpha, are well supported by cladistics analysis (ENGHOFF, 1984, 1990). Important contributions to the classification and the nomenclature of the Diplopods belong to JEECKEL (1970), HOFFMAN (1979), SHELLEY (2003) and SHEAR (2011).

The following classification is used in our paper:

Class **Diplopoda** de Blanville in Gervais, 1844
Subclass **Penicillata** Latreille, 1831 (= Pselaphognatha Latzel, 1884)
Order **Polyxenida** Verhoeff, 1934 (= Schizocephala Verhoeff, 1926)
Superfamily **Polyxenoidea** Lucas, 1840
Family Polyxenidae Lucas, 1840
Family Lophoproctidae Silvestri, 1897
Subclass **Chilognatha** Latreille, 1802–1803
Infraclass **Pentazonia** Brandt, 1833 (= Opisthandria Verhoeff, 1894)
Superorder **Oniscomorpha** Pocock, 1887 (= Armadillomorpha Verhoeff, 1915)
Order **Glomerida** Brandt,1833 (= Plesiocerata Verhoeff,1910)
Family Glomeridae Leach, 1815
Family Trachysphaeridae Strasser, 1965 (= Gervaisiidae Cook, 1895)
Infraclass **Helminthomorpha** Pocock, 1887 (= Proterandria Verhoeff, 1894)
Subterclass **Eugnatha** Attems, 1898
Superorder **Merocheta** Cook, 1895 **(=** Proterospermophora Verhoeff, 1900)
Order **Polydesmida** Pocock, 1887
Suborder **Strongylosomatidea** Brölemann, 1916
Family Paradoxosomatidae Daday, 1889 (= Strongylosomatidae Cook, 1895)
Suborder **Polydesmidea** Pocock, 1887
Superfamily **Polydesmoidea** Leach, 1815
Family Polydesmidae Leach, 1815
Superfamily **Trichopolydesmoidea** Verhoeff, 1910

Family Trichopolydesmidae Verhoeff, 1910
Superorder **Nematophora** Verhoeff, 1913
Order **Chordeumatida** Pocock, 1894, (= Ascospermophora Verhoeff, 1900)
Suborder **Craspedosomatidea** Cook, 1895
Superfamily **Haaseoidea** Attems, 1899
Family Haaseidae Attems, 1899 (= Orobainosomidae Verhoeff, 1899)
Superfamily **Antroleucosomatoidea** Verhoeff, 1899
Family Anthroleucosomatidae Verhoefff, 1899
Superorder **Juliformia** Attems, 1926 (= Opistospermophora Verhoeff, 1900
Order **Julida** Brandt, 1833 (= Symphyognatha Verhoeff, 1910)
Superfamily **Blaniuloidea** C. L. Koch, 1847
Family Blaniulidae C. L. Koch, 1847
Superfamily **Juloidea** Leach, 1814
Family Julidae Leach, 1814

In a previous paper (TABACARU, GIURGINCA & VĂNOAICA, 2004), we have presented the inventory of the cavernicolous Diplopoda of Romania with the caves where they have been collected. There are 55 species, among which 20 can be considered as troglobionts, 11 troglophilic and 24 as trogloxenes. The identification key includes only the troglobitic and the troglophilic species.

2. SOME PROBLEMS REGARDING THE SYSTEMATICS OF THE DIPLOPODA

Among the Diplopoda recorded from the caves of Romania, the families Anthroleucosomatidae (TABACARU, 1968, TABACARU & GIURGINCA, 2006, ČURČIČ & MAKAROV, 2000, ČURČIČ & AL., 2007, 2008) and Haaseidae (MAURIÈS & KIME, 1999, TAJOVSKY & AL., 2014) and the tribes Typhloiulini (STRASSER, 1962, 1973, TABACARU, 1976, 1985, 1992, ENGHOFF, 1987, MAKAROV & AL., 2002, 2008, ČURČIČ & AL., 2005, VAGALINSKI & AL., 2015) and Pachyiulini (TABACARU, 1978, MAURIÈS, 1982), have been the subject of numerous discussions regarding their taxonomic position.

We will reanalyze here the families Trachysphaeridae and Trichopolydesmidae and the tribe Typhloiulini before presenting the identification key.

2.1. THE SYSTEMATIC POSITION OF THE GENUS *TRACHYSPHAERA* HELLER, 1858

The first species of the genus *Trachysphaera* was described by A. F. Waga in 1857 under the name *Gervaisia costata* and, subsequently, 33 species have been described by different authors within the genus *Gervaisia* Waga, 1857. But, in 1962, R. V. CHAMBERLIN showed that the name *Gervaisia* Waga, 1857 is preoccupied by *Gervaisia* Bonaparte, 1854 (Aves) and proposed a new name:

Gervaisicus. One of the authors (TABACARU, 1963) showed there is no need of a new name and that it should be used the name *Trachysphaera* Heller, 1858 created for the species *T. schmidti* Heller, 1858 considered by Latzel (1884) as synonymous with *Gervaisia costata*. Two other species, *T. hirtlii* Wankel, 1861 and *T. transsylvanica* Tömösvary, 1880 are regarded as synonimous with *Gervaisia costata*. Even after SILABER (1987) established the synonimy of *Gervaisia noduligera* Verhoeff, 1906 with *Trachysphaera schmidtii*, the name *Trachysphaera* should replace *Gervaisia*, which is preoccupied. Also, according to the code of nomenclature the family name Gervaisiidae Cook, 1895 should be replaced with Trachysphaeridae Strasser, 1965. Under the genus name *Trachysphaera* have been described 7 more species.

By studying the postembrionary development (TABACARU, 1963) and the morphology (TABACARU, 1986, 1987, 1988) at various species of *Trachysphaera*, Tabacaru argued that this genus presents within the order Glomerida particular characters justifying its inclusion in the family Trachysphaeridae Strasser, 1965 (= Gervaisidae Cook, 1895; Silvestri, 1896) as K. W. VERHOEFF (1912) also argued. But H. BROLEMANN (1913) had included in the same family other genera and proposed the following classification: the family Gervaisidae with two subfamilies 1. Subfamily Gervaisiinae with the tribe Gervaisiina (*Gervaisia*) and the tribe Doderoina (*Doderoa*), 2. Subfamily Adenomerinae with the tribes Adenomerina (*Adenomeris*) and the tribe Spelaeoglomerina (*Spelaeoglomeris*, *Stygioglomeris*, *Geoglomeris*, *Hyleoglomeris*).

In the classification of Diplopoda published by R. HOFFMAN (1979), the family Trachysphaeridae Strasser, 1971 contains three genera: *Adenomeris*, *Doderia* and *Trachysphaera*. Probably, HOFFMAN did not know that the name Gervaisiidae has been replaced by STRASSER in 1965 and TABACARU in 1966 with the Trachysphaeridae.

In 1971 and 2005, J. – P. MAURIÈS suggests for the Glomerida a classification based on the male sexual characters. We have to specify, just as MAURIÈS did (1971), that at Opisthandria the modified male legs do not have the same biological importance as the gonopods from Proterandria and are less differentiated and, as such, cannot provide valuable informations for the phylogenetic systematics. As several authors have pointed out (HAACKER & FUHS, 1970 and WILLBRANDT & AL., 2015) the male copulatory appendages (telopods) are only used to hold the female, not to transfer the sperm. In the classification proposed by MAURIÈS in 2005, the genus *Trachysphaera* is included in the family Glomeridae Leach, 1815, subfamily Glomerinae Leach, 1815, tribe Doderiini Silvestri, 1904. In this tribe, MAURIÈS (2005) inludes 12 genera in 4 groups: 1) *Rhopalomeris* Verhoeff, 1906; 2) *Hyleoglomeris* Verhoeff, 1910, *Speleoglomeris* Brölemann, 1913, *Geoglomeris* Verhoeff, 1908, *Rhyparomeris* Ribaut, 1954, *Stygioglomeris* Brölemann, 1913, *Strasseria* Verhoeff, 1929, *Adenomeris* Ribaut, 1909; 3) *Doderia* Silvestri, 1904; 4) *Trachysphaera* Heller, 1858, *Epiromeris* Strasser, 1976, *Tectosphaera* Mauriès,

2005. Our opinion, based on an analysis of the characters of the genera included in this tribe, this is a very heterogeneous group and that there is no character arguing for the monophyly of the group. On the other side, MAURIÈS (1971) shows that the external characters of these genera are extremely different. Not even the male sexual structures do not justify the inclusion of these genera in a tribe. For example, if we compare the male morphological structures in the genera *Epiromeris* and *Trachysphaera* (considered as closely related in this classification) we note that in *Epiromeris* the modified legs of the males (THALER & KNOFLACH-THALER, 1998) are clearly different from those found in *Trachysphaera*: P.17 is not reduced but is shaped shaped as in *Glomeris*, P.19 presents a femoral process all along the internal side of the femur and the tibia presents a long seta.

The characters endorsing the inclusion of the genus *Trachysphaera* in a suprageneric taxa are:

– There are only 8 tergites between the thoracic tergite and the pygidium;

– On the posterior side of the tergites, there is a transversal rib, characteristic for each species, with calcareous granules and rods;

– On the anterior edge of the tergites fold, there is a row of round or oval structures with concentric circles named ”Grubensäulen” by Verhoeff, “fossettes duplicaturales” by RIBAUT and “piliers duplicaturales” by BRÖLEMANN;

– On the lateral lobes of the middle tergites (4–8), there is a larger fosete named lateral foseta;

– On the lateral lobes of the thoracic tergite, there is a large, oval fosete with concentric striae named auricular foseta;

– On the prozonite of the middle tergites, there is a longitudinal medio-dorsal chitinous edge from the anterior border to the middle of the prozonite;

– No medio-dorsal repugnatory glands as found in *Glomeris* and other glomerids;

– On the anterior edge of the tergites there is a row of chitinous beads;

– On the internal side of the lateral lobes of the middle tergites, there is a spur attaching the lobes of the thoracic tergite during the volvation (VERHOEFF named these spurs “Suprapleuralen Lappen”, Brölemann “boutoirs suprapleuraux” and Strasser “Paratergitwülste”);

– Schism of the thoracic tergite is very reduced and situated on the posterior edge without defining a superior-posterior lobe;

– Tömösvary organs are round or oval and their symmetry axes converge medio-posteriourly (Fig. 11B) (the symmetry axes converge medio-anteriourly in all the Glomeridae genera where this organ has been described, with the exception of *Strasseria*);

– In males, P.17 is reduced to a stump with 1–3 articles, P.18 has merged coxae, P.19 tibia without a digitiform setiferous process and no seta;

– At P.19, between the syncoxit lateral horns there is no hyaline membrane as it can be found at the genera *Doderia*, *Rhyparomeris*, *Geoglomeris*, *Stygioglomeris*.

On our opinion, the name Doderiini should be used, as it was established, strictly for the genus *Doderia* which differs from all the other Glomerida by the presence of longitudinal ribs on the tergites.

2.2. THE DEFINITION PROBLEM OF THE FAMILY TRICHOPOLYDESMIDAE

RICHARD L. HOFFMAN (1980), in his book "*Classification of the Diplopoda*", conceives a superfamily Trichoplydesmoidea Verhoeff, 1910 containing four families: Trichopolydesmidae Verhoeff, 1910, Macrosternodesmidae Brölemann, 1916, Nearctodesmidae Chamberlin & Hoffman, 1950 and Fuhrmannodesmidae, Brölemann, 1916. Besides, since 1975, HOFFMAN had defined a superfamily Trichopolydesmoidea with two families: Trichopolydesmidae and earctodesmidae. However, we have to point out that since 1980, HOFFMAN has on the family Trichopolydesmidae an opinion differing from that of VERHOEFF. In 1910, VERHOEFF had established for the genus *Trichopolydesmus* Verhoeff, 1898 (with the sole species *T. eremitis* Verhoeff, 1898 collected by him from Peştera Hoţilor from Băile Herculane) the subfamily Trichopolydesminae, but, in 1941, he had elevated the subfamily to the rank of family and argued this is an American family which during Early Tertiary reached, over Atlantis, Europe where it remained only as sporadic remnants. Of contrary, HOFFMAN (1980) regards the Trichopolydesmidae as a family made up only by a few European species. In 1990, AGE SIMONSEN made a cladistics analysis of the order Polydesmida in which argues for the idea of Hoffman about the Trichopolydesmidae with the sole difference that the family Nearctodesmidae is regarded as a subfamily within the family Macrosternodesmidae. In the revised classification of the Diplopoda families of ROWLAND M. SHELLEY in 2003, the superfamily Trichopolydesmoidea is accepted as conceived by HOFFMAN (1980, 1999). In 2012, WILLIAM A. SHEAR states: "Hoffman's opinion that Trichopolydesmidae are a small family limited to a few species in eastern Europe is probably correct, but this leaves behind more than 50 genera, many monotypic, uncomfortably agglutinated in the family Fuhrmannodesmidae Brölemann, 1916 (HOFFMAN, 1999)".

