

This article was downloaded by: [University of Bath]

On: 13 February 2014, At: 16:39

Publisher: Taylor & Francis

Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



Journal of Natural History

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/tnah20>

A new cave-dwelling millipede of the genus *Bollmania* Silvestri, 1896 from Yunnan, China, with remarks on the reduction of the second female leg-pair (Diplopoda: Callipodida: Caspiopetalidae)

Pavel Stoev^a & Henrik Enghoff^b

^a National Museum of Natural History, Sofia, Bulgaria

^b Natural History Museum of Denmark (Zoological Museum), University of Copenhagen, Copenhagen, Denmark

^c National Museum of Natural History, Tsar Osvoboditel Blvd 1, 1000 Sofia, Bulgaria E-mail:

Published online: 21 Feb 2007.

To cite this article: Pavel Stoev & Henrik Enghoff (2005) A new cave-dwelling millipede of the genus *Bollmania* Silvestri, 1896 from Yunnan, China, with remarks on the reduction of the second female leg-pair (Diplopoda: Callipodida: Caspiopetalidae), *Journal of Natural History*, 39:21, 1875-1891, DOI: [10.1080/00222930400025896](https://doi.org/10.1080/00222930400025896)

To link to this article: <http://dx.doi.org/10.1080/00222930400025896>

PLEASE SCROLL DOWN FOR ARTICLE

Taylor & Francis makes every effort to ensure the accuracy of all the information (the "Content") contained in the publications on our platform. However, Taylor & Francis, our agents, and our licensors make no representations or warranties whatsoever as to the accuracy, completeness, or suitability for any purpose of the Content. Any opinions and views expressed in this publication are the opinions and views of the authors, and are not the views of or endorsed by Taylor & Francis. The accuracy of the Content should not be relied upon and should be independently verified with primary sources of information. Taylor and Francis shall not be liable for any losses, actions, claims, proceedings, demands, costs, expenses, damages, and other liabilities whatsoever or howsoever caused arising directly or indirectly in connection with, in relation to or arising out of the use of the Content.

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden. Terms & Conditions of access and use can be found at <http://www.tandfonline.com/page/terms-and-conditions>

A new cave-dwelling millipede of the genus *Bollmania* Silvestri, 1896 from Yunnan, China, with remarks on the reduction of the second female leg-pair (Diplopoda: Callipodida: Caspiopetalidae)

PAVEL STOEV¹ & HENRIK ENGHOFF²

¹National Museum of Natural History, Sofia, Bulgaria, and ²Natural History Museum of Denmark (Zoological Museum), University of Copenhagen, Copenhagen, Denmark

(Accepted 22 November 2004)

Abstract

Bollmania beroni sp. n., described from a cave in Jianshui County, Yunnan, China is the first true troglo- and hygrophilic species in the genus. The new locality extends the range of *Bollmania* ca 2500 km towards SE, ca 1700 km SW of the only other Chinese record. Notes are given on *B. orientalis* (Silvestri, 1895), *B. nodifrons* Lohmander, 1933 and *B. oblonga* Golovatch, 1979, based on new material from Turkmenistan and Tajikistan, and on two unnamed, probably new species from Afghanistan. An updated key to the eight described species is presented. Original observations and illustrations of second female legs in various callipodid genera are presented, along with a literature review of this character, which has so far received little attention from taxonomists.

Keywords: *Bollmania*, *Callipodida*, *China*, *Diplopoda*, *taxonomy*, *Yunnan*

Introduction

Millipedes of the order Callipodida have long been known to occur in southern North America and the Mediterranean realm, and have recently become known also from East Asia (Golovatch 1981, 1983; Wang and Zhang 1993; Zhang 1993; Wang 1996; Wang and Mauriès 1996; Shear 2000; Shear et al. 2003; Stoev 2004). This region is considered the third centre of callipodidan diversity by Shear (2000), and is even suspected to surpass the other two in terms of number of species by Shear et al. (2003). Three suborders, six families (Shelley 2003) and ca 36 genera constitute the order, though the higher group systematics is outdated and badly needs re-consideration (Stoev and Enghoff 2003). The world distribution of the Callipodida was recently reviewed by Shear et al. (2003).

The family Caspiopetalidae Lohmander, 1931 comprises only one genus: *Bollmania* Silvestri, 1896 with eight species or subspecies hitherto described: *B. orientalis orientalis* (Silvestri, 1895) and *B. orientalis ajderensis* Lohmander, 1933, from Kopetdagh Mts,

Correspondence: Pavel Stoev, National Museum of Natural History, Tsar Osvoboditel Blvd 1, 1000 Sofia, Bulgaria. Email: stoev@nmnh.bas.bg

Published 29 April 2005.

ISSN 0022-2933 print/ISSN 1464-5262 online © 2005 Taylor & Francis Group Ltd
DOI: 10.1080/00222930400025896

Turkmenistan; *B. serrata* Lohmander, 1933, *B. nodifrons* Lohmander, 1933 and *B. oblonga* Golovatch, 1979, from Tajikistan; *B. nematogona* (Attems, 1951) and *B. gracilis* Golovatch, 1983, from Iran; and *B. kohalana* (Attems, 1936) from Kohala, Pakistan. A ninth species was described in the PhD thesis of Khatoon (1998) from near Islamabad, Pakistan; however, the description has never been properly published and should not be taken into consideration until this happens. Golovatch (1983) provided a key to species in the genus based largely upon the shape of the male gonopods. Females and/or juveniles have been recorded from Afghanistan (Lindberg 1961, 1962), Pakistan (Golovatch 1991) and east China (Golovatch 1981), thus extending the current range of the genus from central to eastern Asia (Figure 19).

The current paper is the fourth one of a series aimed at updating our knowledge of Eurasian genera of Callipodida (see also Stoev and Enghoff 2003, 2004; Stoev 2004). Here, we describe a new species of the genus *Bollmania*, deriving from the material collected by the First Bulgarian–Chinese Speleological Expedition in Yunnan, South China. Formally, this is the first species to be described from the country although the occurrence of the genus there was reported by Golovatch (1981). Judged solely by geography, Shear et al. (2003) considered the last record as representing an unidentifiable genus and species of the family Paracortinidae rather than a species of *Bollmania*. In the light of the new findings this assumption can be considered as erroneous. Most, if not all, hitherto described species of *Bollmania* occur in semi-arid habitats, only exceptionally has the genus been found in caves (cf. Lindberg 1961, 1962). The new species is the first true

