On Main families of millipedes (Myriapoda, Diplopoda) found in south of the 6th parallel North in Cameroon: conservation importance

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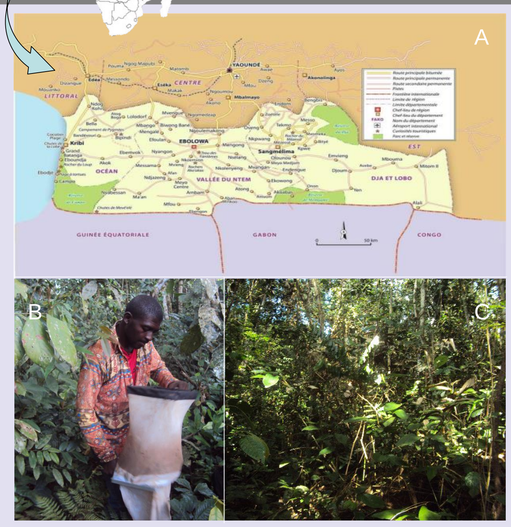

Introduction

Millipedes (Myriapoda, Diplopoda) form a very diverse taxa of terrestrial Arthropods. According to Shelley (2003) this litter dwelling invertebrate has 16 Orders and 146 families with about 12,000 millipede species globally. There have been used for bio-indication of environmental changes (Paoletti et al., 2007). Their propriety for environmental studies is based on their limited dispersal capacities; they are wingless and they move relatively slowly. Furthermore, they are easy to collect by hand or using traps like “pitfall traps”; they can also be extracted from the litter using a Winkler-Mocsarski apparatuses and/or Berlese funnels.

Despite their abundance and ecological importance they are relatively poorly studied particularly in African continent. For most researchers, identification even to family level often requires the assistance of experts. This work presents the main families recently found in South Cameroon and a table with all genera and species of millipedes known from Cameroon is given.

***Figure 1**: A, map of south Cameroon; B, sieving; C, disturbed secondary forest from Zamakoe*

Taxonomy

CLASS DIPLOPODA de Blainville in Gervais, 1844
Subclass PENICILLATA Latreille, 1831
Order Polyxenida Verhoeff, 1934
Family Polyxenidae Lucas, 1840

Small millipedes with the bodies coved by a fields of macrosetae (fig,A).

Subclass CHILOGNATHA Latreille, 1802
Subterclass Eugnatha Attems, 1898
Order Spirobolida Cook, 1895
Family Pachybolidae Cook, 1897

Very large millipede with a long cylindrical body. Leg with two penultimate joints subequal (fig.G).

Order Spirostreptida Brandt, 1833
Family Odontopygidae Attems, 1909b

Slender bodies millipeds with each anal valve tipped with a small tooth or spines on the upper surface (fig.E).

Family Spirostreptidae Pocock, 1894

Millipedes with elongate cylindrical bodies comprising 40-70 body rings and anal valves smooth without teeth or spine (fig.F).

Order Stemmiulida Cook, 1895
Family Stemmiulidae Pocock, 1894

Presence of one or two large convex ocelli on each side of the head(fig.D).

Order Polydesmida Pocock, 1887
Family Chelodesmidae Cook, 1895

Second segment of legs without ventrodistal spine; body form more slender, paranota separated at midbody (fig.I).

Family Gomphodesmidae Cook, 1896

Cranium without epicranial setae. Metaterga smooth and glabrous. Epiproct small schort, subconical (fig.J).

Family Oxydesmidae Cook, 1895

Polydesmoids with a row of series or small field of short dorsomesad to antennal sockets.; epiproct apically broadened with prominent lateral tubercules (fig.H).

Family Paradoxosomatidae Daday, 1889

Family caraterize by paraterga of the 2 nd segment of bodie lie below the collum and very long legs (fig.C).

Family Pyrgodesmidae Silvestri, 1896

Small-bodied Polydesmidea incapable of enrolling into a spiral; collum usually covering head in dorsal view (fig.B) .