A completely different conception on the superfamily Trichopolydesmoidea presents SERGEI I. GOLOVATCH in 2013. Thus, in a reclassification of this superfamily, GOLOVATCH considers the families Fuhrmannodesmidae Brölemann, 1916, Macrosternodesmidae Brölemann, 1916, Nearctodesmidae Chamberlin & Hoffman, 1950 but also Mastigonodesmidae Attems, 1914 as synonymous with the family Trichopolydesmidae Verhoeff, 1910. GOLOVATCH (2013) and GOLOVATCH & AL. (2014) includes two families in the superfamily Trichopolydesmoidea: Trichopolydesmidae (newly defined) and Opisotretidae Hoffman, 1980, a family regarded before by Simonsen (1990) and Shelley (2003) as belonging to the superfamily Opisotretoidea.

In our opinion, the merging of the five families, as suggested by GOLOVATCH does not represent an advance in systematic phylogenetic knowledge of the micropolydesmids. The definition of the family Trichopolydesmidae given by GOLOVATCH (2013) and GOLOVATCH & AL. (2014) is not clear because it includes only characters in common with other families or variable characters. This aspect was already noted in 2014 by DRAGAN Z. ANTIC & AL. As defined by GOLOVATCH, the family Trichopolydesmidae includes a very large number of species but it is not argued by any apomorphy and does not present any character association strictly belonging to this family. In our opinion, only the detailed study of the genera and the use of similar structures, possible apomorfies, can contribute to a phylogenetic systematics. We have to note that GOLOVATCH had shared this opinion because, discussing the Fuhrmannodesmidae, he stated: "This highly heterogeneous assemblage certainly merits splitting into several natural families, but such a task is by necessity to be deferred because of the numerous genera and species involved, many of which require revision" (GOLOVATCH, 2011). By merging the families, GOLOVATCH (2013) proposes an even more "highly heterogeneous assemblage"

We agree here with the family Trichopolydesmidae as defined by HOFFMAN (1980, 1990) and argued by SIMONSEN (1990).

In his cladistics analysis, Simonsen mentions two apomorphies for the family Trichopolydesmidae:

Trend 96. Metaterga with more than three transverse rows of setae.

Trend 97. Telopodite simple and long compared with the gonopod coxae.

Regarding the first character, we have to specify that the rows of setae are irregular or less regular and that the setae are simple, never bi-articulated.

The second character was noted by MAURIÈS (1983) in a study specifying the genera that may be included in the family Trichopolydesmidae and establishes an identification key for them. Mauriès states: "Il est évident que les dix genres qui constituent cette famille des Trichopolydesmidae constituent un ensemble assez homogène que l'on peut, sur le plan des structures gonopodiales, définir par la relative simplicité et le relatif grand développement du telopodite des gonopodes par rapport au coxoïde". This character differentiates the respective genera from those Fuhrmannodesmids with big, hemispheric coxae, like a helmet protecting the telopodite (MAURIÈS & HEYMER, 1996), as we find at *Sphaeroparia*. The presence of the genus *Sphaeroparia* in the Aegean region (GOLOVATCH, 2013) does not indicate a close relationship with the Mediterranean family of Trichopolydesmidae. It is a situation similar with the northward extension, in the same region, of the isopod genus *Cordioniscus* belonging to the family Styloniscidae, distributed in the southern hemisphere on the fragments of the ancient continent of Gondwana (TABACARU, 1993)

Among the other characters of the family, we mention the lack of prostatic ampullae (= seminal chamber) and hair pad (= setose pulvillus) and also the absence of a flagellum. The solenomerite can be narrow, rod-like (*Trichopolydesmus*) but never flagellum-like as in Mastigonodesmidae.

Analyzing the descriptions of the species included in the family Trichopolydesmidae (ATTEMS, 1940; CEUCA, 1958, 1974; STRASSER, 1959, 1966; TABACARU, 1975, 1980; HOFFMAN, 1980; MAURIÈS, 1980, 1983, MAURIÈS & VICENTE, 1977; ANTIC, REIP, DRAZINA, RADA, MAKAROV, 2014), and the characters defining the family, we consider the following genera as belonging to this family: *Trichopolydesmus* Verhoeff,1898, *Bacillidesmus* Attems,1898, *Cottodesmus* Verhoeff, 1936; *Galliocookia* Ribaut, 1955; *Verhoeffodesmus*, Strasser, 1959; *Occitanocookia* Mauriès, 1961; *Napocodesmus*, Ceuca,1974; *Banatodesmus* Tabacaru,1980; *Balkanodesmus* Antic & Reip, 2014; *Solentanodesmus* Antic & Reip, 2014; *Velebitodesmus* Antic & Reip, 2014. In our opinion, here should also be included the species described from the caves of Crimea and attributed to the genus *Caucasodesmus* Golovatch, 1985. Analyzing the descriptions from GOLOVATCH (1985, 2011) and GOLOVATCH & VANDENSPIEGEL (2015), we consider the species found in caves from Crimea (*C. tauricus*, *C. svetlanae*, *C. turbanovi*) and attributed to the genus *Caucasodesmus* are, in fact, not congeneric with *Caucasodesmus inexpectatus* Golovatch, 1985 found in a cave from Caucasus (North Ossetia). As the descriptions show, the species from Crimea differ from the type-species of the genus *Caucasodesmus* by important characters: metatergal setation more abundant and less regular, the presence of prostatic groove (= seminal canal), the presence of the solenomere (seminal branch), tibiotarsus (= exomere, solenophore) not fringed apically, body with 19 segments.

In our opinion, the genus *Ingurtidorgius* Strasser, 1974 does not belong to the Trichopolydesmidae, as HOFFMAN (1980) and MAURIÈS (1983) thought, but to the family Mastigonodesmidae (Subfamily Ingurtidorgiinae) as considered by STRASSER, due to its characters: metazonites with three rows of setae, very big coxite, flagellum-like solenomere, presence of spermatic vesicle (= prostatic ampullae).

The genus *Banatodesmus* Tabacaru, 1980 was established as a subgenus of the genus *Trichopolydesmus* but MAURIÈS (1983) considers it a genus and includes it in the family Fuhrmannodesmidae. In our opinion (TABACARU, GIURGINCA & VĂNOAICA, 2004) it should be included in the Trichopolydesmidae and differs from the genus *Trichopolydesmus* by the fact that it has a prefemur split into two branches: solenomere and tibiotarsus (= exomere, solenophore) instead of an acropodite with three branches.

Concerning the genus *Napocodesmus*, it was erroneously stated (GOLOVATCH & AL., 2009) that the species *N. endogeus* Ceuca, 1974 is a troglobite from Romania and *N. florentzae* Tabacaru, 1975 is a partenogenetic soil species found in Romania and Republic of Moldova. In fact, only female individuals of *N. endogeus* have been collected in the garden of the Zoology Cathedra from Cluj and probably found again in Republic of Moldova (AKKARI & ENGHOFF, 2011) while *N. florentzae* has been collected by I. Tabacaru and I. Căpuşe from only one cave in the Vâlcan Mountains (Southern Carpathians). As the species *Napocodesmus endogeus* Ceuca, 1974 was established on female exemplaries, the identification of

this species and the inclusion of the species *N. florentzae* Tabacaru, 1974 in this genus cannot be certain.

The differences in the gonopods structure allow the definition of the genera included in this family. The absence of the cannula (= solenite, Hüfthörnchen or Coxithörnchen for the German authors, crochet coxal for the French authors) is characteristic for the genus *Solentanodesmus* and for the species recorded from the caves of Crimea belonging to the genus *Caucasodesmus*. However, taking into account the differences with the species *Caucasodesmus inexpectatus* (which we regard as belonging to the family Trichopolydesmidae) in our opinion, the sole presence of this character does not argue the inclusion of the species from Crimea in the genus *Caucasodesmus*.

The seminal channel (= prostatic groove) opens on a seminal branch (solenomere) at the genera *Trichopolydesmus*, *Bacillidesmus*, *Galliocookia*, *Verhoeffodesmus*, *Napocodesmus*, *Banatodesmus* as well as the species from Crimea. But at *Banatodesmus* and the species from Crimea, the prefemur continues with two branches, respectively a solenomere and an exomerite (= tibiotarsus). At the other genera, the prefemur continues with a triramous (*Trichopolydesmus*) or a biramous acropodite with the seminal branch detached at different levels.

At the genera lacking the seminal branch, the telopodite has very different aspects: it can have a prefemoral process (*Solentanodesmus*); the distal part of the acropodite can be thickened (*Cottodesmus*, *Occitanocookia*) or, of contrary, it can be strongly thinned (*Solentanodesmus*) or it can have various characteristic blades (*Balkanodesmus*, *Velebitodesmus*).

2.3 THE SYSTEMATIC POSITION OF THE GENERA *LAMELLOTYPHLUS* TABACARU, 1976 AND *BANATOIULUS* TABACARU, 1985

The renowned biospeologist and diplopodologist KARL STRASSER published in 1962 a monographic study on the blind and depigmented Iulids forming the so-called "tribe Typhloiulini". The genera *Typhloiulus* Latzel, 1884, *Leptotyphloiulus* Verhoeff, 1899, *Trogloiulus* Manfredi, 1931, *Buchneria* Verhoeff, 1941, *Serboiulus* Strasser, 1962 and *Alpityphlus* Strasser, 1967 are considered as belonging to the tribe Typhloiulini Verhoeff, 1930 (STRASSER, 1962, 1967; HOFFMAN, 1980).

ATTEMS (1959 – in a posthumous paper) has elevated the tribe Typhloiulini to the rank of subfamily, Typhloiulinae, but without arguing his decision. STRASSER (1962) disputed this opinion and argued in the conclusions of his study on the Typloiulini that this is not a phylogenetic systematic unit. In fact, besides the absence of the visual organs and of the body pigmentation, there are no significant characters common to all the genera included now within this tribe. In the same time, STRASSER points to the fact that within this tribe the main male characters show different aspects: the first leg pair is ambulatory only at *Buchneria* and at the sub-genus *Haploprotopus* (from the genus *Typhloiulus*) the other genera presenting

an uncus (hook-like first leg pair); the gonopods have no flagellum at the genera *Trogloiulus* and *Serboiulus*, the other genera having a flagellum; STRASSER also specifies that neither *Buchneria* and *Haploprotopus*, nor *Trogloiulus* and *Serboiulus* have no other characters arguing for a relationship among them.

Studying the gonopods structure at the Typhloiulini, STRASSER (1962, p.23) notices a very interesting peculiarity of the posterior gonopods, not very well studied until then, namely an intermediary lamella (Zwischenblättchen), respectively a thin membrane between meso- and opisthomerite; STRASSER regarding this membrane as a proof the former unit made up by the opisthomerite and the mesomerite. In his study, he even suggests three stages in the evolution of the divide between the meso- and the opisthomerite: 1. *Oncoiulus*, 2. *Typhloiulus*, 3. *Leptoiulus*, *Ophiiulus* and other genera. In fact, STRASSER maintains VERHOEFF's point of view.

Regarding the origin of the mesomerite, its origin (according to the majority of opinions) is in the division of the posterior gonopod in an anterior (mesomerite) and posterior (opisthomerite) part. The mesomerite is closely pressed on the promerite adapting to its groove. But concerning the intermediary lamella between the mesomerite and the opisthomerite, we note that even the classics of the diplopod morphology had different opinions: VERHOEFF (1926–1932, p.1664), maintains about the species with intermediary lamella at their gonopods that "there is no divide of the posterior gonopode between the mesomerite and the opisthomerite, but it is proved by the fact that both parts are reunited by a thin membrane, the mesomerital part being already adapted to the promerite". As such, VERHOEFF sees the presence of this lamella as a precursory stage in the complete disjunction of the two parts. However, ATTEMS (1940, p. 301) states: "I cannot share this opinion as I regard this lamella uniting the two parts, mesomerite and opisthomerite, as a secondary evolution…"

The intermediary lamella is recorded at many species of the genus *Typhloiulus* Latzel, 1884. Up to the present, this genus contains 32 species grouped during time in different ways by VERHOEFF, ATTEMS and STRASSER. The intermediary lamella is present in almost all species of the subgenus *Typhloiulus* s.str. and can present different aspects. Thus, it can be independent between the mesomerite and opisthomerite (*T. psilonotus, T. hauseri, T. longinquus*), it can be joined with the mesomerite (*T. strictus, T. albanicus, T. kotelensis, T. gangelbaueri)* or it can be joined with the opisthomerite (*T. incurvatus, T. bureschi, T. giganteus, T. orpheus, T. rhodopinus)*. At the species *T. serborum* Curcic & Makarov 2005, lamella represents a clear connection between the opisthomerite and mesomerite: lamella starting in the base of uppermost mesomeral lobe, surrounding opisthomerite on lateral side and finishing subapically on caudal side of solenomerite (ĆURČIĆ, MAKAROV, TOMIĆ & MITIĆ, 2005).

