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# Immature Stages and Hosts of Two Plesiomorphic, Antillean Genera of Membracidae (Hemiptera) and a new species of *Antillotolania* from Puerto Rico

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## Abstract

The nymphs of *Antillotolania* Ramos and *Deiroderes* Ramos are described for the first time, along with the first host record for the genus *Antillotolania*, represented by *A. myricae*, **sp. n.** Nymphal features of both genera, such as a ventrally fused, cylindrical tergum IX (anal tube), the presence of abdominal lamellae, and heads with foliaceous ventrolateral lobes confirm their placement in Membracidae and are consistent with phylogenetic analyses placing them in Stegaspidinae but in conflict with a cladistic analysis showing a closer relationship to Nicomiinae. Head processes and emarginate forewing pads in the last instars of both genera support an earlier estimate, based on nuclear genes, that the two genera form a monophyletic group in Stegaspidinae. Distinguishing features of the four species of *Antillotolania* are tabulated.

## Keywords

Caribbean, Antilles, new species, immature stages, host plant

## Introduction

Treehoppers of the family Membracidae are best known for an enlarged, often extravagant pronotum expanded posteriorly over the scutellum (completely or partially concealing the scutellum) or more usually over the entire body. Indeed, until recently this was a diagnostic feature of the family Membracidae. Deitz (1985) was the first since 1928 to include species in this family with pronota that did not project posteriorly – *Hemicentrus* Melichar (Leptocentrini) of the Old World and *Abelus* Stål (Abelini) of the New World. Both *Hemicentrus* and *Abelus* have a distinctly emarginate scutellum, which was characteristic of all membracids that have the pronotum expanded over, but not concealing the scutellum (extant Stegaspidinae and Centrotinae). The emarginate scutellum therefore suggests that the posteriorly projecting pronotum was secondarily lost in *Hemicentrus* and *Abelus*.

Other treehoppers lacking a posteriorly projecting pronotum, but with an acuminate or truncate scutellum, were placed in the treehopper families Aetalionidae, Biturritiidae, and Nicomiidae (Metcalf and Wade 1965). Based on a the first phylogenetic analysis of the superfamily membracoidea (Dietrich and Deitz 1993), Deitz and Dietrich (1993) referred some nicomiid species to the treehopper family Aetalionidae but incorporated many of these taxa into a newly defined Membracidae as the subfamilies Endoiastinae and Nicomiinae, except for two genera for which they erected the new family Melizoderidae. They left four genera, previously placed in Nicomiidae (with short pronotum) unplaced within Membracidae: *Holdgatiella* Evans, *Euwalkeria* Goding, *Antillotolania* Ramos, and *Deiroderes* Ramos.

*Antillotolania* and *Deiroderes* (Ramos 1957) are endemic to the northern Antilles. There are also a number of membracids without a posteriorly projecting pronotum known from Eocene-Miocene amber deposits from the Dominican Republic (McKamey 1998); none have been described but one was correctly identified (Shcherbakov 1992) as a member of the subfamily Stegaspidinae.

Several attempts have been made to determine the phylogenetic placement of *Deiroderes* and *Antillotolania* within Membracidae. In a molecular phylogenetic investigation of Membracidae, Cryan et al. (2000) found these two genera to be placed with Microcentrini (Stegaspidinae), although the subfamily was paraphyletic in that analysis. Dietrich et al. (2001) recovered, in a cladistic analysis of Membracidae based on morphological evidence, *Deiroderes* within the subfamily Stegaspidinae, whereas *Antillotolania* was placed as the sister group to (Nicomiinae + (Centronodinae + Centrodontinae)); statistical support for those placements was equivocal, however.

In a separate phylogenetic analysis based on morphological evidence, Cryan et al. (2003) recovered [*Deiroderes* + *Antillotolania*] as the monophyletic sister-group to [Microcentrini + Stegaspidini]. Later, Cryan et al. (2004) presented the results of an analysis combining molecular and morphological evidence, yielding similar placements of *Deiroderes* and *Antillotolania* as in the Cryan et al. (2000) study; they concluded that both *Deiroderes* and *Antillotolania* should remain unplaced within Stegaspidinae until further analysis could resolve these relationships.