Family Cryptodesmidae Karsch, 1880

Polydesmoids with high, horizontal paranota and a large collum completely covering the head (fig.K).

Family Trichopolydesmidae Verhoeff, 1910

Small polydesmidans (ca 2–20 mm long). Tegument microalveolate, paraterga from absent to strongly developed (fig.L).

Table 1: List of millipedes species already known from Cameroon

Taxa	Taxa	Taxa	Taxa
Order Polyxenida Verhoeff, 1934	*Odontostreptus sjoestedti* (Porat, 1894)	*Eurydesmus mossambicus* (Peters, 1855)	*Lacnodesmus campi* (Cook, 1895)
Family Polyxenidae Lucas, 1840	*Odontostreptus intricatus* (Voges, 1878)	*Basacantha tuberculifer* (Loksa 1967)*	*Scystodesmus valdaui* (Porat, 1894)
Polyxenidae gen. sp.*	*Ophistreptus digitulatus* (Brölemann, 1926)*	Kyphopyge granulosa Attems, 1931	*Scystodesmus Kribi* (Cook, 1896)
Order Spirobolida Cook, 1895	*Spirostreptus sinuaticolis* Porat, 1894	*Parademus sanguinicornis* (Porat, 1892)	Family Paradoxosomatidae Daday, 1889
Family Pachybolidae Cook, 1897	*Spiropoeus fischeri* (Brandt, 1833)	*Paracordyloporus porati* Verhoeff, 1938	*Scolodesmus grallator* (Cook, 1896)*
Pachybolus eixcsus (Cook, 1897	*Odontostreptus aff. colicoferus* (Attems 1914)*	*Paracordyloporus porati papillatus* Attems, 1931	*Scolodesmus scutigerinus* (porat, 1894)
Amblybolus spp*	*Odontostreptus rugistriatus* (Porat, 1893)	*Paracordyloporus vitiosus* Attems, 1931	*Scolodesmus Porati* (Mauriès, 1967)
Family Spirobolidae	*Orthoporus levigatus* (Attems, 1950)	*Paracordyloporus makokanus* Mauriès, 1967*	Family Pyrgodesmidae Silvestri, 1896
Paraspirobolus lucifugus (Gervais, 1836)	*Spirostreptus bibundinus* (Attems, 1914)	*Paracordyloporus occupatus* (Attems, 1938)	*Urodesmus erinaceus* Porat, 1894
Spirobolus laeviventris (Porat, 1892)	*Spirostreptus procerus* (Gerstäcker, 1873)	*Paracordyloporus trissolabis* Hoffman, 1963	*Urodesmus . sexcarinatus* Porat, 1894,
Spirobolus pulvillatus Newport, 1894	*Spirostreptus propinquus* (Porat, 1893)	*Diaphorodesmus dorsicornis* Porat, 1894	*Urodesmus camerunensis* (Silvestri, 1927)
Spirobolus angusticollis Karch, 1881	*Spirostreptus servatius* (Attems, 1914)	*Diaphorodesmus attemsi* Verhoeff, 1938	*Urodesmus cornutus* Golovatch *et al*., 2015
Spirobolus laeticollis Porat, 1894	*Spirostreptus sulcatus* (Voges, 1878)	*Diaphorodesmoides lamottei* VandenSpiegel et al.2016	*Monachodesmus longicaudatus* Golovatch *et al*., 2015
Trigoniulidae	*Telodeinopus bibundinus* (Attems, 1914)	Family Gomphodesmidae Cook, 1896	*Monachodesmus armorum* Golovatch *et al*., 2015
Thrinciulus laevicollis (Porat, 1894)	*Telodeinopus canaliculatus* (Porat, 1894)	*Tymbodesmus figlinus* (Cook, 1897)	*Monachodesmus* lentus Silvestri, 1927
Order Spirostreptida Brandt, 1833	*Urotropis carinatus* (Porat, 1894)	*Tymbodesmus* sp.	*Monochodesmus spurcus* Silvestri, 1927