Some authors use for the intermediary lamella the term vellum but this term was used (as MAKAROV & AL., 2008 has shown) for a small recurved, fringed

lamella (sometimes reduced to a pointed spur) situated in the terminal part of the solenomerite, having probably a protective role. At many species, the vellum coexists with the intermediary lamella, clearly proving they are two different structures.

In 1976, from several caves situated in the western part of the Southern Carpathians, a new troglobitic julid, regarded a belonging to a new subgenus of the genus *Typhloiulus*, was described. The species, known in the present as *Lamellotyphlus mehedintzensis* (TABACARU, 1976), was initially included in the genus *Typhloiulus* taking into account the following characters: absence of the ocelli and the body pigmentation; presence of the occipital hairs; absence of the mandibular lobes; presence of hair verticils on the posterior edge of the metazonites; short and wide gonopods; presence of flagellum at the anterior gonopods; absence of coxal structures at the gonopods. The subgenus *Lamellotyphlus* was argued especially by the presence of a lamella uniting the mesomerite and the opisthomerite in a single piece.

In 1985, from a cave in southern Banat, was described a remarkable, small-bodied trogolobitic julid belonging to a new genus, *Banatoiulus troglobius* Tabacaru, 1985. The genus *Banatoiulus* represents a relict endemite characterized by the absence of the mesomerite, the posterior gonopods apically differentiated in a lobe with a granulated surface toward the promerite and a fringed lamella and the very robust and elongated flagellum is curved toward the posterior gonopods. Although the posterior gonopode of *Banatoiulus* is a unitary structure, we can recognize in the anterior part a lobe (mesomerital) opposed to the promerite.

HENRIK ENGHOFF (1987) in an ample study on the genus *Nepalmatoiulus* Mauries, 1983 elevates the subgenus *Lamellotyphlus* Tabacaru, 1976 to the rank of genus and considers it as part of the tribe Leucogeorgini Verhoeff, 1930. As it was defined by MAURIÈS (1983) and ENGHOFF (1987), this tribe contains the cavernicolous genera *Leucogeorgia* Verhoeff, 1930, *Archileucogeorgia* Lohmander, 1936, *Syniulus* Strasser, 1974, *Paratyphloiulus* Mauries, 1983 (=*Paratyphloiulus* Ceuca, 1971, nomen invalidum), *Telsonius* Strasser, 1976, *Lamellotyphlus* Tabacaru, 1976 and the surface-dwelling genera *Chromatoiulus* Verhoeff, 1894, *Heteroiulus* Verhoeff, 1897 and *Nepalmatoiulus* Mauries, 1983. In ENGHOFF's opinion, this tribe, along with the tribe Oncoiulini Verhoeff, 1909 (=Uncigerini Lohmander, 1936), containing the genera *Unciger* and *Chaitoiulus*, form the subfamily Oncoiulinae. He defines the family by the presence of an intermediary lamella with an antero-distally, strongly sclerotized mesomerital process, forming together with the promerite a forceps. As ENGHOFF points out this definition is not cladistically satisfactory as the mesomerital process is connected to the solenomerite by a lamella, this represents an plesiomorphy in relation with the Julids in which the pro/mesomerital forceps presents the mesomerite as an independent branch. Also, in ENGHOFF's opinion the tribe Leucogeorgini is not supported by synapomorphies.

Regarding the genus *Banatoiulus* Tabacaru, 1985, ENGHOFF considers it as phylogenetically close to the Oncoiulinae but also differing by the absence of a well-developed pro/mesomerital forceps.

In 2002, S. E. MAKAROV, B. M. MITIĆ and S.B. ĆURČIĆ describe from a cave in Eastern Serbia, the species *Lamellotyphlus sotirovi* Makarov, Mitić & Ćurčić, 2002. The authors recognize the generic rank for *Lamellotyphlus* Tabacaru, 1976 and consider it as a member of the Typhloiulini tribe.

In 2008, S. E. MAKAROV, L. R. LUČIĆ and B. D. DUDIĆ published a study about the genus *Lamellotyphlus* describing a new species – *Lamellotyphlus belevodae* Makarov, 2008 – discuss the taxonomical and phylogenetic position of the genus, present the geographic spreading of the three known species and provide an identification key for them. Accepting that in higher julids the mesomerite is developed as an independent branch, they regard the genus *Banatoiulus* as the most basal typhloiulid taxa, then the genus *Lamellotyphlus* as the next step in the evolution of the gonopods and, finally, the *Typhloiulus* species with the mesomerite as a free and independent branch. As such, MAKAROV & AL., (2008) argue for an evolution from the absence of a mesomerite (*Banatoiulus*) to a mesomerite fused with the opisthomerite (*Lamellotyphlus*) and then to a free and independent mesomerite, the evolution taking place inside the Typhloiulini tribe.

Certainly, the fact that the posterior gonopods was a single piece which, gradually, evolved in an anterior part (mesomerite) and a posterior part (opisthomerite) is a highly probable hypothesis. The mesomerite, inconjunction with the anterior gonopods (promerite) formed a pincer (forceps) with an important role in the mating process (HAACKER & FUCHS, 1970). The opisthomerite houses the flagellum (if the promerite has a flagellum) and has the role to transport the sperm. The presence at some julids, on the opisthomerite, of a robust mesomerital elongation (but in this case without an intermediary lamella) argues for the mesomerite breaking away from the opsthomerite.

If, initially, the intermediary lamella had united, more or less completely, the mesomerite with the opisthomerite and gradually was reduced to an independent lamella and, in the end, it disappeared, then we can consider it as a plesiomorphic character. In our opinion, it is difficult to argue that all the julids with an intermediary lamella form a monophyletic unit (respectively the subfamily Oncoiulinae), based only on this plesiomorphic character.

On the other hand, it might be maintained the opposite hypothesis (ATTEMS, 1940), namely the intermediary lamella as a secondary structure which initially was independent and gradually developed in a single structure – the posterior gonopod. In this case, it is an apomorphy but the very different conformation of the julids gonopod with this lamella leads us to regard this as a phenomenon taking place in parallel in different lineages and in this case the character can not argue for monophyletic taxa.

In our opinion (TABACARU, 1976, 1985; TABACARU, GIURGINCA & VĂNOAICA, 2004) the genera *Lamellotyphlus* and *Banatoiulus* are closely related with the genus *Typhloiulus* and not with the Oncoiulini.

Comparing the recent diagnosis of the genus *Typhloiulus* by VAGALINSKI, STOEV & ENGHOFF (2015), with the diagnosis of the genus *Lamellotyphlus* made

by TABACARU (1976) and completed by MAKAROV ET AL., (2008), we note a single difference: a freely articulated mesomere at *Typhloiulus* and the mesomerite fused with the opisthomerite by an intermediary lamella at *Lamellotyphlus*. We have to point out that "a freely articulated mesomere" is not valid for all species of *Typhloiulus* and excludes even the type species of the genus (JEEKEL, 1970), namely *T. strictus* (Latzel, 1882). At this species, the intermediary lamella unites the opisthomerite with the basal half of the mesomerite (TABACARU, 1976).

As we have pointed out (TABACARU, GIURGINCA & VĂNOAICA, 2004) a synonymy between the tribe Typhloiulini Verhoeff, 1930 and the tribe Leptoiulini Lohmander, 1936, as suggested by MAURIES, GOLOVATCH & STOEV, 1997, does not seem to be justified neither from the point of view of the nomenclature rules, nor from the point of view of the morphological characters. In the first place the Leptoiulini are characterized by the paracoxal process as an apomorphy (READ, 1990).

3. IDENTIFICATION KEY TO THE CAVERNICOLOUS DIPLOPODA OF ROMANIA

1 (4) Body with soft, elastic tegument, not calcified; tergites with transversal rows of robust, serrated spines (trichomes), on the sides there are groups of long trichomes; telson with penicilli made by very long trichomes (Fig.1); males without legs modified for copulating (Subclass **Penicillata**, Order **Polyxenida**)..... 2

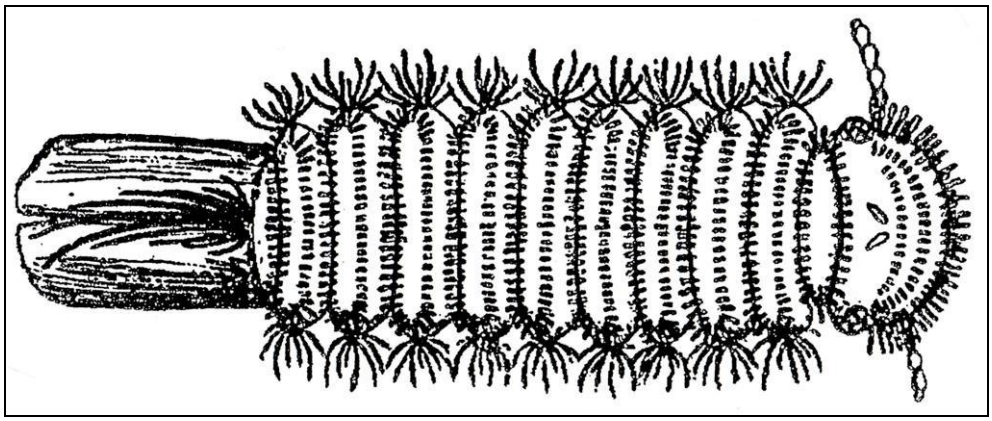


Fig.1. *Polyxenus lagurus* (after SCHUBART, 1934).

2 (3) Palpi of the gnatochilarium with a long lateral expansion with sensitive rods (Fig. 2A); last antennal segment shorter than the penultimate; (Family **Polyxenidae**); with ocelli; grey body with a yellowish or brownish hue; body length: 2–3.3 mm .....*Polyxenus lagurus* (Linné, 1758)

3 (2) Palpi of the gnatochilarium without lateral expansion (Fig. 2B); last antennal segment equal or longer than the penultimate; (Family **Lophoproctidae**); without ocelli; body silver-grey; body length: 2–4 mm.....
.....*Lophoproctus lucidus* (Chalande, 1888)

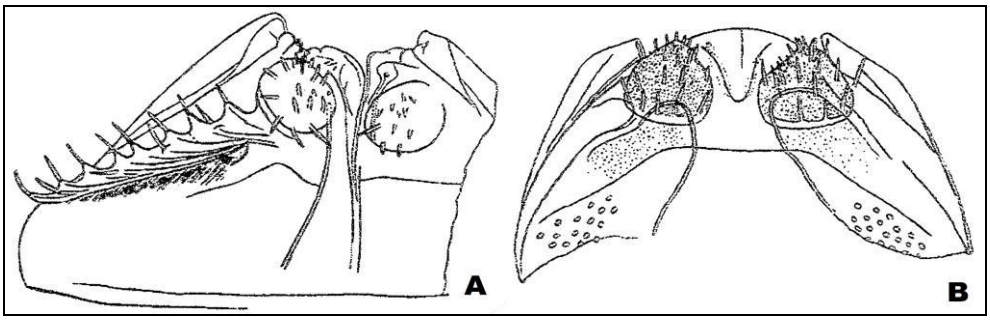


Fig.2. Gnathochilarium of *P. lagurus* (A) and *L. lucidus* (B)
(after TABACARU, 2011, modified).