Cryan and Bartlett (2002) described two new species of *Antillotolania* but left the genus unplaced, noting conflicting hypotheses of relationship between the Dietrich et al.

(2001) morphological analysis, which suggested it was allied to Nicomiinae, and that of Cryan et al. (2000), in which *Antillotolania* was most closely related to *Deiroderes* and some Stegaspidinae. They suggested that it may be warranted to expand the concept of Stegaspidinae to include both *Antillotolania* and *Deiroderes*. Cryan and Deitz (2002) described a new species of *Deiroderes* and a new genus, *Togotolania*, also from the Antilles that lacks a posteriorly projecting pronotum. They referred *Deiroderes* to unplaced Stegaspidinae and argued that their new genus most likely is allied to Nicomiinae.

Both cladistic estimates incorporating morphology (Dietrich et al. 2001, Cryan et al. 2004) used features of immatures, hitherto unknown for *Antillotolania* and *Deiroderes*. Both genera are exceedingly rare in collections and no immatures were known.

In the present paper we describe a new species of *Antillotolania*, with host and habitat based on multiple series of adults and immatures collected along the central mountain range of Puerto Rico and describe its immature stages. We also describe the fifth instar of *Deiroderes*, based on one specimen collected from the reported host and adjacent to the type locality of *D. inermis* Ramos in the xeric region of Guánica, Puerto Rico. We also discuss the subfamiy placement of the two genera in the light of the new evidence.

## Taxonomy

### *Antillotolania* Ramos

Prior to this work, this genus contained three species: *A. doramariae* Ramos and *A. extrema* Cryan & Bartlett from Puerto Rico, and *A. microcentroides* Cryan & Bartlett from Guadeloupe and Tortola (British West Indies). These are represented by a total of seven specimens and nothing is known of their biology. No male of *A. extrema* has been collected. The new species is represented by 11 adult specimens and nymphs.

The originally monotypic genus was described based on one female, lost, and one male, both from Maricao, Puerto Rico. The forewing venation, which contains phylogenetically important characters, differed in the two illustrations. In recent years, a few additional *Antillotolania* have been captured by sweeping vegetation in the U.S. Virgin Islands (J. Cryan, C. Bartlett, pers. comm.), which has enabled their incorporation into phylogenetic estimates using molecular data (Cryan et al. 2000; Cryan et al. 2004).