Family Odontopygidae Attems, 1909	*Urotropus atrata* (Porat, 1894)	*Tymbodesmus vidua* (Cook, 1899)	*Udodesmus camerunensis* Golovatch *et al*., 2015
Coenobothrus bipartitus (Porat, 1894)	*Urotropis porathi* (Demange, 1973)	Family Oxydesmidae Cook, 1895	*Cordylonotum formicarium* (Attems, 1952)
Odontopyge trivialis Porat, 1894	*Urotropis trachyura* (Porat, 1894)	*Crystallomus thyridotus* (Cook, 1896)	Cryptodesmidae
Odontopyge grandis Porat,1894	*Urotropis propinqua* (Porat, 1893)	*Crystollomus Schoutedini* (Attems, 1937)	*Aporodesmus crinitus* Porat,1894
Odontopyge ecarinata Porat,1894	*Porostreptus multicostis* (Porat, 1894)	*Coromus vittatus* (Cook, 1896)	*Aporadesmus cupulifer* Porat,1894
Odontopyge accincta Porat, 1894	*Rhopalopoditius molleri* (Verhoeff, 1892)	*Coromus vitatus kalanatus* (Attems,1931)	*Aporadesmus falcatus* Porat, 1894
Patinatiella uncinata (Porat, 1894)	Order Stemmiulida Cook, 1895	*Coromus granulosus* (Beauvois, 1805)	*Aporodesmus gabonicus* (Lucas, 1858)
Family Spirostreptidae Pocock, 1894	Family Stemmiulidae Pocock, 1894	*Coromus inhonestus* (Attems, 1931)	*Aporaodesmus knutsoni* Porat,1894
Spirostreptus crenulatus Porat, 1894	*Stemmiulus proximatus* (Silvestri, 1916)	*Coromus thomsoni* (Lucas, 1858)	*Aporadesmus kuako* Porat,1894
Kartinicus colonus Attems, 1914*	*Stemmiulus camerunensis* (Silvestri, 1916)	*Coromus barombi* (Cook, 1896)	*Aporodesmus limacinus* Porat, 1894
Kartinicus colonus colonus Attems,1914*	*Stemmiulus beroni* Mauriès, 1989*	*Exochoromus grandicollis* Hoffman ; 1990	*Aporodesmus perlatus* Porat, 1894
Kartinicus australis, Attems, 1914*	*Stemmiulus nigricolis* Porat,1894	*Exochoromus teaniatus* Hoffman ; 1990	*Aporadesmus subrectangulus* Porat,1894
Kartinikus colonus denticulatus (Attems, 1914)*	*Stemmuilus infuscatus* Mauriès 1989	*Exochoromus petasatus* Hoffman ; 1990	*Aporodesmus spinatus Porat*, 1894
Kartinikus laevis (Voges, 1878)	Order Polydesmida Pocock, 1887	*Exochoromus tuberculifron* (Porat, 1893)	Trychopolydesmidae
Lemostreptus tuberculosus (Porat, 1894)	Famille des Chelodesmidae	*Exochoromus johnstoni* (Cook ; 1896)	*Parademus integratus* Porat 1894
Lophostreptus poriger (Verhoeff, 1941)	*Anisodesmus erythropus* (Lucas, 1858)	*Heptadesmus granulatus* (Verhoeff, 1938)	
Scaphiostreptus aff. parilis Karsch, 1881*	*Anisodesmus latus* (Verhoeff, 1938)	*Heptadesmus orator* (Hoffman, 1982)	
Spirostreptus pancratius Attem, 1914*			

*: Newly reported species of millipedes in Cameroon

***Figure 2**: Main family of diplopoda found in South Cameroon* (A: Polyxenidae gen. sp., B: *Stylodesmus horridus*, C: *Scolodesmus porati*, D: *Stemmiulus beroni*, E: *Peridontopyge trauni*, F: *Scaphiostreptus aff. parilis* , *G: Pachybolus eixcsus, H : Crystallomus thyridotus* , *I: Kyphopyge* sp., *J: Tymbodesmus figlinus* , *K: Aporodesmus falcatus and L: Sphaeroparia* sp.)