4 (1) Body with rigid tegument, calcified; no trichomes; males have legs modified for copulating (Subclass **Chilognatha**).....5

5 (26) The male modified legs (telopods) are situated in the posterior part of the body (Infraclass **Pentazonia** or Opisthandria); body short and robust with the ability to roll into a ball (complete endoantennal volvation) (Superorder **Oniscomorpha**); segments 2 and 3 are merged forming the thoracis segment following the collum; females with 17 leg pairs, males with 19 leg pairs (Order **Glomerida**).....6

6 (7) Smooth tergites, without transversal ribs and without calcareus granules and rods; the lateral lobes of the thoracic tergite without a foseta and have a deep schism defining a superior-posterior lobe; 9 tergites between the thoracic tergite and the pygidium (Family **Glomeridae**); pigmented ocelli; body black (Fig. 3) with yellow spots (4 spots on the thoracic tergite and 2 paramedian spots on tergites 4–9); body length: 5–11 mm ..... *Glomeris pustulata* Latreille, 1804

7 (6) Tergites with a transversal rib with calcareous granules and rods on the posterior side; the lateral lobes of the thoracic tergite with a big, oval foseta and a strongly reduced schism, on the posterior edge; only 8 tergites between the thoracic tergite and the pygidium; body weakly pigmented or completely depigmented (Family **Trachysphaeridae**, Genus *Trachysphaera*) 8

8 (11) With obvious, pigmented ocelli 9

9 (10) Weakly developed transversal ribs do not form a prominent edge and have 2–4 rows of granules with small rods (Fig. 4); P.19 with the median lobe of the syncoxite with short, rare hairs; body length: 2.5–5 mm……*Trachysphaera costata* (Waga, 1857)

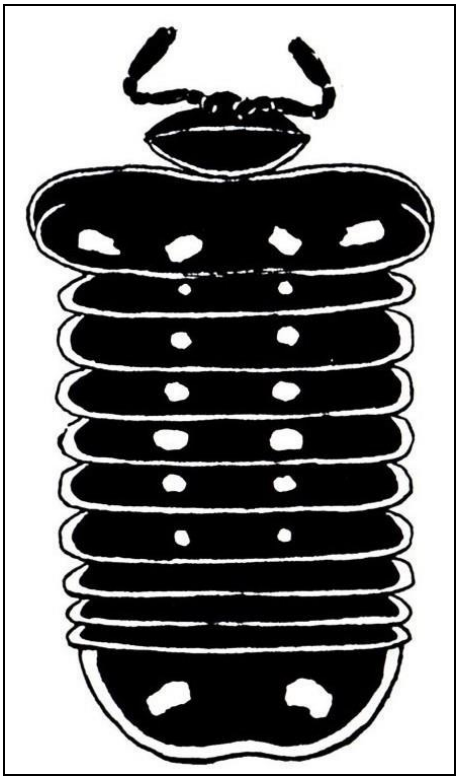


Fig. 3. *Glomeris pustulata* (after SCHUBART, 1934).

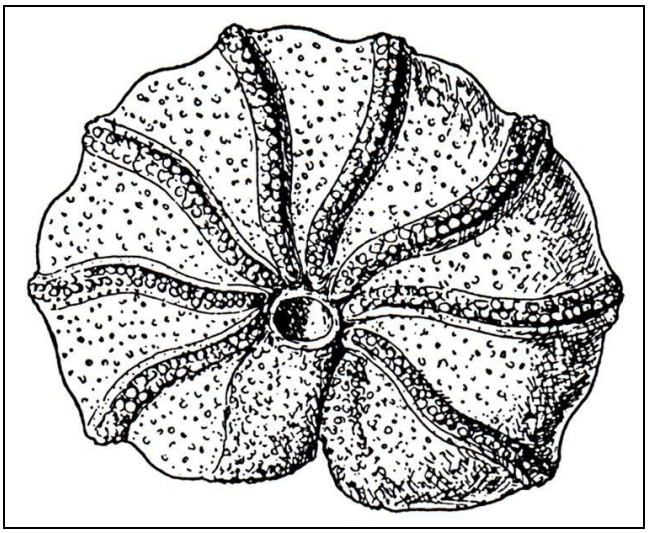


Fig. 4. *Trachysphaera costata* (after SCHUBART, 1934)

10 (9) Well developed transversal ribs forming a prominent edge with a row of granules with claviform rods; P.19 with the median lobe of the syncoxite with a tuft of long hairs (Fig. 5A, B, C); body length: 4–4.5 mm .... *Trachysphaera schmidtii* Heller, 1858

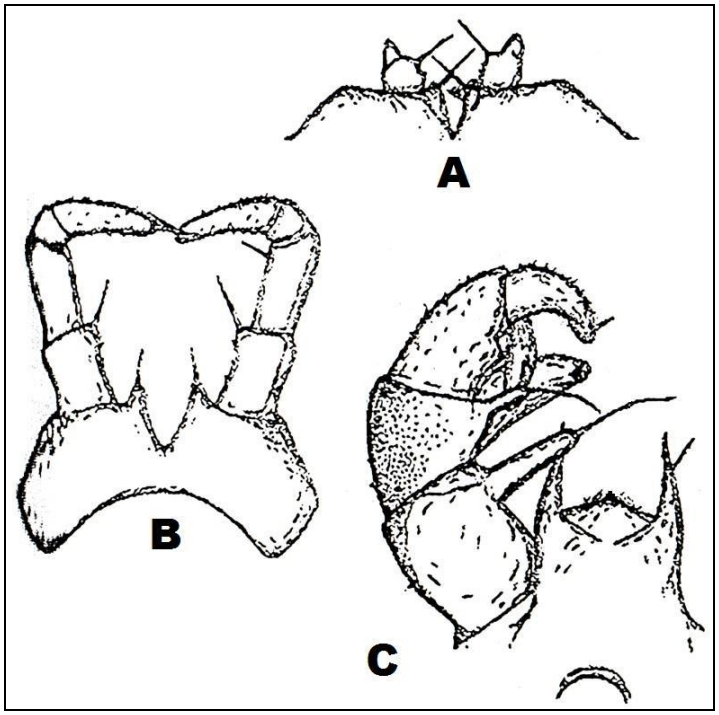


Fig. 5. *Trachysphaera schmidtii*: A. 17th leg pair; B.18th leg pair; C.19th leg pair (after TABACARU, 1990 modified).

11 (8) Barely visible, completely depigmented ocelli 12

12 (13) Pygidium with a small protuberance, more developed in males; P.19 with the syncoxite lateral horns brusquely narrowed at the basis (Fig. 6A, B, C); body length: 2.8–3.4 mm ..... *Trachysphaera dobrogica* (Tabacaru, 1960)

13 (12) Pygidium without a protuberance; P.19 with the syncoxite lateral horns gradually narrowing from base to tip 14

14 (15) P.17 telopodite with 3 articles; P.19 syncoxite median lobe with a median tubercle (Fig. 7A, B, C); body length: 3.5–3.9 mm……. ……*Trachysphaera racovitzai* (Tabacaru, 1960)

15 (14) P.17 telopodite with 2 or even one article; P.19 syncoxite median lobe without a tubercle……16

16 (17) P.19 syncoxite median lobe deeply grooved in the middle, so it seems to have two lobes (Fig. 8A, B, C); body length: 3.5–4 mm……..... …….. *Trachysphaera biharica* (Ceuca, 1961)

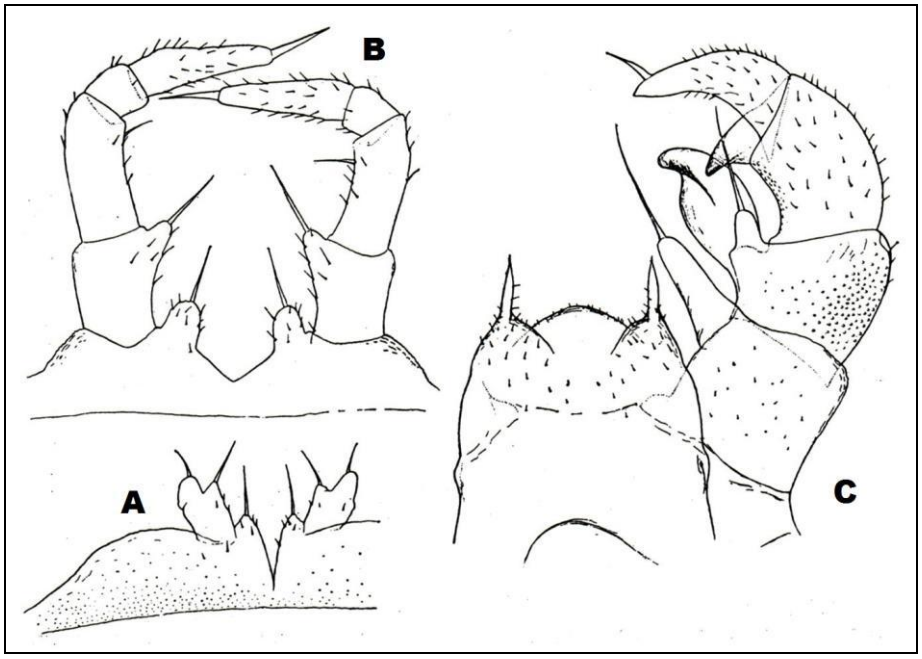


Fig. 6. *Trachysphaera dobrogica*: A. 17th leg pair; B.18th leg pair; C.19th leg pair (after TABACARU, 1960 modified).

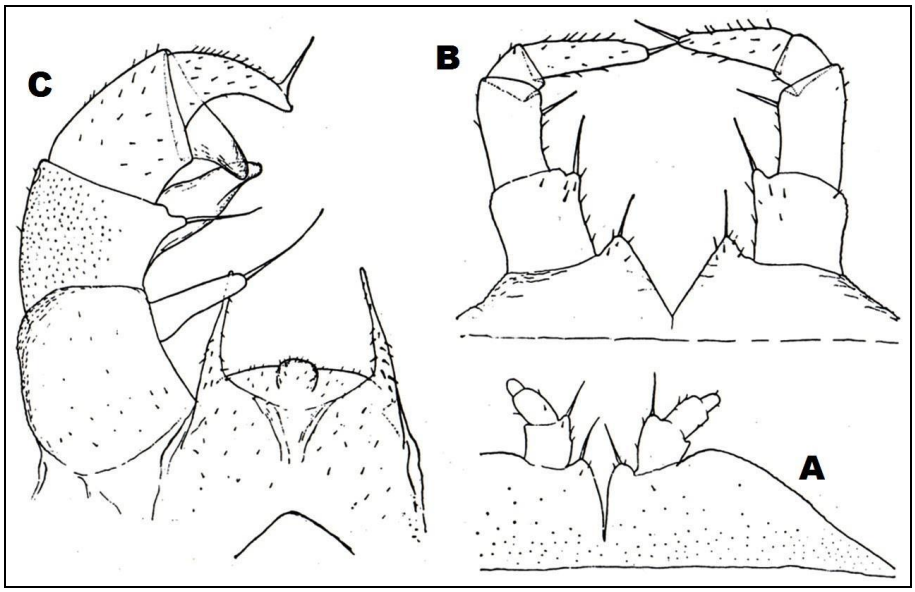


Fig. 7. *Trachysphaera racovitzai*: A. 17th leg pair; B.18th leg pair; C.19th leg pair (after TABACARU, 1960 modified).

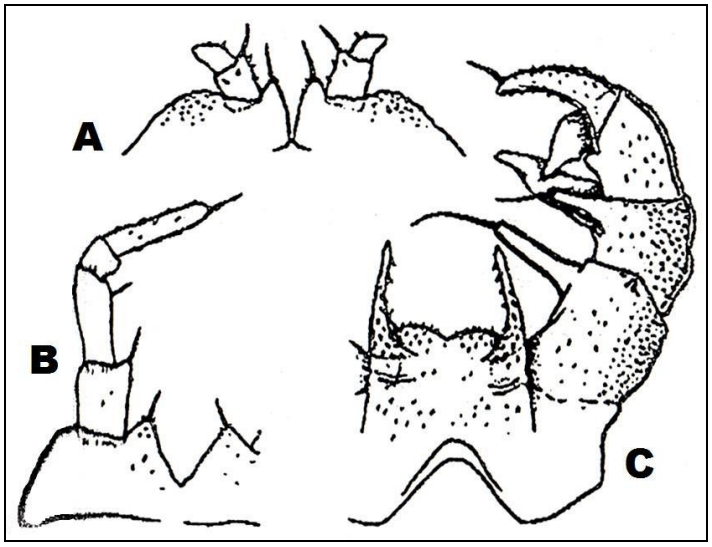


Fig. 8. *Trachysphaera biharica*: A. 17th leg pair; B.18th leg pair; C.19th leg pair (after CEUCA, 1961 modified).