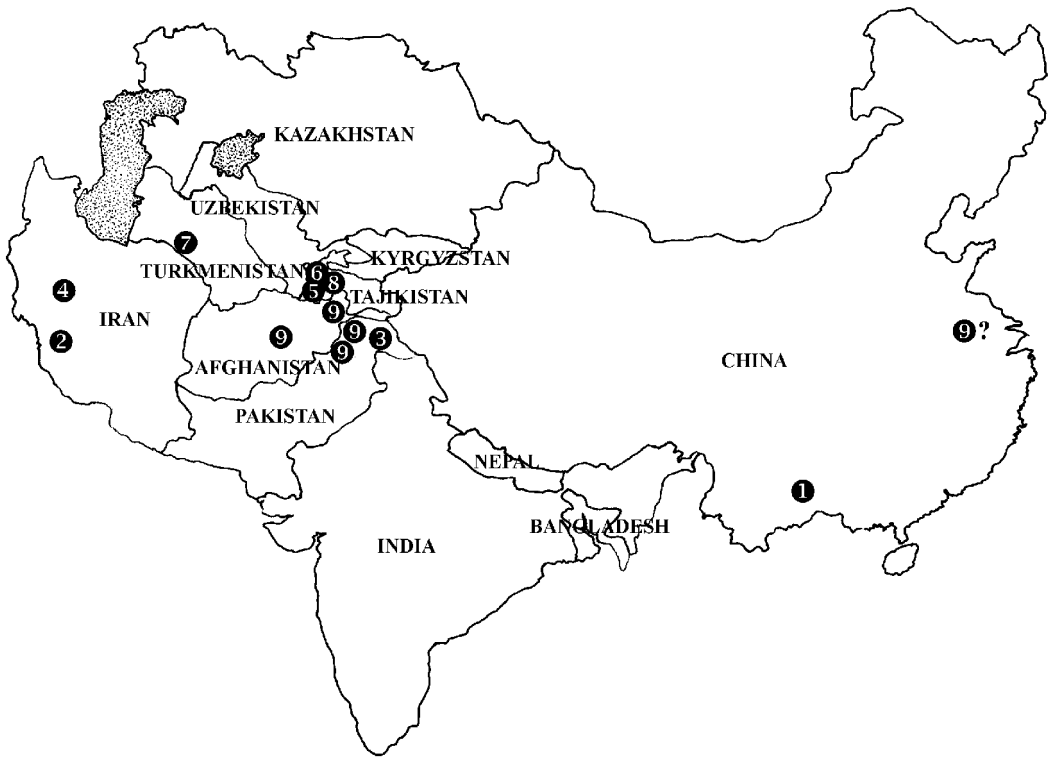


Figure 19. Distribution of the genus *Bollmania*: 1, *beroni*; 2, *gracilis*; 3, *kohalana*; 4, *nematogona*; 5, *nodifrons*; 6, *oblonga*; 7, *orientalis*; 8, *serrata*; 9, *Bollmania* spp.

troglo- and hygrophile (s.l.) to be described, dwelling in a large, humid cave with a permanent stream. The new record extends the current range of *Bollmania* by 2500 km towards the south-east, to within ca 1700 km south-west of the only other Chinese record, from near Nanjing.

We also provide descriptive notes on hitherto undescribed specimens of *Bollmania* belonging to already described, but as yet poorly known species, as well as the female specimens recorded from Afghanistan by Lindberg (1961, 1962). An updated version of the key to species published by Golovatch (1983) is also given.

Finally, we present a general review of the morphology of the female second leg-pair in *Bollmania*, and in Palaearctic genera of the order as a whole. These legs are strongly reduced in many species and, although this character has largely been ignored in previous descriptions, the morphology of the reduced legs offers useful characters for species separation.

Material and methods

The description of the new species is based upon material collected by Dr Petar Beron in the caves of Jianshui County, Yunnan. All specimens are preserved in 70% ethanol. The drawings were made with the aid of a camera lucida. The holotype and two paratypes are preserved in the collection of the National Museum of Natural History, Sofia (NMNHS); a male paratype is deposited in the Zoological Museum, University of Copenhagen (ZMUC). In addition to the Chinese material, Lindberg's millipede collection from Afghanistan (preserved in the Natural History Museum of Göteborg), containing some female and juvenile specimens of *Bollmania*, was examined. Further material from Central Asia was obtained from the Zoological Museum of Moscow University (ZMMU, courtesy S. Golovatch and A. Schileyko). The spelling of the locality names follows Könemann's *Geographica: The Complete Illustrated Atlas of the World* (1999).

Systematics

Family CASPIOPETALIDAE Lohmander, 1931

Genus *Bollmania* Silvestri, 1896

Type species: Callipus orientalis Silvestri, 1895.

Bollmania beroni sp. n.

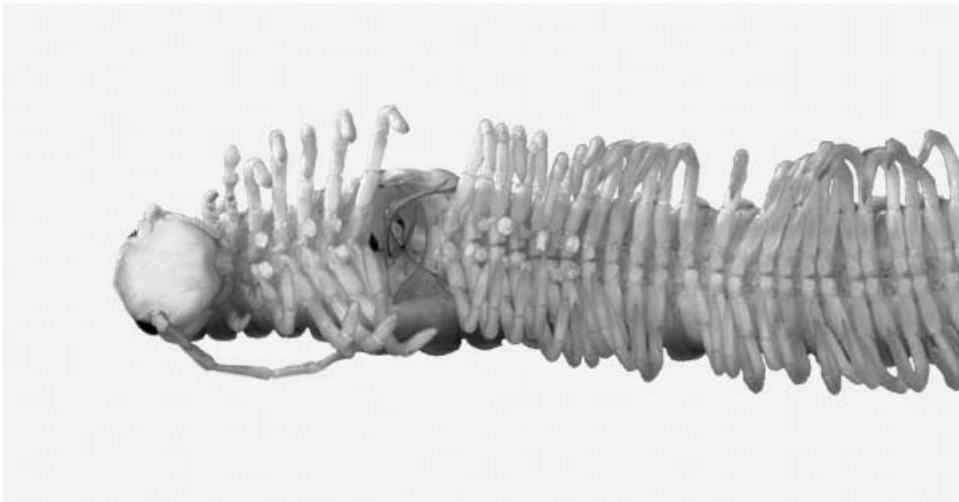
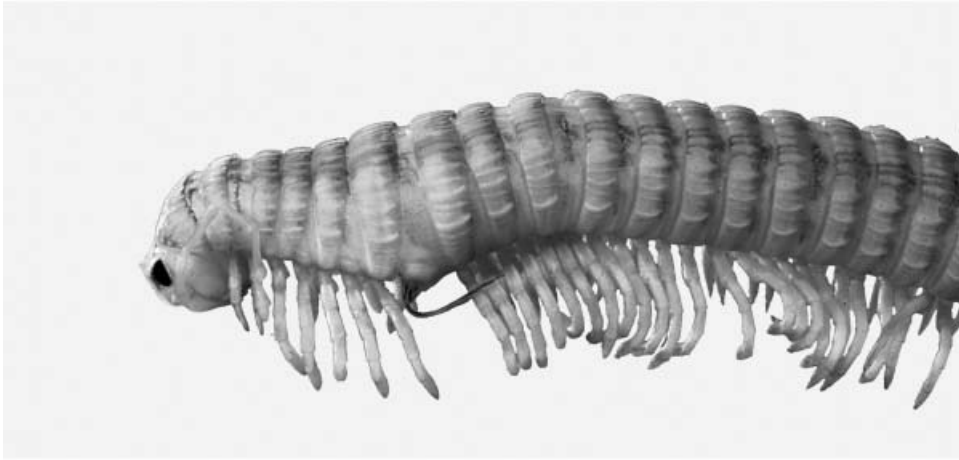
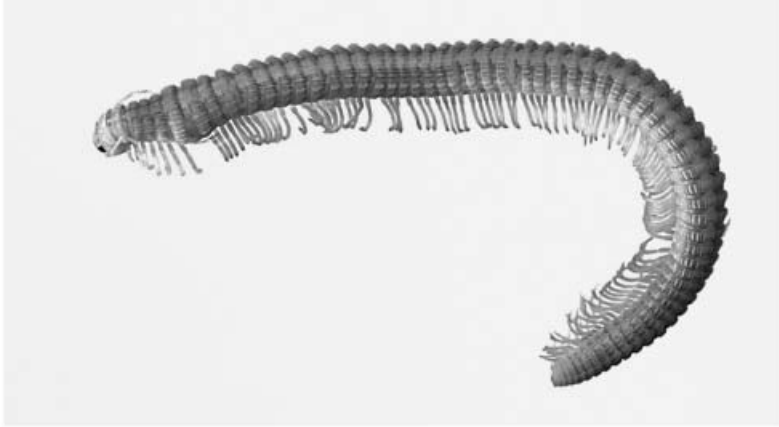
(Figures 1–11)