Importance of millipedes and implications for conservation

Climate changes and other environmental factors resulting from human activities such as land use changes and forest fragmentation have already affected and will increasingly affect animal species, especially poikilotherms which are in contact with soil litter, such as millipedes (David, 2009). The reduction of number of species is the most evident. This important taxa has received very little attention in terms of conservation study on animal biodiversity in Africa and particularly in Cameroon. To date, no conservation mesure and status are defined for these species in Cameroon, this despite the alarming rate of conversion of forest into cultivated land. It is therefore imperative to identify major threats and define the protection status of these species ; mainly those of forest environments which are under enormous pressure with regard to the preliminary data that we have record.

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A survey of the western African millipede genus *Tymbodesmus* Cook, 1899 (Diplopoda: Polydesmida: Gomphodesmidae), with the description of a new species from Cameroon

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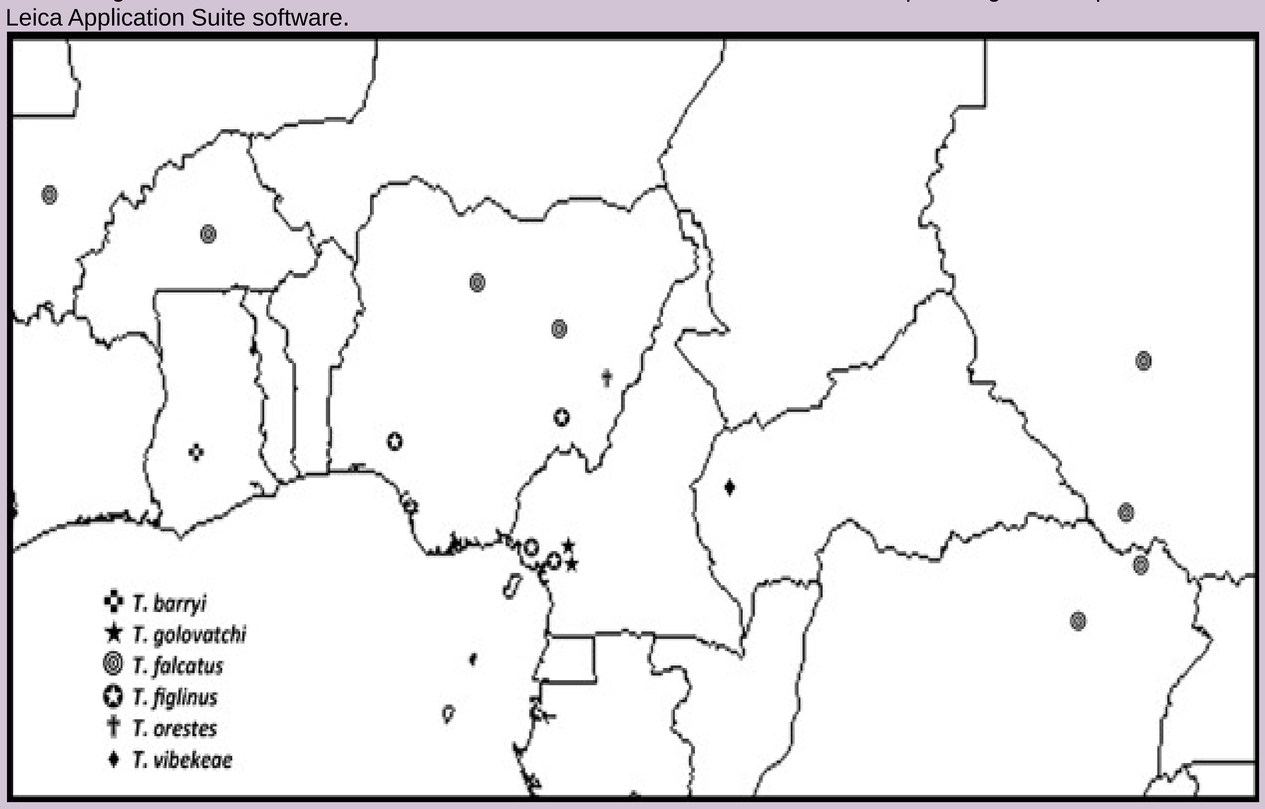
Introduction