17 (16) P.19 syncoxite median lobe prominent, not with two lobes..... 18

18 (19) P.18 with a rounded groove; P.19 syncoxite median lobe bulging and apically slightly grooved (Fig. 9A, B, C); body length: 4–4.7 mm……..... ……*Trachysphaera spelaea* (Tabacaru, 1960)

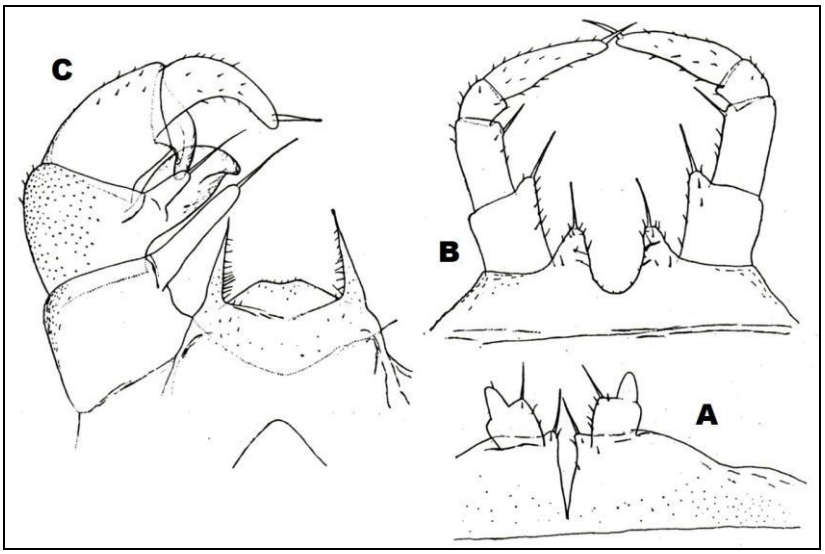


Fig. 9. *Trachysphaera spelaea*: A. 17th leg pair; B.18th leg pair; C.19th leg pair (after TABACARU, 1960 modified).

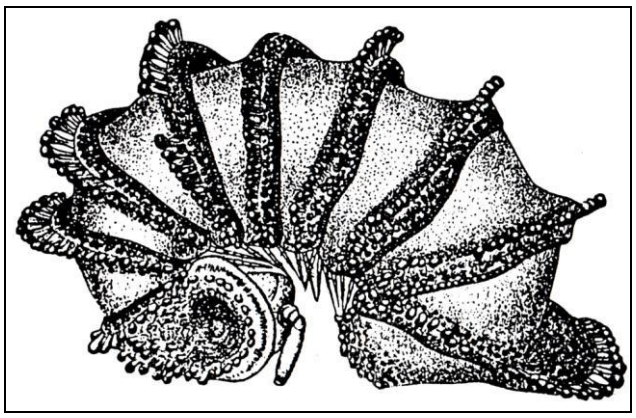


Fig. 10. *Trachysphaera orghidani* (after Tabacaru, 1958).

19 (18) P.18 with an ogival or angled groove; P.19 syncoxite median lobe prominent and without apical groove..... 20

20 (21) Transversal ribs with a high ridge, especially that from tergite 8; high, club-like rods on the ridges (Fig.10); body length: 3.5–6.8 mm…….. ……*Trachysphaera orghidani* (Tabacaru, 1958)

21 (20) Weakly developed transversal ribs with short, fragile rods (Fig.11A, B, C, D); body length: 4.5–5.7 mm…….. ……*Trachysphaera jonescui* (Brölemann, 1914)

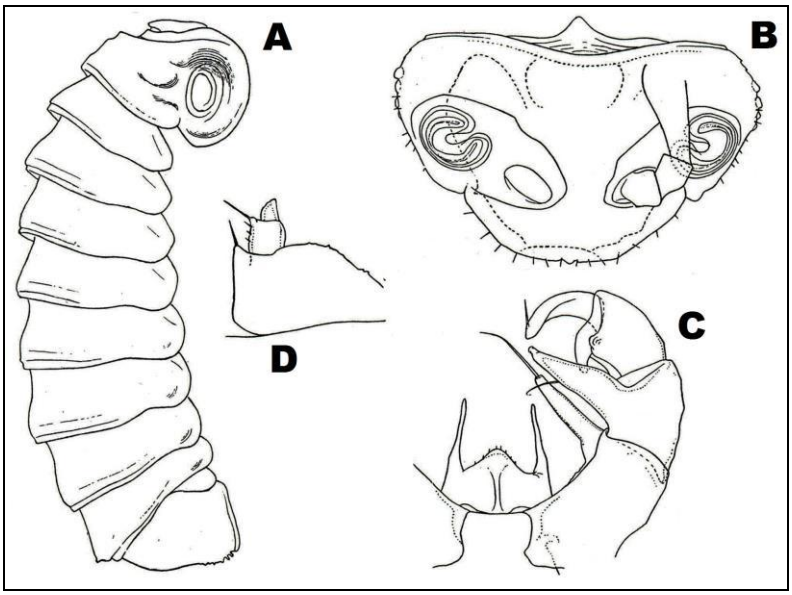


Fig. 11. *Trachysphaera jonescui*: A. habitus; B.head anterior view; C. 19th leg pair; D. 17th leg pair (after BRÖLEMANN, 1914 modified).

22 (23) Auricular foseta completely without calcareous secretions ……...*Trachysphaera jonescui tismanae* (Tabacaru, 1989)

23 (22) Auricular foseta covered by frequently merged, calcareous granules.... 24

24 (25) Transversal ribs and the metazonite (beyond the folding line in the posterior part of the prozonite) are completely covered by irregular, calcareous granules……..*Trachysphaera jonescui isvernae* (Tabacaru, 1989)

25 (24) The calcareous granules do not pass beyond the folding line in the posterior part of the prozonite ……. ……*Trachysphaera jonescui jonescui* (Brölemann, 1914)

26 (5) The male modified legs (gonopods) are situated in the anterior part of the body; body elongated, without the ability to roll into a ball; segments 2 and 3 are not merged (Infraclass **Helmintomorpha**); before the gonopods there are only 7 leg pairs, the eight pair being modified into gonopods (Subterclass **Eugnatha**) 27

27 (52) Males with only one leg pair modified for mating (gonopods), respectively the first leg pair of the 7th segment; body with 19–20 segments; ocular apparatus always absent (Superorder **Merocheta**, Order **Polydesmida**) 28

28 (31) Metezonites without lateral extensions (paranota); medially narrowed opening of the gonopodal sternites; completely separated gonopod coxae (Suborder **Strongylosomatidea**, Family **Paradoxosomatidae**) 29

29 (30) Third leg pair femur with a glandular tubercle in males; gonopod solenomere with a rounded lobe at the base and the tibiotarsal branch perpendicular on the solenomere (Fig. 12A); light brown body; body length; 8–9 mm……..... ……..*Strongylosoma jaqueti* Verhoeff, 1898

30 (29) Third leg pair femur without a glandular tubercle (Fig. 12B); solenomere without a lobe and the tibiotarsal branch is parallel with the solenomere (Fig.12C&D); dark reddish-brown body; body length: 16–23……. ……*Strongylosoma stigmatosum* (Eichwald, 1830)

31 (28) Metazonites with lateral extensions (paranota); opening of the gonopodal sternites is oval and not medially narrowed; gonopod coxae fused (Suborder **Polydemidea**) 32

32 (37) Metezonites with many irregular rows of setae; gonopodes without a hair pad (setose pulvillus) and no seminal vesicle (Family **Trichopolydesmidae**) 33

33 (34) Body with 19 segments; elongated posterior corners of the 3–17 segments upwardly curved toward the median line (Fig.13A, B); gonopodes with the prefemur continued by an acropodite divided in its distal third in two branches: a wide solenomerital branch and a narrow, curved, claw-like, tibiotarsal branch (13C); body length: 3–4 mm ..... *Napocodesmus florentzae* Tabacaru, 1975

34 (33) Body with 20 segments; posterior corners of tergites without curved elongations 35

35 (36) Leg femur in males with denticles on the internal edge; gonopodes with the prefemur continued by an acropodite divided in three branches at its half: an oval paddle, a thin and pointed solenomerital branch and a robust and much longer tibiotarsal branch (Fig.14A, B); body length: 8.5 mm……. ……*Trichopolydesmus eremitis* Verhoeff, 1898

36 (35) Leg femur without denticles; gonopodes prefemur with a solenomere enlarged like an oval paddle and a longed and apically divided tibiotarsus (Fig. 14C, D); body length: 7–7.5 mm.....*Banatodesmus jeanneli* (Tabacaru, 1980)

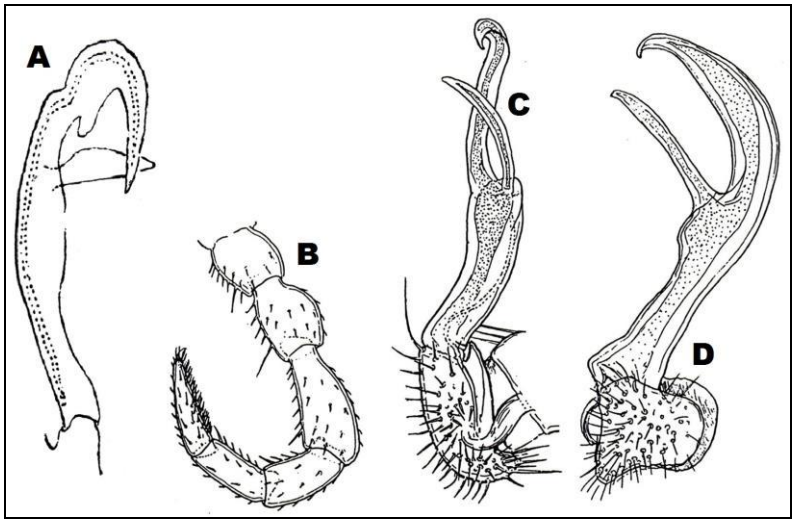
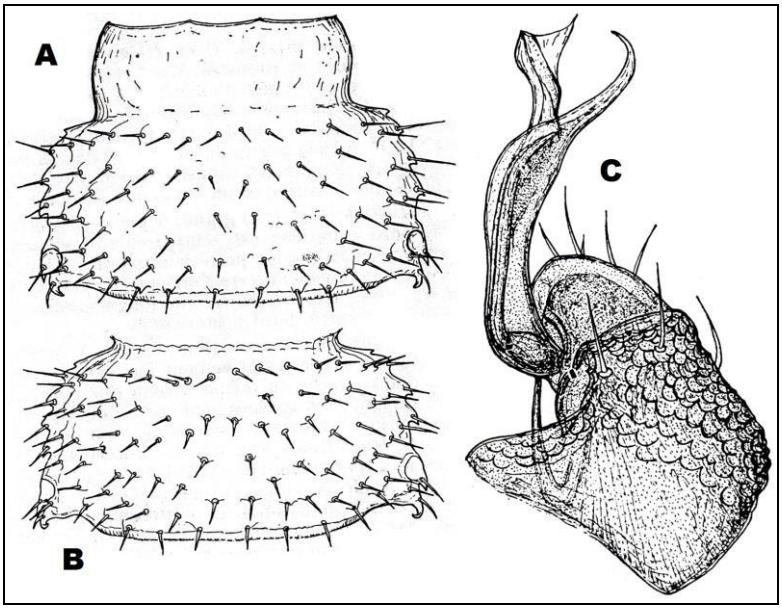


Fig.12. *S. jaqueti* (A. gonopod after ATTEMS, 1937) and *S. stigmatosum* (B. third leg; C, D. gonopod after SCHUBART, 1934).



Gig.13. *Napocodesmus florentzae*: A. 7th body segment; B. 13th body segment; C. gonopod, anterior view (after TABACARU, 1975).