Material examined

Holotype: adult male; 63 pleurotergites+telson, length 37–38 mm, width 1.9–2.0 mm; China, Yunnan, Jianshui County, Yan Dong Cave, 12 January 1989, P. Beron leg. Paratypes: adult male, 64 pleurotergites+telson and adult female, 65 pleurotergites+telson, same data, all in NMNHS; adult male, 65 pleurotergites+telson, same data, ZMUC.

Description of locality

The cave is situated in Jianshui County, Yunnan. It is spacious, with at least two levels, and a stream about 40–50 cm deep. During heavy rains the floor is flooded. There are many



Figures 1–3. *Bollmania beroni* sp. n., male paratype. (1) Habitus, total length 35 mm. (2, 3) Close-ups of anterior end in lateral and ventral views, showing swollen gonopodal region and long protruding gonopods *in situ*.

stalactites. The Bulgarian–Chinese expedition explored ca 1237 m between its two entrances, Nan Ming Dong and Wan Xiang Dong, but, undoubtedly, the cave is longer. Cave fauna have been collected on the sand and the river mud. Associated fauna: Isopoda: *Nagurus sundaicus* (Dollfus, 1898), *Porcellionides pruinosus* (Brandt, 1833), *Sinodillo troglophilus* Do Heon Kwon and Taiti, 1993, *S. ferrarai* Do Heon Kwon and Taiti, 1993 (Do Heon Kwon and Taiti 1993); Chilopoda Scutigermorpha: *Thereuopoda longicornis* (Fabricius, 1793) (Stoev 2002); Araneae: *Howaia* sp., *Heteropoda* sp.; two other species of Diplopoda; Chilopoda Lithobiomorpha; Orthoptera; Coleoptera Carabidae and Staphylinidae; Trichoptera; Diptera (P. Beron, personal communication).

Etymology

The species honours Dr Petar Beron who collected the material.

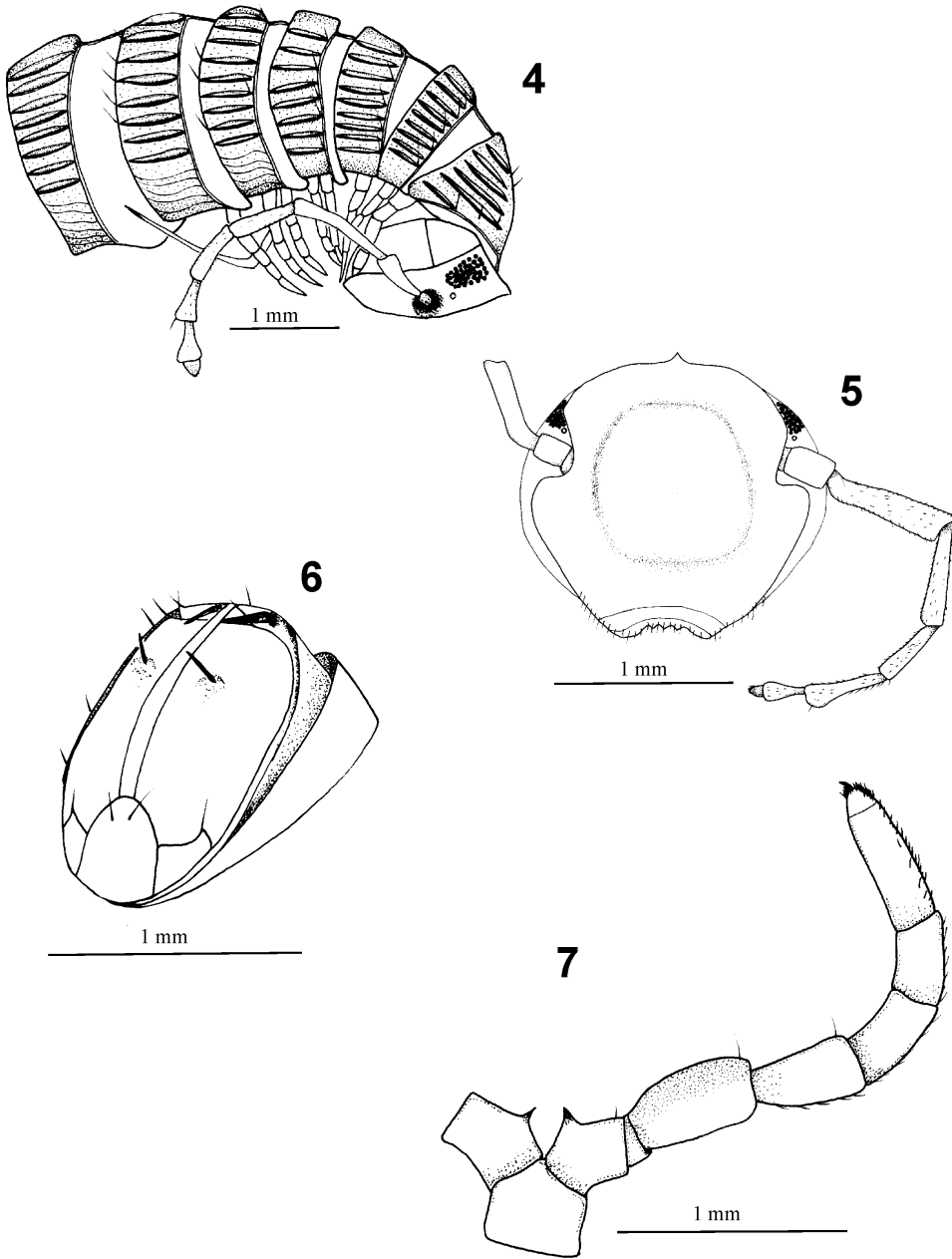
Description

Length: 35–40 mm, width 1.9–2.0 mm, 63–65 pleurotergites. Dimensions of the largest pleurotergite in male paratype: prozonite width 1.7 mm; height 1.6 mm; metazonite width 2.0 mm; height 1.8 mm; width of metazonite including the basal crests 2.3 mm; width of metazonite between the largest (sixth) crests 1.88 mm.