The Afrotropical family Gomphodesmidae is a clearly defined and homogeneous group of polydesmodan Diplopoda that currently encompasses 146 species or subspecies in 54 genera [Hoffman, 2005]. The genus *Tymbodesmus* Cook, 1899 is known to contain five recognized and one dubious species, the former keyed. The generic distribution ranges across Subsaharan Central Africa, covering an area bounded by the Niger Uele and Nile rivers [Hoffman, 2005]. The only species definitely known to occur in Cameroon has hitherto been *T. figlinus* Cook, 1899, the type-species of the genus, whereas *T. viadus* Cook, 1899, also reported from Cameroon, remains dubious. The present note puts on record a new species of *Tymbodesmus* from Cameroon, which is markedly distinct from congeners in gonopod conformation and several somatic characters. In addition, fresh material of *T. figlinus* coming from a rainforest region of Cameroon is illustrated.

Material and methods

Most of the material treated here derives from the collection of the Laboratory of Zoology of the University of Yaoundé 1, Cameroon (LZUYC) and the Musée Royal de l'Afrique Centrale (MRAC), Tervuren, Belgium, with only a few duplicates donated to the Zoological Museum, State University of Moscow (ZMUM), Russia. The samples are stored in 70% ethanol. Specimens for scanning electron microscopy (SEM) were air-dried, mounted on aluminium stubs, coated with gold and studied using a JEOL JSM-6480LV scanning electron microscope. Photographs were taken with a Leica digital camera Leica DFC 500 mounted on a Leica MZ16A stereo microscope. Images were processed with Leica Application Suite software.



Map. Distribution of the genus *Tymbodesmus*.

Taxonomic part

Genus *Tymbodesmus* Cook, 1899

The genus *Tymbodesmus* is diagnosed within the tribe Aulodesmini by the following characters (adapted from Hoffman [2005]): Antennae with four apical sensory cones. Sternum 6th with a large median process. Apical tarsal pads present on # legs 1–6. Hypoproct with small paramedian tubercles, median projection scarcely evident. Elevated posterior rim of gonopod aperture with a broad, deep, postcoxal emargination. Gonopods notably large and robust, coxae with a dorsal and a paracannular setal fields; entire lateral side of prefemoral region deeply excavate; telopodite predominantly endonodal, nodus variable in size, usually with one or two nodal spines on mesal side and a like number on lateral one; process M slender, straight, lateral process L, when present, usually larger and longer, postnodal telopodite merging gradually and only gradually curved, slender and flagelliform, with some apical modification, but no lobes on the length.

Survey of the species

The following list provides details concerning all known species currently referred to *Tymbodesmus*:

1. *Tymbodesmus barryi* Schiøtz, 1965. Holotype #, 14 # paratypes, all from Kwame N'Krumah University, Kumasi, Ghana (ZMUC).
2. *Tymbodesmus falcatus* (Karch, 1881). Holotype # (ZMB 629), from Seriba Ghattas, Djur (Bahr-el-Ghazal region), Sudan. 1 # (AMNH), from Medje (2.25N, 27.30E), Oriental Province, Zaire; Lang-Chapin Expedition. 1 # (AMNH), from Faradje (3.40N, 29.40E), Oriental Province, Zaire; Lang-Chapin Expedition. 1 # (CAS), from southwest Segou, Mali. 1# (ZMH), from Yambio (4.34S, 28.23E), Sudan. 1 # (ZMH), from "Ngoupé am Oubangi", République Centrafricane. Numerous ## & $$, from Ougadougou, Burkina Faso (MRAC 12269). 4 ## (VMNH), from Nigeria.
3. *Tymbodesmus figlinus* Cook, 1899. Holotype #, from Cameroon (ZMB 5562). 1 # (ZMUC), from Idanre Hills (7.06N, 5.20E), Oyo State, Nigeria.
NEW MATERIAL: 1 # (MRAC 22682), Cameroon, Ongot, Forest, N 03°51', E 011°25', 810 m a.s.l., 24.V.2016. leg. A.R. Nzoko Fiemapong. 2 ## (LZUYC0017), Cameroon, Buea, forest, pitfall traps, 24.V.2016, leg. Simeu Noutchom.
4. *Tymbodesmus orestes* Hoffman, 2005. Holotype #, 3 $$ paratypes (VMNH), all from Shebshi Mountains, near Ganye, Sardauna, Taraba State, Nigeria.
5. *Tymbodesmus vibekeae* Hoffman, 2005. Numerous ## and $$ (BMNH), from Bouar (5.57N,15.36E), République Centrafricaine.25

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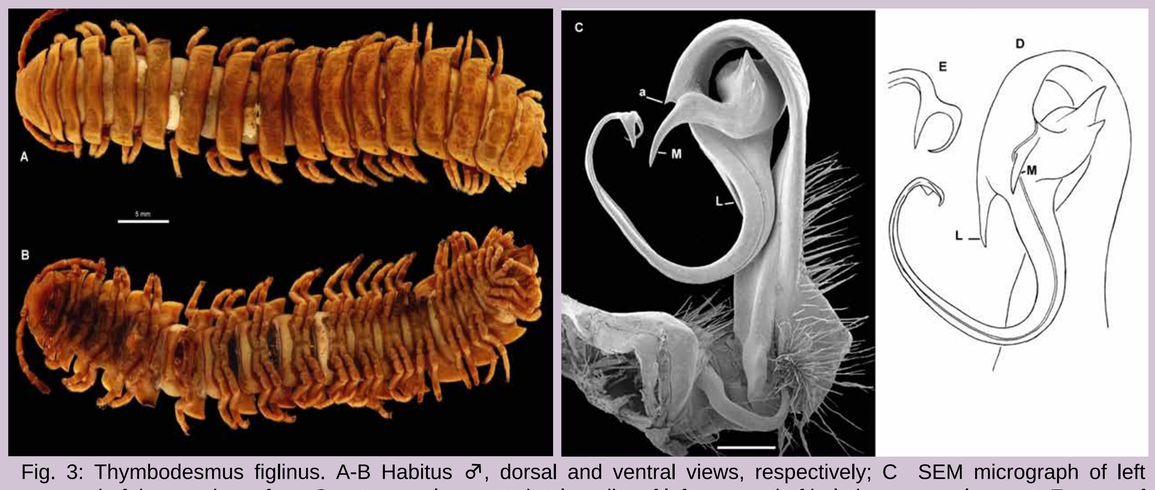

Fig. 3: Thymbodesmus figlinus. A-B Habitus ♂, dorsal and ventral views, respectively; C SEM micrograph of left gonopod of the specimen from Ongot, mesal aspect; d, telopodite of left gonopod of holothype, mesal aspect. E, apex of telopodite enlarged (d&E from Hoffman 2005, not to scale). Scale bars: A,B = 5.0 mm; C = 500µm

A sixth species of *Tymbodesmus* from Cameroon
Tymbodesmus golovatchi Nzoko Fiemapong et VandenSpiegel, **sp.n.** Figs 1 & 2.