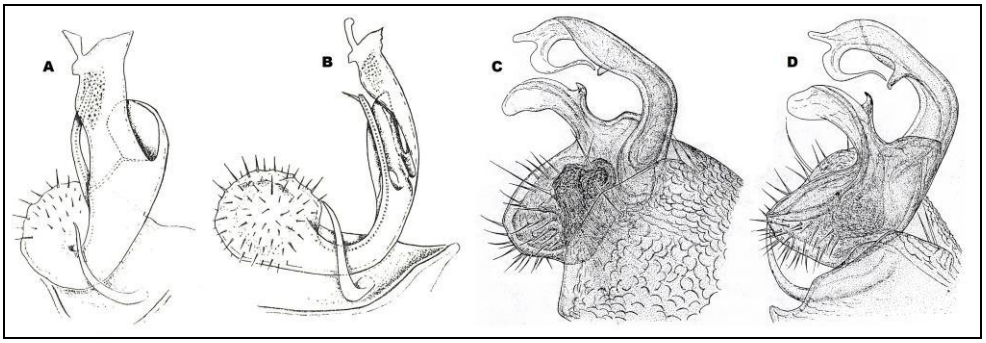


Fig. 14. *Tr. eremitis* (gonopode A. antero-mesal and B mesal view, after CEUCA, 1958) and *B. jeanneli* (gonopode C. lateral and D. mesal view, after TABACARU, 1980)

37 (32) Metazonites with three regular rows of setae; gonopodes with hair pad (setose pulvillus) and seminal vesicle (Family **Polydesmidae**)..... 38

38 (43) Body with 19 segments (Genus *Brachydesmus*)..... 39

39 (40) Gonopods with a field of robust spines on the prefemur (Fig. 15A); white or greyish-white color; body length: 6.5–0.5 mm…….. ……*Brachydesmus* (*Stylobrachydesmus*) *dadayii* Verhoeff, 1895

40 (39) Gonopods without a field of robust spines on the prefemur 41

41 (42) Gonopods with the narrow telopodite not divided into a femoral and a tibiotarsal branch (Fig. 15B); greyish-white, sometimes with a pinkish hue, color; body length: 7.9–9.5 mm…….....… ……*Brachydesmus* (*Eubrachydesmus*) *superus* Latzel, 1884

42 (41) Gonopods with robust telopodite, divided into a femoral and a tibiotarsal branch (Fig. 15C); white or yellowish-white color; body length: 9–10.5 mm ……*Brachydesmus* (*Brachydesmus*) *troglobius* Daday, 1889

43 (38) Body with 20 segments (Genus *Polydesmus*)..... 44

44 (47) Narrow gonopods without a seminal branch (solenomere) distinct from the tibiotarsus (Subgenus *Spanobrachium*)..... 45

45 (46) Gonopods with the hair pad (setose pulvilus) placed on a spur, parallel with it is a robust spine (endomerite) (Fig. 16A); uniformly arched anterior edge of the gonopode; completely white color; body length: 8.4 mm……. ……...*Polydesmus* (*Spanobrachium*) *oltenicus* Negrea & Tabacaru, 1958

46 (45) Gonopods with the hair pad (setose pulvilus) directly on the tibiotarus (not on a spur) lacking a robust spine (Fig. 16B); a wide, rounded lobe on the anterior edge of the gonopode, after the constriction between the prefemur and femur; white, with a slight yellowish hue, color; body length: 10.7 mm…… ……...*Polydesmus* (*Spanobrachium*) *dumitrescui* Negrea & Tabacaru, 1958

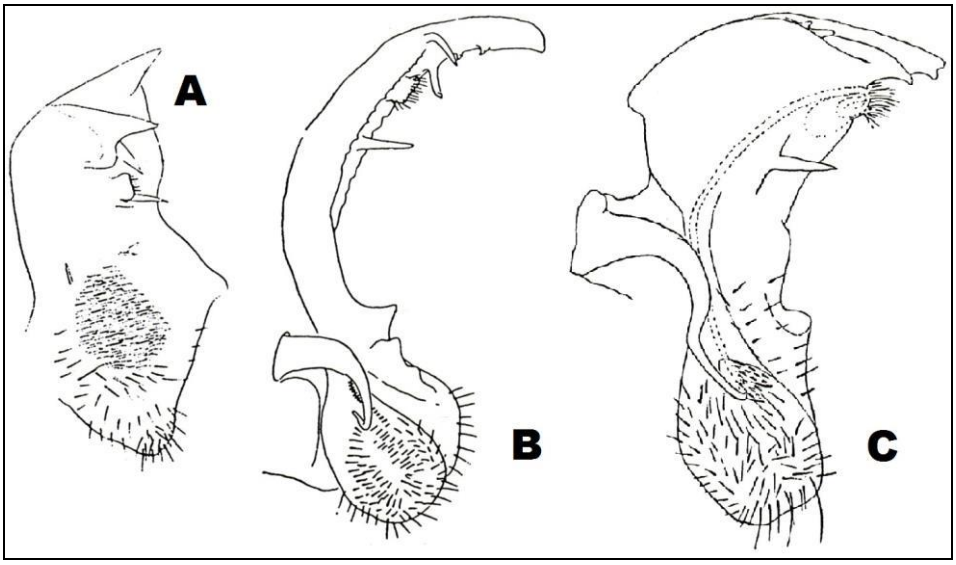


Fig. 15. *Br*. *dadayii* (A), *Br*. *superus* (B) and *Br*. *troglobius* (C) (after ATTEMS, 1940).

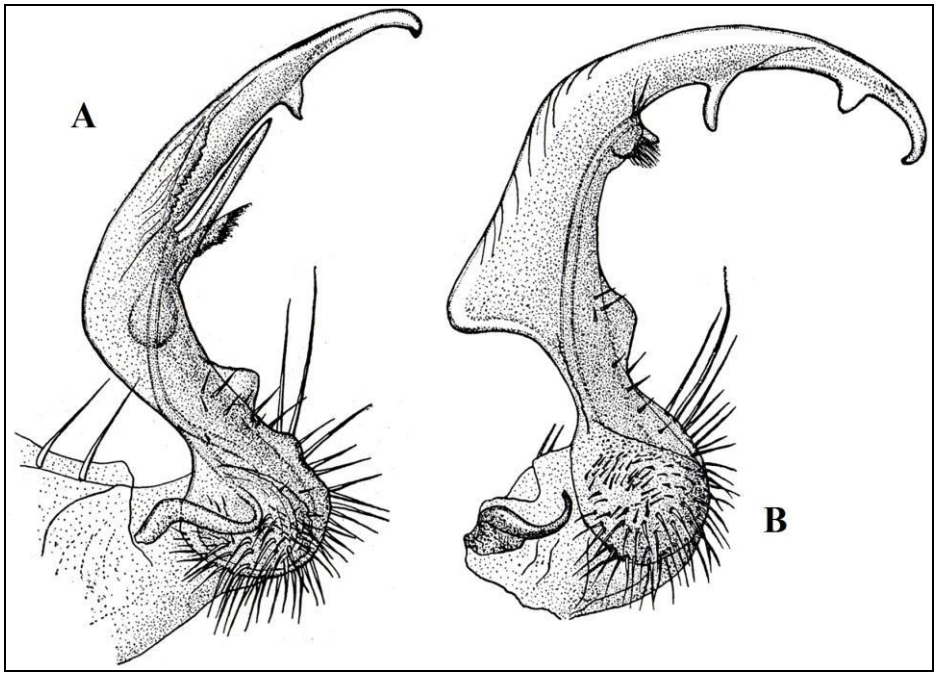


Fig. 16. *P*. *oltenicus* (A) and *P*. *dumitrescui* (B) (after NEGREA &TABACARU, 1958).

47 (44) Gonopods with a seminal branch (solenomere) distinctly from the tibiotarsus..... 48

48 (49) Gonopods with a clear demarcation between the femur and tibiotarsus (Subgenus *Nomarchus*); tibiotarsus presents on the curve a triangular tooth, more robust than the end part of the tibiotarsus (Fig.17A, B,C); brick-red-brownish color; body length: 13–18 mm……..... ……*Polydesmus* (*Nomarchus*) *subscabratus* Latzel, 1884

49 (48) Gonopods with the femur continued by the tibiotarsus without a clear demarcation between the femur and the tibiotarsus (Subgenus *Polydesmus*)..... 50

50 (51) Gonopods with a small tooth on the anterior edge; after the curve, the tibiotarsus is not widened into an angular lamella (Fig. 18A); brick-red color; body length: 21–23mm……..... .....*Polydesmus (Polydesmus) montanus* Daday, 1889

51 (50) Gonopods without a tooth on the anterior edge; after the curve, the tibiotarsus is greatly enlarged into a triangular blade (Fig. 18B, C); pale brick-red color; body length: 8.3–0.5 mm……..…… ……..*Polydesmus* (*Polydesmus*) *microcomplanatus* Negrea & Tabacaru, 1958

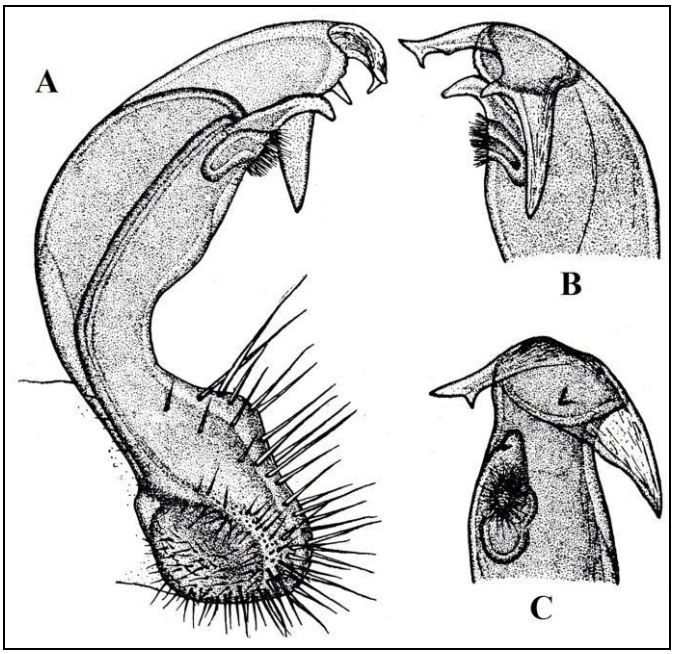


Fig. 17. *P. subscabratus*: left gonopode, mesal view (A); gonopode tip, lateral view (B); gonopode tip, posterior view (C) (after TABACARU & NEGREA, 1961)

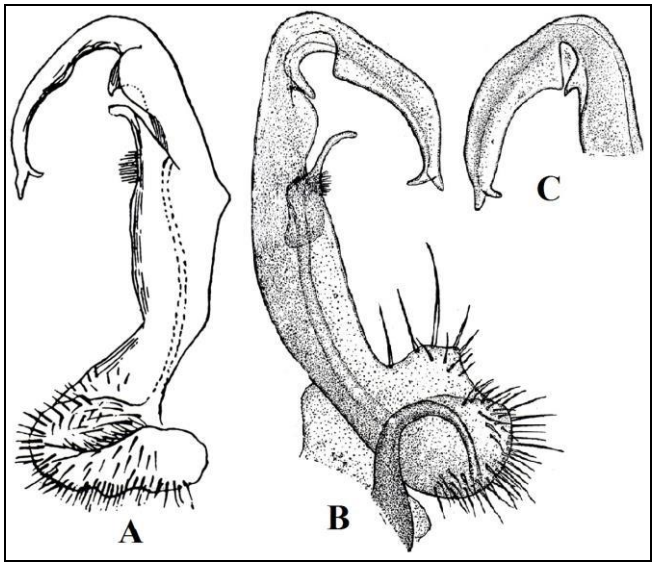


Fig.18. *P.montanus* (A, after ATTEMS, 1940) and *P. microcomplanatus* (B, C) (after NEGREA & TABACARU, 1958)

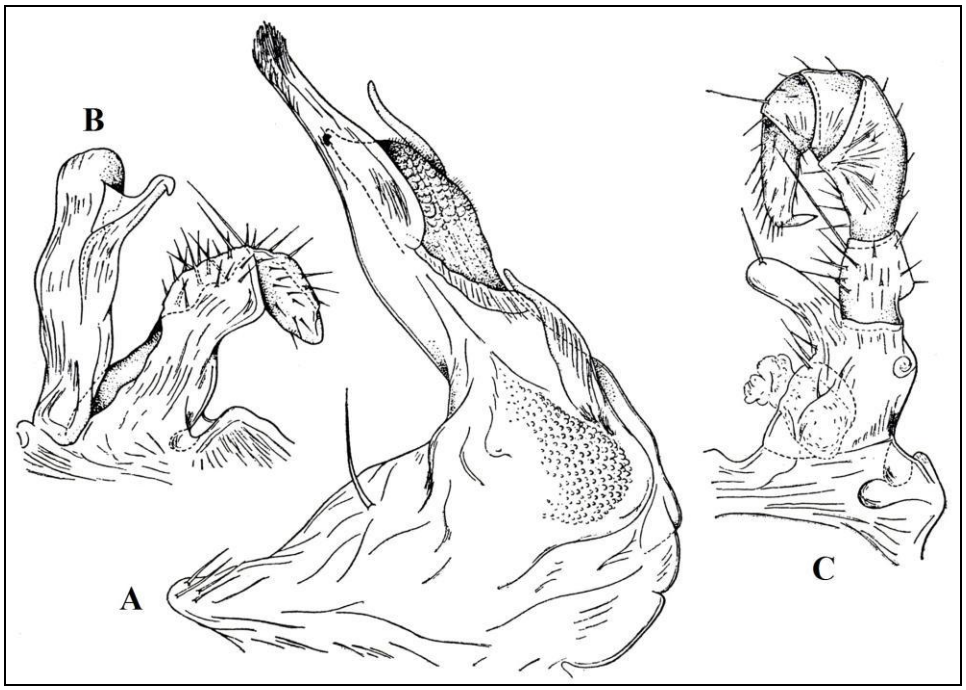


Fig. 19. *H. cavernicola*: anterior gonopode (A); posterior gonopode (B); 8th leg pair (C) (after CEUCA, 1967).