Body colour brown-yellowish. Dorsum with two paramedian light brown stripes and a broad median yellow stripe along the whole body length. Head and legs yellowish. Posterior part of head marbled brown-yellowish. Ocellaria in a rhomboid form composed of 35–40 black ocelli in seven rows. Organ of Tömösváry of same size as ocelli, easily seen between ocellaria and base of antennae. Head in males slightly concave frontally, covered with minute setae, and bearing a well-expressed frontal knob (Figures 4, 5); in female ovoid, evenly rounded. Labrum light brown, a little darker in contrast to the yellowish-brown forehead. Labral edge covered with larger setae in an irregular row. Antennae yellowish-white, densely covered with minute setae, reaching the posterior margin of sixth pleurotergite when folded backward. First antennomere almost one-quarter of second; second and third almost equal in size; fourth antennomere four-fifths length of third. Fifth and sixth antennomeres enlarged distally, seventh cone-shaped (Figure 4).

Male pleurotergites 1–5 visibly narrower than 6–8 and just a little narrower than 9–11. Each hemipleurite of pleurotergite 7 (the widest of all) with about 18 crests. Size of crests on pleurotergite 7: $6 > 10 > 8 = 2 = 4 > 1 = 3 = 5 = 7 = 9$. Female second and third pleurotergites strongly enlarged. Ozopores visible from sixth to penultimate pleurotergite, placed on top of the sixth, the most pronounced crest of all. Table I shows the chaetotaxy of the anterior pleurotergites.

First and second leg-pair in males shorter than following legs, with prefemur, femur, postfemur and tibia densely covered with setae that are missing in the subsequent legs. Male leg-pairs 2, and 4–7 with coxal projections (Figure 7); pairs 1 and 3 without. Gonopore on posterior side of the coxa of leg 2. Prefemur of male leg-pair 7 much stouter than femur, its ventral side covered with a field of fine setae. A long seta emerging on the postero-ventral side of coxa, prefemur and femur (Figure 7). Tarsus divided into a long basitarsus and a very short distitarsus, the latter ending with a claw. Tarsal pads present from leg-pair 3, larger on anterior legs. Coxae 9 and 10 normal. Female second leg-pair strongly reduced (Figure 11). Hypoproct tripartite, median sclerite largest. Anal valves with two paramedian macrosetae. Spinnerets long and slender (Figure 6).



Figures 4–7. *Bollmania beroni* sp. n., male. (4) Head, anterior pleurotergites and gonopod, lateral view. (5) Head, frontal view. (6) Telson, postero-lateral view. (7) Leg-pair 7, posterior view.

Male gonopods (Figures 8–10): telopodites in situ crossing each other (Figure 8); coxae subquadrate, prolonged posteriad. Inner coxal process (*ip*) comparatively short and straight (not long and loop-shaped as that of *B. oblonga* and *nodifrons*) equivalent to half of the coxal length. Coxae connected to each other through membranous ligament. Two perpendicular round-triangular sternal processes (*st*) originating between coxae (Figure 8). Femoroid long

Table I. Chaetotaxy of anterior pleurotergites in *Bollmania beroni* sp. n.

	Anterior setae	Posterior setae
Collum	5+5	–
Pleurotergite 2	5+5	–
Pleurotergite 3	5+5	–
Pleurotergite 4	5+5	–
Pleurotergite 5	<i>a, d+a, d</i>	<i>b, c, e+b, c, e</i>
Pleurotergite 6	–	5+5
Pleurotergite 7	–	5+5

and thin, pointing caudad. Basal part of solenomere with ovoid, porous plate (*k*) pointing meso-caudal (Figures 9, 10). Solenomeres with long, sharp and S-shaped basal processes (*p*), crossing each other in situ (Figure 8). Posterior part of solenomere ending with two branches, the upper one a little shorter and bearing a well-pronounced dorsal tooth (*z*) and a small but visible spine at its base (*j*). Another tiny spine (*ha*) emerging at the posterior end of the main branch. Seminal groove (*sg*) beginning from the base of the femoroid following its main stem and ending between the branches.

Remarks

Bollmania beroni sp. n. differs from its congeners by the following characters: antennae white-yellowish; coxae of male leg-pairs 2, 4–7 with projections; gonopods with a well-pronounced porous plate (*k*), dorsal tooth (*z*) and S-shaped process (*p*); female second leg-pair bipartite, with characteristic shape. Although found in a cave, there are no characters of troglomorphism, except probably for slightly longer legs (compared to the examined specimens from Afghanistan, Turkmenistan and Tajikistan, see below) and white-yellowish body and antennae (the other *Bollmania* species are usually dark brown, especially the antennae). *Bollmania kohalana* was, so far, the easternmost species described in the genus. The locality of *B. beroni* extends its range about 2500 km in a south-eastern direction, being the southernmost of all known localities and lying ca 1700 km south southwest of the only other (dubious, cf. above) Chinese record of *Bollmania*, near Nanjing (Golovatch 1981). The new species is the first true troglo- and hygrophile (s.l.) described in the genus, living in a large cave system supporting a permanent stream.

Notes on other *Bollmania* species

Bollmania nodifrons Lohmander, 1933

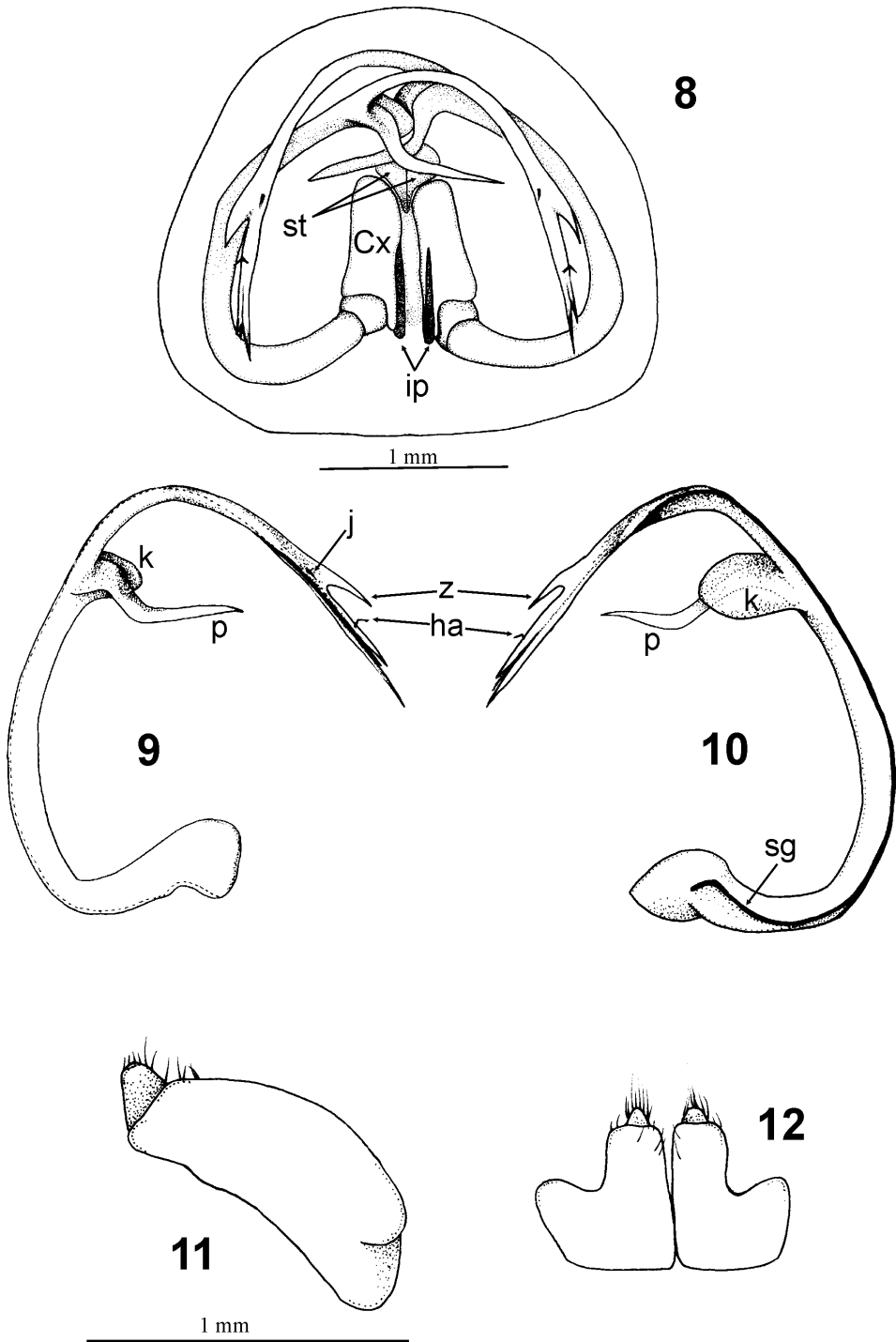
(Figure 14)