Gonopod aperture large, posterior rim elevated adjacent to coxae of 8th legs and deeply emarginated medially (Fig. 2G). Telopodite with a pyriform prefemur, base very thick, basal part deeply excavated medially. Nodus relatively massive, entirely on inner side of curvature with only one mesal spine (M); inner lobe of nodus crenulated or with very short spines. Postnodal telopodite slender, simple, with a small subterminal projection; prostatic groove visible in mesal aspect along most of telopodite length (Fig. 2H, I).

Fig. 1. *Tymbodesmus golovatchi* sp.n., # (A–B) and $ (C–E) paratypes: A & B – habitus, dorsal and lateral views, respectively; C & D – habitus, dorsal and lateral views, respectively; E – cyphopods, ventral view. Scale bars: 5.0 mm.

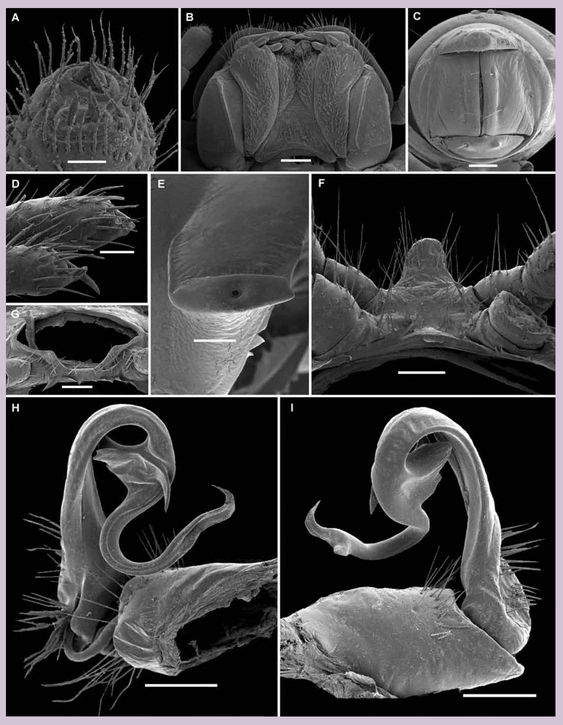

Fig. 2. SEM micrographs of *Tymbodesmus golovatchi* sp.n., # paratype. A – apical antenomere; B – gnathochilarium, ventral view; C – posterior part of body, caudal view; D –tarsal pads; E – ozopore region, lateral view; F – sternal process of body segment 6; G – gonopod aperture, ventral view; H–I – right gonopod, mesal and lateral views, respectively. Scale bars: 0.5 (B, C, G–I) and 0.05 mm (A).

KEY TO SPECIES OF *TYMBODESMUS* (after Hoffman [2005], modified):

1(4) Sternal process of 6th segment cuneate, broadest at base, distally narrowed; sterna without transverse carinae, 15 without paxillae; postnodal telopodite broad nearly to apex, distal sixth notably narrowed…… 2
2(3) Lateral nodal process (L) absent …… *T. golovatchi* sp.n.
3(2) lateral nodal process (L) present…….. *T. barryi*
4(1) Sternal process of 6th segment elongated, narrowed near midlength, broadest at apex; sterna with four conspicuous carinae and a triangular paxillus. …… 5
5(6) Postnodal telopodite relatively short, very abruptely recurved at base of nodus, thence curved laterad with apex on ventrolateral side of nodal region…..…….. *T. vibikeae*
6(5) Postnodal region of telopodite longer and more slender, at base nearly coaxial with nodus, thence curved ventrad with apex on median side of nodus…… 7
7(8) Endonodus produced ventrad into a simple acute cone, at most with one small accessory spine …….. *T. figlinus*
8(7) Endonodus more massive, armed with several subequal spines …….. 9
9(10) Distal half of postnodal telopodite relatively broad; solenomere with a small triangular process at base…….. *T. orestes*
10(9) Distal half of telopodite slender; solenomere with neither a triangular process nor a lobe at base……...……...*T. falcatus*

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