52 (27) Males with two pairs of legs modified for mating (P.8 – anterior gonopods and P.9 – posterior gonopods or paragonopods); body with at least 26 segments; ocular apparatus generally present (reduced or absent in troglobionts) 53

53 (64) Pre-anal segment with a pair of spinning organs (spinnerets); no repugnatory glands (foramina repugnatoria); most frequently, body with 28 or 30 segments (Superorder **Nematophora**, Order **Chordeumatida**) 54

54 (57) Tarsal papillae on male leg pairs 3–7; segment VIII first leg pair (P.10) with a coxal process in males (Family **Haaseidae**); body with 28 segments 58

55 (56) Anterior gonopods with pseudo-flagellum; posterior gonopods with the coxal process longer than the femur; segment VIII first leg pair with thickened articles (Fig.19A, B, C); completely white body; without ocelli; body length: 8.5 mm ……...……*Hylebainosoma cavernicola* (Ceuca, 1967)

56 (55) Anterior gonopods without pseudo-flagellum but with an opercular appendix (epithema) and a toothed blade (keratit) with 4–5 teeth; posterior gonopods with the coxal process much shorter than the femur; segment VIII first leg pair articles are not thickened (Fig. 20A, B, C); yellowish-white body with a weak reddish-brown pigmentation; 9–10 pigmented ocelli forming a triangle; body length: 8.5–10 mm .....*Haasea hungaricum orientale* (Tabacaru, 1965)

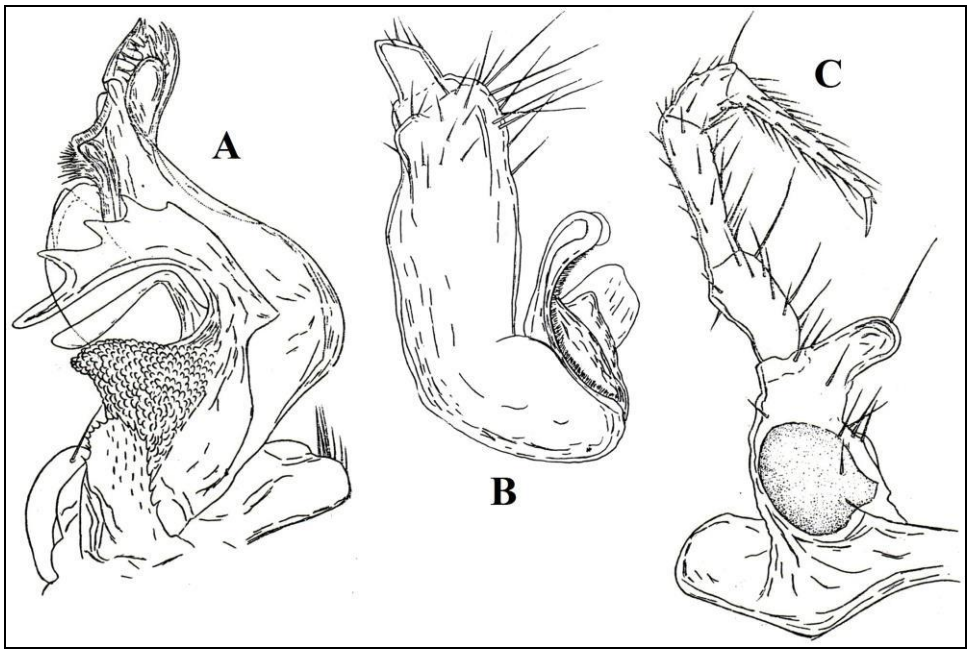


Fig. 20. *H. hungaricum orientale*: anterior gonopode (A); posterior gonopode (B); 8th leg pair (C) (after TABACARU, 1965 modified).

57 (54) Male leg pairs 3–7 lack tarsal papillae; segment VIII second leg pair (P.11) with a coxal process in males (Family **Anthroleucosomatidae**); body with 30 segments..... 58

58 (59) Anterior gonopods with a single median process (Fig.21A, B); posterior gonopods without sternal median processes and without telopodites but with a pair of membraneous, paramedian processes with hairs (colpocoxitae) and a pair of longer, chitinous and recurved lateral processes (angiocoxitae) (Fig. 21C); white body lacking pigment but with 13, pigmented ocelli forming a triangle; body length: 14–14.5 mm..... *Banatosoma ocellatum* (Tabacaru, 1967)

59 (58) Anterior gomopods with two paramedian processes instead of a single median process; posterior gonopods with a median sternal process and with rudimentary telopodites; completely depigmented body and without ocelli 60

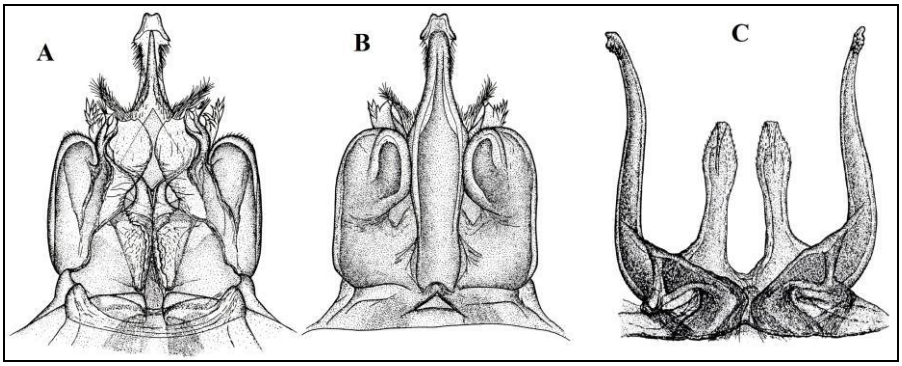


Fig. 21. *Banatosoma ocellatum*: anterior gonopode, anterior view (A) and posterior (B); posterior gonopode (C) (after TABACARU, 1967).

60 (61) Anterior gonopods with the two paramedian processes merged at their base in a narrow common unit (Fig. 22A, B); posterior gonopods have a very narrow median sternal process with a membraneous coxal process on each side (colpocoxitae) (Fig.22C); posterior gonopods telopodites reduced to a stump made of 4 articles; body length: 14 mm……..……*Dacosoma motasi* Tabacaru, 1967

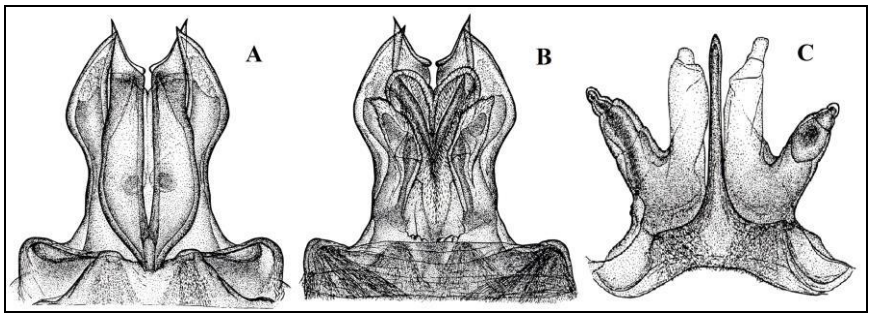


Fig. 22. *Dacosoma motasi*: anterior gonopode, anterior view (A) and posterior (B); posterior gonopode (C) (after TABACARU, 1967).

61 (60) Anterior gonopods with two independent paramedian processes; posterior gonopods with a robust median sternal process and lacking coxal processes; rudimentary posterior gonopods telopodites laterally placed on a femoroid (Genus *Anthroleucosoma* Verhoeff, 1899)..... 62

62 (63) Leg pairs 3–7 are thin and unmodified (Subgenus *Anthroleucosoma* s.str.) anterior gonopods lateral processes (telopodites or angiocoxites) narrower than the width of the syngonopode (Fig. 23A, B, C) ……..... .....*Anthroleucosoma banaticum* Verhoeff, 1899

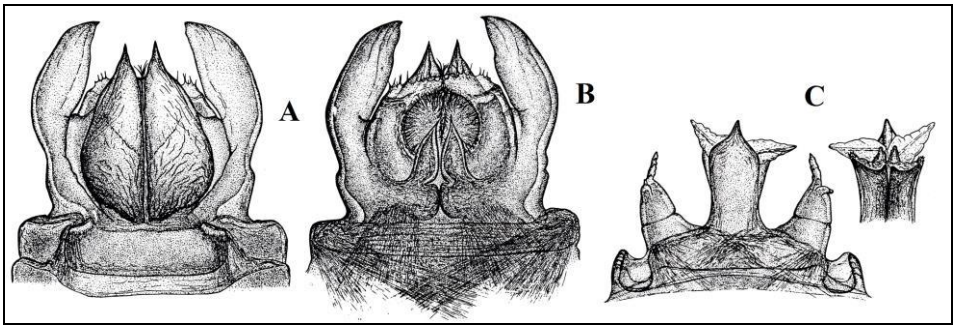


Fig. 23. *Anthroleucosoma banaticum*: anterior gonopode, anterior view (A) and posterior (B); posterior gonopode (C) (after TABACARU, 1967).

63 (62) Leg pairs 3–7 are thick and modified (Subgenus *Heteranthroleucosoma* Ceuca, 1964); anterior gonopods lateral processes (telopodites or angiocoxites) longer than the width of the syngonopode (Fig. 24A, B)……..... .....*Anthroleucosoma spelaea* Ceuca, 1964

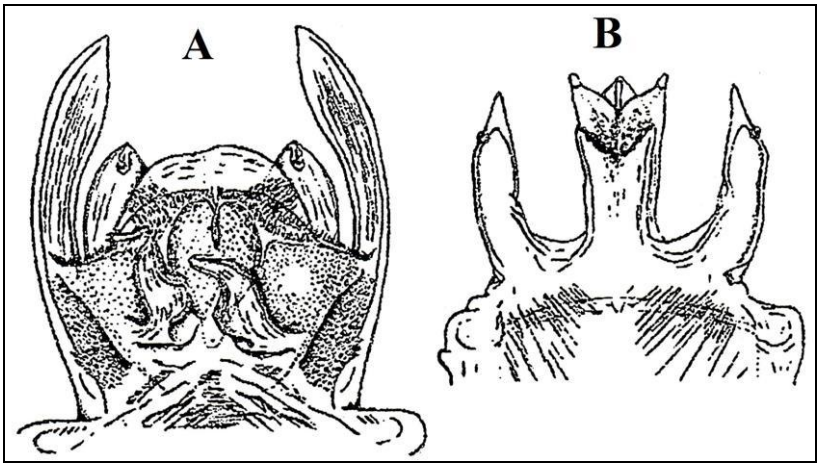


Fig. 24. *Athroleucosoma spelaea*: anterior gonopode, posterior view (A); posterior gonopode (B) (after CEUCA, 1964).

64 (53) Without spinning glands (spinnerets); with defence/repugnatory glands beginning from segment 6 up to the apodous segments (Superorder **Juliformia**, Order **Julida**) 65

65 (66) Promentum long, completely separating the lamellae linguales; gonopods freely projecting from the 7th segment (Family **Blaniulidae**); in males, the hook-like leg pair 1 with a pointed apophysis with two tips on the tibia; anterior gonopods with two long, paramedian coxal processes; posterior gonopods apically divided into two lamellae (Fig. 25A, B,C); grey-brown body with 30–51 segments; 5–10 pigmented ocelli; body length: 5.5–13 mm……..... .....*Nopoiulus kochii* (Gervais, 1847)

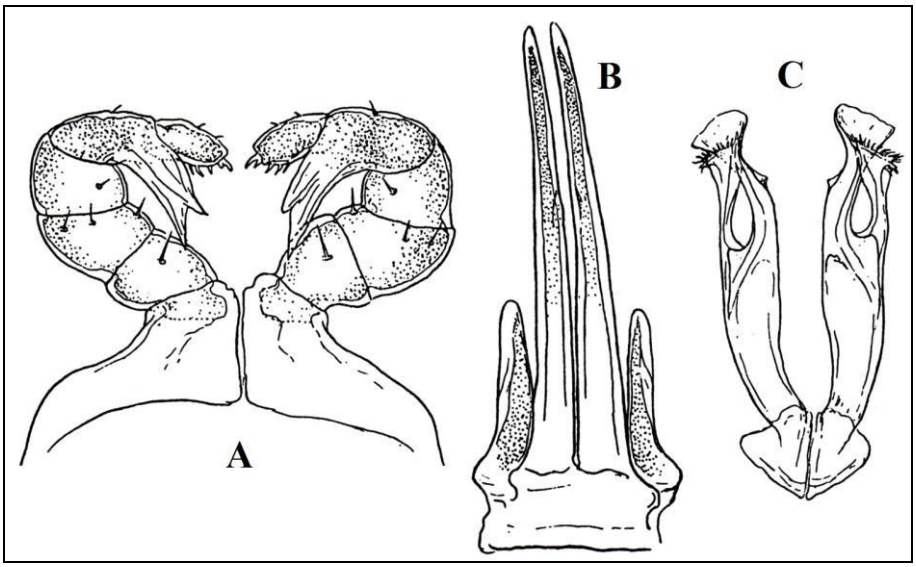


Fig. 25. *Nopoiulus kochii*: A. male first leg pair; B. anterior gonopods; C. posterior gonopods (after SCHUBART, 1934).