Caspiopetalum nodifrons Lohmander 1931, p 5, Figure 2, **nomen nudum**.

Bollmania nodifrons Lohmander 1933, p 49, Figures 45–47.

Material examined

Six adult males, three subadult males, four adult females, one subadult female (adult male and adult female–NMNHS), Tajikistan, Hodzha-Moston Ridge, 1700 m alt., 13 April 1985, V. Dolin leg. (ZMMU).



Figures 8–12. (8–11) *Bollmania beroni* sp. n. (8) Gonopods, position in situ, caudal view. (9) Gonopod, mesal view. (10) gonopod, lateral view. (11) female: leg-pair 2, posterior view. (12) *Bollmania* sp. 1 from Afghanistan: leg-pair 2, posterior view.

Remarks

The examined specimens correspond well with the original description of the species, which was probably based on a not fully mature male. Having further material at our disposal we can improve the species diagnosis with the following characters: adult males with 58–60 pleurotergites+telson; females composed of 60 pleurotergites+telson; subadult males without a knob on the head; inner gonopodal coxal process (*ip*) longer than that illustrated by Lohmander (1933), sharpened, and apically curved as in *B. oblonga*. Female second leg-pair reduced (Figure 14). The new locality is situated south of the town of Kurgan-Tyube, about 60–80 km east of the type and so far only known locality: Babatag Mt, SW Tajikistan.

Bollmania oblonga Golovatch, 1979

(Figure 15)

Bollmania oblonga Golovatch 1979, p 990, Figures 13–15.*Material examined*

Five adult males, 16 females (two males and three females–NMNHS), Tajikistan, Gazi-Malek, Isambai, 1600 m alt., 17–18 April 1985, V. Dolin leg. (ZMMU).

Remarks

This species is close to *B. nodifrons*, both species being characterized by the absence of a basal process of the solenomere, and in having a similar shape to the anterior part of the gonopod (compare Figures 13–15 in Golovatch 1979 with Figures 45–47 in Lohmander 1933). However, *B. oblonga* was distinguished by Golovatch by the absence of a knob on the head, the long antennae in males, comparatively small gonopods, a much longer distal process of the solenomere (*e* in Golovatch 1979, Figures 13–15), a much longer, S-shaped and apically swollen *ip* (*hs* in Golovatch 1979, Figure 13), and the existence of small swellings on the coxae of leg-pair 9 (Golovatch 1979). Although the subadult *B. nodifrons* males are without a knob on the head, and the *ip* in adults is longer than that described by Lohmander (1933), both species are well distinguished by the size of the gonopods, the length of the distal process, the shape of the apical part of the gonofemur (with two small denticles in *B. nodifrons*), and the shape of *ip*. The female second leg-pair is modified (Figure 15). This species was hitherto known only from its type locality near Kondary Gorge, north of Dushanbe. Our material comes from Gazi-Malek, a mountain located about 150 km further south and very close to the known range of *B. nodifrons*.

Bollmania orientalis (Silvestri, 1895)*Callipus orientalis* Silvestri 1895, p 180.*Bollmania orientalis*: Silvestri 1896, p 150.*Material examined*

One adult male, Turkmenistan, Central Kopetdagh, ca 20 km south of Geok Tepe, Dushak Mt, towards Chuli, ca 2000 m alt., 21 April 1989, K. Mikhailov leg.; one adult male, three

adult females (males and females–NMNHS), near Ashgabat, Firyuza Gorge, 14 March 1966 (ZMMU); two adult males, three adult females, Kara Kala, 12 April 1984.

Remarks

This species is confined to the region of Kopetdagh Mts, Turkmenistan. The new locality at Kara Kala is situated ca 190 km north-west of Ashgabat, thus extending the species range some 80–100 km to the north-east, but still within the limits of the mountain.

***Bollmania* females from Afghanistan**

Lindberg's collection from Afghanistan contains two *Bollmania* species, both unfortunately represented only by females. To facilitate future work we give below a brief description of the examined material.

***Bollmania* sp. 1**

(Figure 12)

Bollmania sp.: Lindberg 1961, p 34; 1962, p 11.

Material examined

Two adult females, two juveniles, Afghanistan, small cave in landslide granite, 15 km south of Faizabad (Badakhchan), 1330 m alt., 15 July 1959, K. Lindberg leg. (NMG).

Description

Length (adult female): 41–42 mm; 64–66 pleurotergites+telson. Antennae short, reaching the end of third or the anterior part of fourth pleurotergite; brown, somewhat lighter laterally. Head convex, covered with fine, dense setae. Vertex with two light spots. Ocelli ca 36 in six to seven rows. Prozonites pale blue-greyish anteriorly, dark brown posteriorly. Metazonites dark brown with lighter yellowish spots beginning from sixth crests downwards; crests 1–5 dark brown, 6 yellow-brownish, bearing ozopore on the top; crests 7–10 brownish, laterally with large yellowish spots. Size of crests: $6 > 8 = 10 > 2 = 4$. The lighter medial band on the dorsum, usually present in *Bollmania*, is missing. The median dorsal pleurotergite suture is pale brown-yellowish contrasting to brown pro- and metazonites. Hypoproct divided into three sclerites, with four stout setae. Legs pale yellowish; tibiae and tarsalia darker. Second leg-pair of adult females reduced (Figure 12).

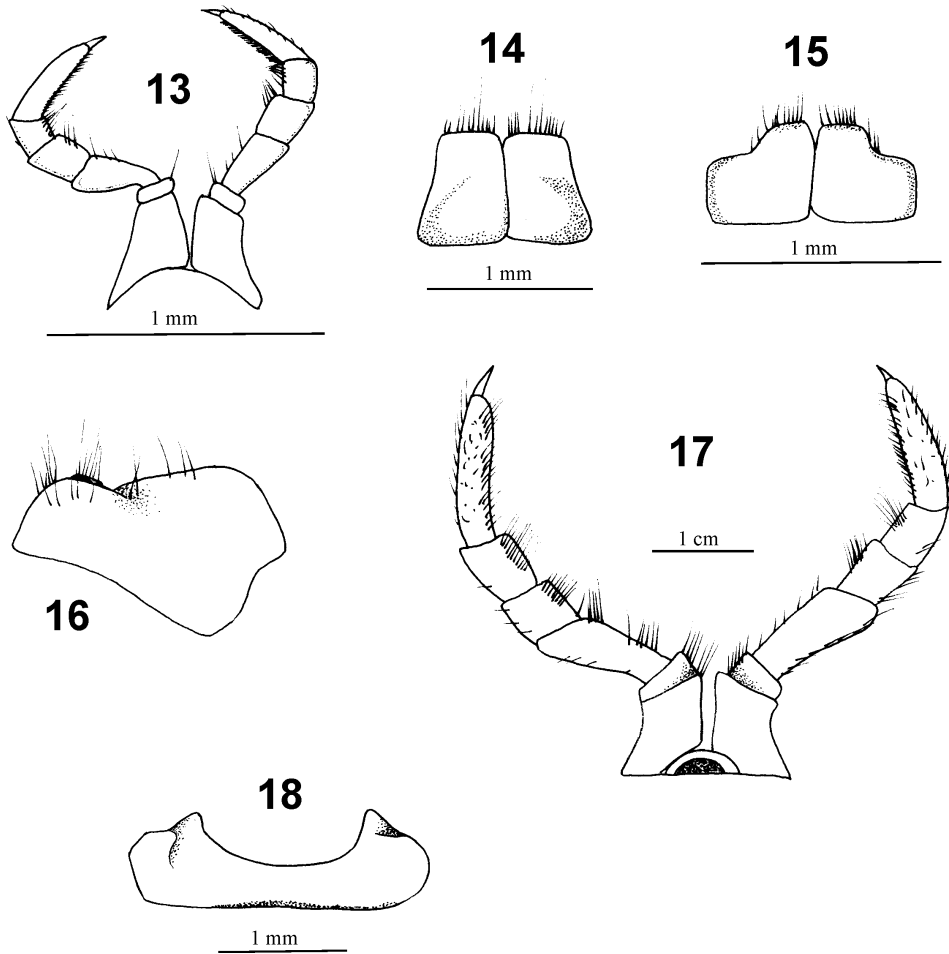
Remarks

This species resembles *B. oblonga*, having a similar shape of the second female leg-pair (compare Figure 12 with Figure 15). It was found ca 230 km east of the Babatag Mt, the type locality of *B. oblonga*.

***Bollmania* sp. 2**

(Figure 13)

Bollmania sp.: Lindberg 1962, p 11.



Figures 13–18. (13) *Bollmania* sp. 2 from Afghanistan: leg-pair 2, posterior view. (14) *B. nodifrons*, female: leg-pair 2, posterior view. (15) *B. oblonga*, female: leg-pair 2, posterior view. (16) *Callipus foetidissimus*, female: leg-pair 2, posterior view. (17) *Apfelbeckia lendenfeldii*, female: leg-pair 2, posterior view. (18) *Callipodella fasciata*, female: leg-pair 3, posterior view.

Material examined

Subadult female, Afghanistan, Sabz Tchachmeh, approximately 200 km north-north-east of Qandahar, between Orozgan and Bareki, limestone cliff in the gorge, shallow cave below the source, under stone, 3030 m alt., 16 June 1960, K. Lindberg leg. (NMG).

Description

Length: ca 35 mm; 56 pleurotergites+telson. Head: medial part dark brown with two large, lighter spots; vertex, stipes and cardo marbled brown. Antennae: as in *Bollmania* sp. 1. All crests (except the first) dark brown, contrasting with brown-yellowish pro- and metazonites. First crests yellowish. A light medial band on the dorsum. Crests: $6 > 8 = 10 > 2 = 4$. Ozopores on crest 6. Hypoproct divided into three sclerites, with four stout setae. Second leg-pair normal (Figure 13).

Key for identification of the species of *Bollmania* (based on that provided by Golovatch 1983)

- 1 (12) Gonopod solenomere with a process at very base (*fs* in Lohmander 1933; *Ti* in Attems 1951) 2
- 2 (3) Basal process of solenomere thick, stout, with evidence of torsion (*fs* in Lohmander 1933, Figures 30–32). *B. orientalis* (Silvestri) (including *B. orientalis ajderensis* Lohmander, 1933, described by Lohmander as a “Form” of uncertain rank)
- 3 (2) Basal process of solenomere more or less thin, slender, without evidence of torsion 4
- 4 (7) Basal process of solenomere quite short, about as long as one-fifth of the total length of solenomere 5
- 5 (6) Basal process of solenomere baton-shaped, surmounted by a couple of setae (*Ti* in Attems 1951, Figure 37) *B. nematogona* (Attems)
- 6 (5) Basal process of solenomere blade-shaped, without apical setae (Figure 56c in Attems 1936) *B. kohalana* (Attems)
- 7 (4) Basal process of solenomere much longer, slender 8
- 8 (9) Apical part of gonofemur without porous process (*k*); apical part of solenomere with branches of equal size (Figures 42, 43 in Lohmander 1933) *B. serrata* Lohmander
- 9 (8) Apical part of gonofemur with a porous process (*k*); apical part of solenomere with branches of different sizes 10
- 10 (11) Apical part of gonofemur with only a small porous process (*k* in Golovatch 1983, Figure 1); basal process of solenomere straight, more than half as long as solenomere *B. gracilis* Golovatch
- 11 (10) Apical part of gonofemur with a well-developed porous process (*k*, Figures 9, 10); basal process of solenomere as long as half of solenomere, directed upwards *B. beroni* sp. n.
- 12 (1) Solenomere without a basal process 13
- 13 (14) Gonopods minute; distal process of solenomere long; *ip* apically swollen; gonofemoral apex with a field of minute setae; head in both sexes without a knob *B. oblonga* Golovatch
- 14 (13) Gonopods large; distal process of solenomere short; *ip* apically sharpened, not swollen; gonofemoral apex with lateral and apical denticles; head in adult males with a knob *B. nodifrons* Lohmander

Remarks on the reduction of the second leg-pair in female Callipodida

Some female callipodidans have long been known to show the second leg-pair strongly reduced. This condition occurs in various suborders, families, genera, and species. Table II

Downloaded by [University of Bath] at 16:39 13 February 2014

Table II. Reduction of the second female leg-pair in Palaearctic callipodidan genera: list of genera after Hoffman (1980), with updates.