66 (65) Short, rhombic promentum separating the lamellae linguales only at their base; main part of the gonopods retracted in the 7th segment (Family **Julidae**)....67

67 (68) With ocelli; in males the first leg pair with three processes (femoral-tibial- and tarsal processes) (Fig. 26A, B, C); body with 56 segments, body length: 14 mm .....*Stenophyllum tabacarui* Vănoaica, 2003.

68 (67) Without ocelli; in males the first leg pair simple, hook-like..... 69

69 (76) Anterior gonopods with flagellum 70

70 (73) Gonopods with a distinct mesomerite, separated from the opisthomerite..... 71

71 (72) Labrum with three teeth; promerite internal lobe without setae; mesomerite apically mace-like and with small teeth; opisthomerite without a

posterior spur (Fig. 27A, B); body with 46–64 segments; body length: 23–45 mm ……..*Typhloiulus strictus* (Latzel, 1882)

72 (71) Labrum without teeth; promerite internal lobe with 3–6 setae; apically narrowed mesomerite without small teeth; opisthomerite with a posterior spur; body with 29–35 segments (Fig. 27C, D); body: 13–16 mm……..... ……..*Typhloiulus serbani* (Ceuca, 1956)

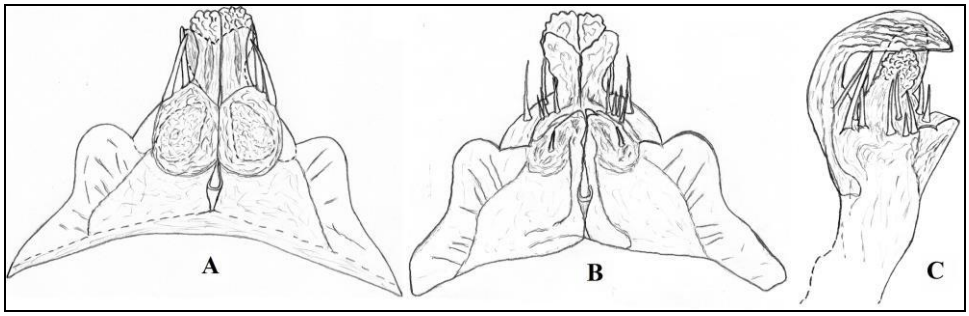


Fig. 26. *Stenophyllum tabacarui*: male first leg pair, anterior (A), posterior (B) and lateral view (C) (after VĂNOAICA, 2003, modified).

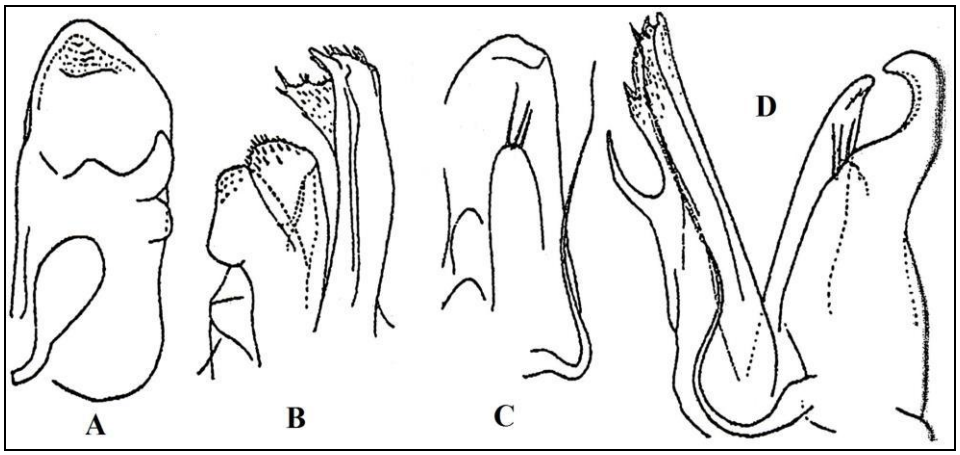


Fig. 27. *Typhloiulus strictus*: A. promerite; B. mesomerite and opisthomerite, lateral view and *Typhloiulus serbani*: C. promerite; D. gonopodes, mesal view (after STRASSER, 1962 modified).

73 (70) Gonopodes without a distinct mesomerite; the mesomerite is fused with the opisthomerite..... 74

74 (75) Head with 2 long occipital setae; promerite without an apically narrowed prolongation; flagellum shorter than the opisthomerite; a fringed, curved blade (vellum) on the anterior side in the distal part of the opisthomerite (Fig. 28A, B, C); body with 44–55 segments; body length: 13–23 mm……... ……..…*Lamellotyphlus mehedintzensis* (Tabacaru, 1967).

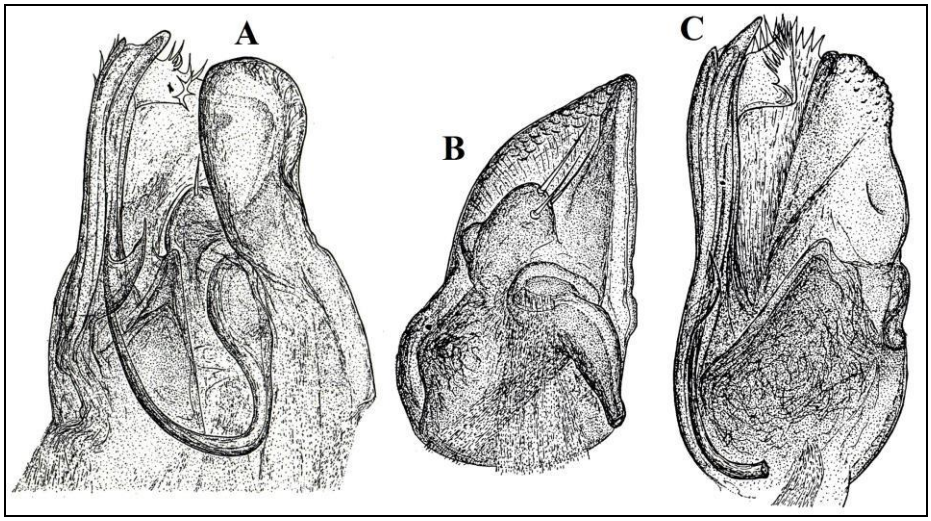


Fig.28. *Lamellotyphlus mehedintzensis*: A. gonopodes, mesal view; B. promerite; C. posterior gonopode, mesal view (after TABACARU, 1976 modified).

75 (74) Head without occipital setae; promerite with a narrow apical prolongation in the median part; robust flagellum longer than the opisthomerite; opisthomerite without a curved blade (vellum) in the distal part (Fig. 29A, B, C); body with 35 segments; body length: 7.5 mm……. ……...*Banatoiulus troglobius* Tabacaru, 1985

76 (69) Anterior gonopods without flagellum 77

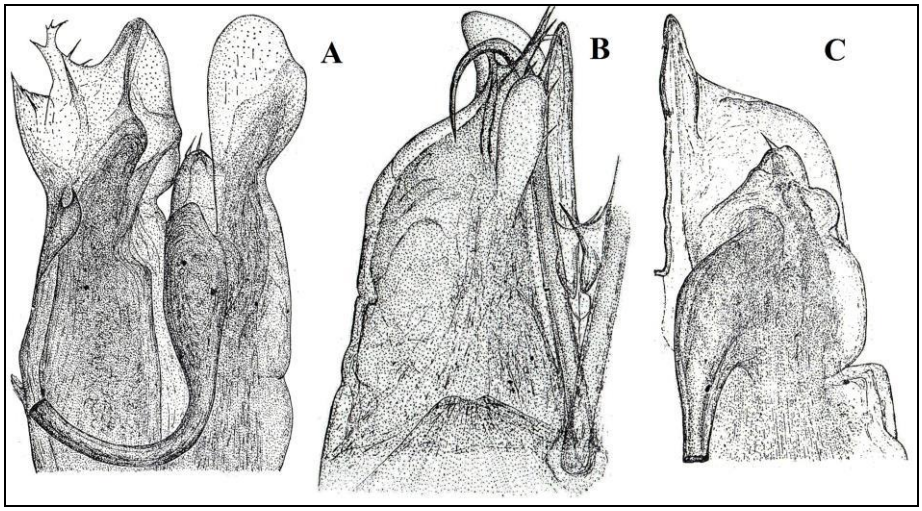


Fig. 29. *Banatoiulus troglobius*: gonopodes, mesal view (A) and posterior view (B) and the promerit (C) (after TABACARU, 1985).

77 (78) Head with two long occipital setae; labrum with 4 supra-labral spines; posterior gonopods with a mesomerital process; opisthomerite apically divided in three lobes (Fig. 30A, B); body with 36 segments; body length: 7.5 mm …..……*Geopachyiulus negreai* Tabacaru, 1978

78 (77) Head without occipital setae; labrum with 8–13 supra-labral spines; posterior gonopods without a mesomerital process but with a spermatic foseta and a pseudo-flagellum; opisthomerite apically not divided in three lobes (Fig. 30C, D); body with 42–44 segments; body length: 15–16 mm……..…..... ……...…*Apfelbeckiella dobrogica* Tabacaru, 1966

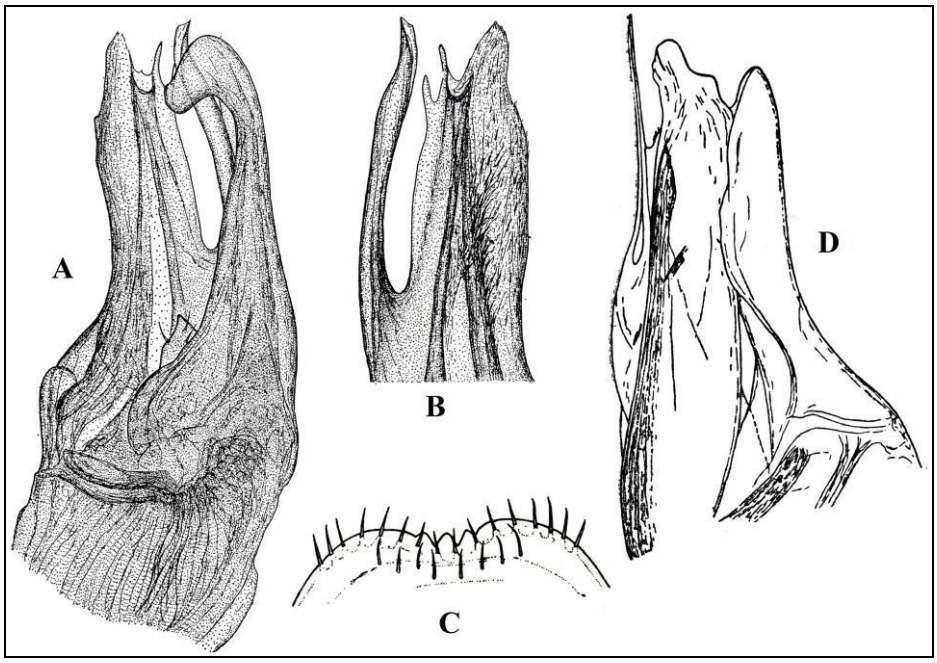


Fig. 30. *Geo*. *negreai* (A. gonopodes, mesal view; B.posterior gonopode, lateral view) (after TABACARU, 1978 modified) and *Apf. dobrogica* (C. labrum; D. gonopodes, lateral view) (after TABACARU, 1966 modified).

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