Genus	Second female legs	Reference(s)	Notes and studied species
Suborder Sinocallipodidea			
Family Sinocallipodidae			
<i>Sinocallipus</i>	N	Zhang 1993, p 128, Figure 8; Shear et al. 2003, p 13, Figure 14	
Suborder Callipodidea			
Family Callipodidae			
<i>Callipus</i>	R	Demange 1967, Figures 46–48; Strasser 1974, Figure 42; present study	<i>C. foetidissimus</i> (Savi, 1819) (Figure 16)
<i>Sardopus</i>	?	Strasser 1974	Female unknown
Suborder Schizopetalidea			
Family Schizopetalidae			
<i>Schizopetalum</i>	?		
<i>Callipodella</i>	N	Present study	<i>C. fasciata</i> (Latzel, 1882), third leg-pair strongly reduced (Figure 18)— <i>C. vinciguerrae</i> (Silvestri, 1894)
<i>Dischizopetalum</i>	N	Present study	<i>D. illyricum</i> (Latzel, 1884)
<i>Euxinopetalum</i>	R	Hoffman 1972, p 88, Figure 3	
<i>Prolysiopetalum</i>	N	Hoffman 1972, p 89	
<i>Acanthopetalum</i>	N	Present study	<i>A. albidicolle</i> (Verhoeff, 1900), <i>A. carinatum</i> (Brandt, 1840), <i>A. hoplites</i> Strasser, 1973, <i>A. minotauri</i> (Attems, 1902), <i>A. richii</i> (Gray, 1832)
<i>Balkanopetalum</i>	N	Present study	<i>B. armatum</i> Verhoeff, 1926, <i>B. beskovi</i> Strasser, 1973, <i>B. bulgaricum</i> Stoev and Enghoff, 2003, <i>B. graecum</i> Stoev and Enghoff, 2003, <i>B. petrovi</i> Stoev and Enghoff, 2003, <i>B. rhodopinum</i> Verhoeff, 1937
<i>Eurygyrus</i>	N	Hoffman and Lohmander 1964, p 128; Hoffman 1972; Glaubrecht and Spelda 1993, p 288	
<i>Apfelbeckia</i>	N	Present study	<i>A. wohlberedi</i> Verhoeff, 1909, <i>A. lendenfeldii</i> (Verhoeff, 1896) (Figure 17)
<i>Antropetalum</i>	?		
<i>Himatiopetalum</i>	?		
Family Paracortinidae			
<i>Paracortina</i>	R	Wang and Zhang 1993, Figures 5, 12, 13, 17, 18, 22, 23, 27, 28, 30, 31; Stoev 2004, p 5, Figure 11	

Table II. (Continued).

Genus	Second female legs	Reference(s)	Notes and studied species
Family Dorypetalidae			
<i>Dorypetalum</i>	N	Present study	<i>D. bulgaricum</i> Strasser, 1966, third leg-pair strongly reduced— <i>D. bosporanum</i> Hoffman and Lohmander, 1964— <i>D. n. sp.</i> (Turkey)
<i>Cyphocallipus</i>	R	Present study	<i>C. excavatus</i> Verhoeff, 1909
<i>Dorycallipus</i>	?		
<i>Lusitanipus</i>	?		
Family Caspiopetalidae			
<i>Bollmania</i> part.	R	Lohmander 1933, Figures 37, 38; Attems, 1936, Figure 55g; present study	<i>B. nodifrons</i> , <i>B. kohalana</i> , <i>B. oblonga</i> , <i>B. orientalis</i> , <i>B. sp. 1.</i> from Afghanistan (Figures 12, 14, 15)
<i>Bollmania</i> part.	N(?)	Attems 1951; present study	<i>B. sp. 2.</i> from Afghanistan (Figure 13)

N, normal; R, reduced.

summarizes the situation for all Palaearctic callipodidan genera. Concerning the North American genera, the published information (Loomis 1937; Buckett and Gardner 1969; Hoffman 1972, 1982) is far from exhaustive and partly contradictory. We have examined females of *Abacion magnum* (Loomis, 1943) and can confirm that the second leg-pair is indeed strongly reduced in adult females. Rowland Shelley has kindly studied a number of North American callipodidans at our request and informs (in litt.) that adult females of *Abacion tessellatum* Rafinesque, 1820, *A. lactarium* (Say, 1821), *A. texense* (Loomis, 1937), and *Delophon georgianum* Chamberlin, 1943 (all belonging to the family Abacionidae) have indeed reduced second legs. In the North American “schizopetalids” (Shelley doubts that they are really confamilial with the European ones), he found adult females of *Tynomma mutans* (Chamberlin, 1910) to have reduced second legs; the females he examined of *Idrionaria dineh* Shelley, 1996, *Colactis utorum* (Chamberlin, 1925) and *C. protenta* Loomis, 1937 all had well-developed second legs, but all these females had no obvious ovipositor and thus may be subadult.

At present it is not possible to say if the character is of value for analysing the suprageneric relationships of the Callipodida. A more complete study, involving more genera, is necessary before this can be assessed, as well as a comprehensive phylogenetic analysis performed. Intuitively, one would presume that normal, non-reduced legs represent the plesiomorphic state, which is also supported by the absence of modification in *Sinocallipus simplipodicus* Zhang, 1993, the most primitive callipodidan hitherto described (Zhang 1993; Shear 2000; Shear et al. 2003). On the other hand, reduced second female legs have been found among species of both of the other suborders (see Table II), thus showing that the modification has appeared several times independently. It is worth mentioning that in some *Callipodella* and *Dorypetalum* species, we found the third pair of legs to be reduced instead of the second.

In *Bollmania*, the reduction of the second female legs apparently only happens in some of the species. Thus, female *B. nematogona* and *B. sp. 2* from Afghanistan have normal legs. A possible explanation for this could be that the studied females of these species are not fully mature. Thus, in *Callipus foetidissimus* (Savi, 1819), the reduction of the second legs takes place at the last moult; females in the second-last stadium have fully developed second legs at the base of which the vulvae are placed instead of being retracted into the body as in the adults (Nguyen Duy-Jacquemin 1976). Similarly, it is only the larger females of *Paracortina wangi* Stoev, 2004 (Paracortinidae) which have reduced second legs (Stoev 2004), cf. also Shelley’s findings on North American material, referred to above.

The second female legs as a species-specific character

In *Bollmania* the reduced second female legs are of a different shape in each species and hence are useful for species distinction. The same is true in *Callipus* (Strasser 1974) and *Paracortina* (Wang and Zhang 1993; Stoev 2004). There is an interesting parallel to this situation in the order Julida where females of *Nopoiulus* subgenus *Paranopoiulus* (Blaniulidae) have reduced second legs, the shape of which is species-specific (Enghoff 1984).

Acknowledgements

Dr Ted von Proschwitz (Göteborg) and Dr Sergei Golovatch (Moscow) helped with the loan of unidentified material. We are especially obligated to S. Golovatch for advising on

localities in Tajikistan and for commenting on the final version of the manuscript, and to R. M. Shelley (Raleigh, NC, USA) for studying female North American callipodids on our request. Dr Jean-Jacques Geoffroy (Paris) helped in obtaining some obscure literature. Dr Petar Beron (NMNHS) shared unpublished information on the fauna of the Yan Dong Cave. Fani Bozarova (NMNHS) inked the illustrations and G. Brovad (ZMUC) provided photographs. Part of the work was undertaken with support from the European Commission's programme "Transnational Access to Major Research Infrastructures" to P.S. for a month's stay at COBICE (Copenhagen Biosystematics Centre).

References

- Attems C. 1936. Diplopoda of India. *Memoirs of the Indian Museum* 11(4):133–323.
- Attems C. 1951. Myriopoden vom Iran gesammelt von der Expedition Heinz Löffler und Genossen 1949/50. *Sitzungsberichte der Österreichischen Akademie der Wissenschaften, Abteilung I* 160:387–426.
- Buckett J, Gardner M. 1969. Revision of the chordeumid milliped genus *Tynomma* Loomis from California (Chordeumida: Lysiopetalidea: Lysiopetalidae). *The Pan-Pacific Entomologist* 45(3):204–216.
- Demange J-M. 1967. Recherches sur la segmentation du tronc des Chilopodes et des Diplopedes Chilognathes (Myriapodes). *Mémoires du Muséum National d'Histoire Naturelle, Paris, N.S. Série A, Zoologie* 44:1–188.
- Do Heon Kwon K, Taiti S. 1993. Terrestrial Isopoda (Crustacea) from Southern China, Macao and Hong Kong. *Stuttgarter Beiträge zur Naturkunde, Serie A (Biologie)* 490:1–83.
- Enghoff H. 1984. A revision of Nopoiulinae, with notes on the classification of blaniulid millipedes. *Senckenbergiana Biologica* 64:393–427.
- Glaubrecht M, Spelda J. 1993. On the genus *Eurygyrus* Koch, 1847 (Diplopoda: Callipodida: Schizopetalidae) in the Dodecanese: zoogeography and female choice theory. *Mitteilungen aus dem Hamburgischen Zoologischen Museum und Institut* 90:285–311.
- Golovatch S. 1979. The composition and zoogeographic relationships of the diplopod fauna of Middle Asia, Part 1. *Zoologicheskyy Zhurnal* 58(7):987–1001.
- Golovatch S. 1981. Some East-Asiatic millipedes (Diplopoda) in the collection of the Institute of Zoology of the Polish Academy of Sciences. *Annales Zoologici, Warszawa* 36(8):161–168.
- Golovatch S. 1983. A contribution to the millipede fauna of Iran (Diplopoda). *Annalen des Naturhistorischen Museums in Wien* 85B:157–169.
- Golovatch S. 1991. On a small collection of millipedes (Diplopoda) from northern Pakistan and its zoogeographic significance. *Revue Suisse de Zoologie* 98(4):865–878.
- Hoffman R. 1972. Studies on Anatolian callipodoid Diplopoda. *Mitteilungen aus dem Hamburgischen Zoologischen Museum und Institut* 69:81–108.
- Hoffman R. 1980. Classification of the Diplopoda. Geneva: Muséum d'Histoire naturelle. 237 p.
- Hoffman R. 1982. Diplopoda. In: Parker S, editor. *Synopsis and classification of living organisms. Volume 2*. New York: McGraw-Hill. p 689–724.
- Hoffman R, Lohmander H. 1964. The Diplopoda of Turkey. *Mitteilungen aus dem Hamburgischen Zoologischen Museum und Institut* 62:101–151.
- Khatoon S. 1998. Taxonomic and ecological studies of chilopods and diplopods in Rawalpindi and Islamabad districts [PhD thesis]. Lahore: Department of Zoology, Punjab University, 326 p, 144 plates.
- Könemann. 1999. *Geographica: the complete illustrated atlas of the world*. Cologne: Könemann Verlagsgesellschaft mbH. 618 p.
- Lindberg K. 1961. Recherches biospéléologiques en Afghanistan. *Lunds Universitets Årsskrift, N. F. Avd. 2* 57(1):1–39.
- Lindberg K. 1962. Recherches biospéléologiques en Afghanistan II. *Lunds Universitets Årsskrift, N. F. Avd. 2* 58(2):1–15.
- Lohmander H. 1931. *Caspiopetalum*, eine neue Diplopoden-Gattung aus dem russischen Zentralasien. *Arkiv för Zoologi* 22B(1):1–6.
- Lohmander H. 1933. Über Diplopoden aus Zentralasien. *Arkiv för Zoologi* 25A(6):1–71.
- Loomis HF. 1937. Crested millipeds of the family Lysiopetalidae in North America, with descriptions of new genera and species. *Proceedings of the United States National Museum* 84(3006):97–135.
- Nguyen Duy-Jacquemin M. 1976. Contribution à l'étude du développement postembryonnaire de *Callipus foetidissimus* Savi, 1819 (Myriapode, Diplopode). *Bulletin du Muséum National d'Histoire Naturelle, Paris, Série 3* 408(Zoologie 285):1115–1127.

- Shear R. 2000. A new genus and species of callipodidan milliped from Vietnam (Callipodida, Schizopetalidae). *Myriapodologica* 6(11):95–100.
- Shear W, Shelley R, Heatwole H. 2003. Occurrence of the milliped *Sinocallipus simplipodicus* Zhang, 1993 in Laos, with reviews of the Southeast Asian and global callipodidan faunas, and remarks on the phylogenetic position of the order (Callipodida: Sinocallipodidea: Sinocallipodidae). *Zootaxa* 365:1–20.
- Shelley R. 2003. A revised, annotated, family-level classification of the Diplopoda. *Arthropoda Selecta* 11(3):187–207.
- Silvestri F. 1895. 4. Beitrag zur Kenntnis der Chilopoden und Diplopoden-Fauna der palaearktischen Region. *Zoologischer Anzeiger* 18(474):179–180.
- Silvestri F. 1896. I Diplopodi, Parte I—Sistematica. *Annali del Museo Civico di Storia Naturale di Genova* 36:121–254.
- Stoep P. 2002. The scutigeromorphs (Chilopoda: Scutigeromorpha) in the collection of the National Museum of Natural History, Sofia. *Historia Naturalis Bulgarica* 15:79–85.
- Stoep P. 2004. The first troglomorphic species of the millipede genus *Paracortina* Wang & Zhang, 1993 from south Yunnan, China (Diplopoda: Callipodida: Paracortinidae). *Zootaxa* 441:1–8.
- Stoep P, Enghoff H. 2003. Systematics, phylogeny and biogeography of genus *Balkanopetalum* Verhoeff, 1926 (Diplopoda: Callipodida: Schizopetalidae). *Zootaxa* 272:1–26.
- Stoep P, Enghoff H. 2004. The first indigenous species of the millipede genus *Eurygyrus* C. L. Koch, 1847 from the European mainland, with remarks on *E. nicarius* (Verhoeff, 1901) and *E. euboicus* (Verhoeff, 1901), and a key to the species of the genus (Diplopoda: Callipodida: Schizopetalidae). *Zootaxa* 419:1–8.
- Strasser C. 1974. I Diplopodi Chilognati della Sardegna. *Fragmenta Entomologica* 10:231–293.
- Wang D. 1996. A preliminary study on phylogeny and biogeography of the family Paracortinidae (Myriapoda: Callipodida): a cladistic analysis. *Mémoires du Muséum National d'Histoire Naturelle* 169:307–311.
- Wang D, Mauriès J-P. 1996. Review and perspective of study on myriapodology of China. *Mémoires du Muséum National d'Histoire Naturelle* 169:81–99.
- Wang D, Zhang C. 1993. A new family of millipeds (Diplopoda: Callipodida) from southwestern China. *Peking National History Museum Memoirs* 53:375–390.
- Zhang C. 1993. Diplopoda from Yunnan caves. II. Contribution to the study of a new cavernous taxon of the nematophoran millipeds (Diplopoda: Coelocheta: Callipodida). *Proceedings of the XI International Congress of Speleology, Beijing; 1993. Beijing: International Union of Speleology.* p 128–130.