### *Antillotolania myricae* McKamey & Brodbeck, sp. n.

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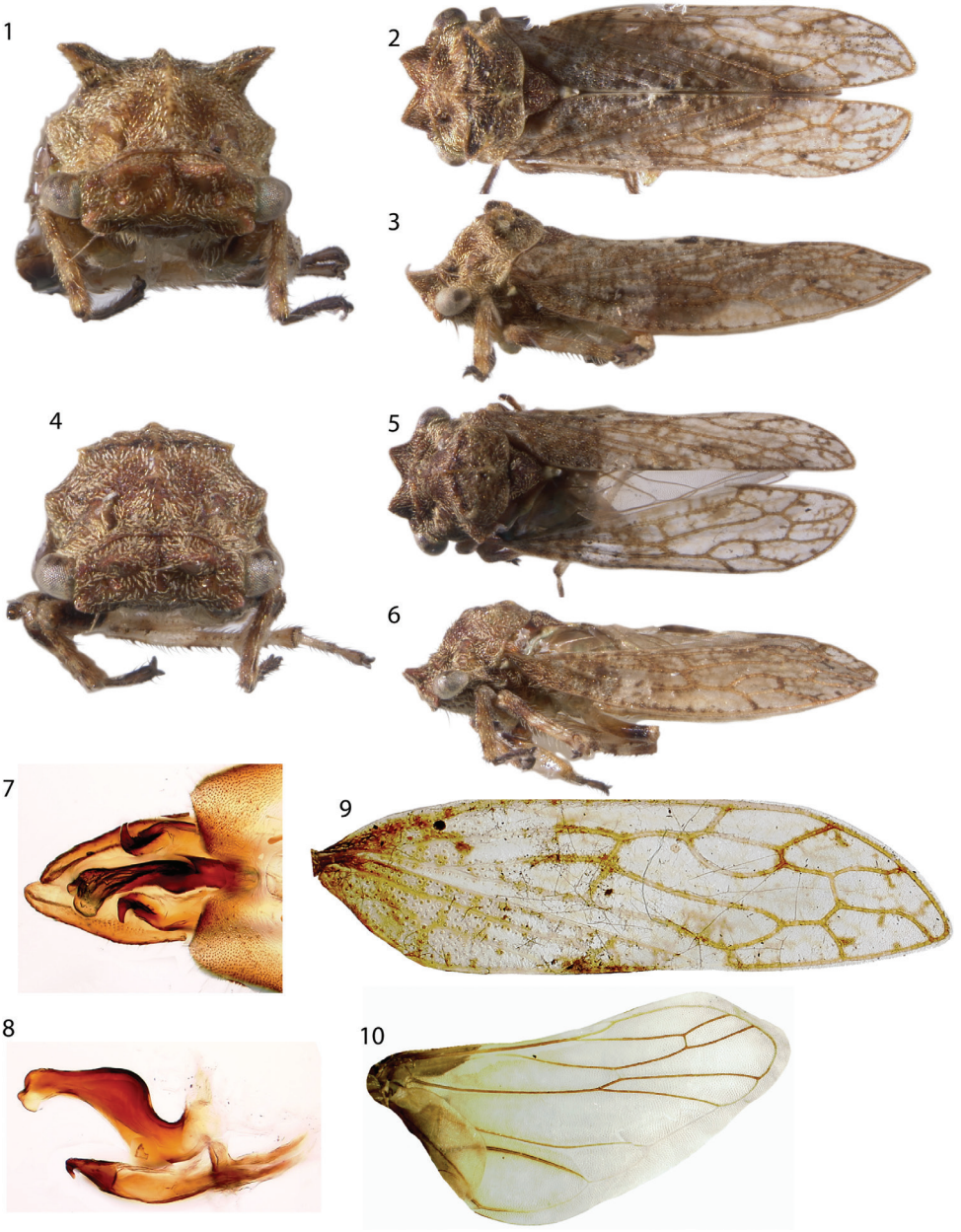
http://species-id.net/wiki/Antillotolania_myricae
Figs 1–17, 28–31

**Description.** Dimensions (mm): Length with forewings in repose female 6.2, male 5.8, width between humeral angles female 1.8, male 1.6. Head and thorax densely pilose. Head quadrate in anterior view, in dorsal view with two subtriangular projections, longitudinally carinate behind eyes. Forewing (Fig. 9) M and Cu fused at base, 3 m-cu




**Figures 1–10.** *Antillotolania myricae*, sp. n. **1–3** female habitus in anterior, dorsal, and lateral views, respectively **4–6** male, same views **7** Dorsal views, distal half of pygofer with aedeagus and styles in resting position over subgenital plates. **8** Lateral view, aedeagus and styles **9–10** left forewing and hind wing, respectively.

crossveins, 2 r-m veins, R branched into $R_{1-3}$ and $R_{4+5}$ basad of fork of vein M. Hindwing (Fig. 10) with 1 r-m crossvein and 1 m-cu crossvein, cubital vein un-branched, anal vein branched. Pro- and mesothoracic legs lacking cucullate setae. Metathoracic

tibia with cucullate setae in rows I, II, and III as follows: ca. 20 in row I along entire length; ca. 10 in row III throughout distal half; and fewer than 10, larger cucullate setae in row II irregularly spaced in conjunction with darkly pigmented sections of tibiae (pale row II edge densely pilose but setae without cucullate bases). Abdomen lacking abdominal lamellae, vestiture (see Dietrich 1989) consisting of microtrichia (Fig. 17), as in *Microcentrus* Stål.

Male (Figs 4–8): Pronotum with small shelf like suprahumeral developments, little more than carinae that do not extend from the pronotal surface (Fig 4–6). Pygofer and subgenital plates bare, not setose, lacking projections. Styles with base long and subparallel, acute apices recurved laterally (Fig. 7). Aedeagus asymmetrical in dorsal view, lobe of apex curving to the right (Fig. 7); shaft sinuate, directed dorsally then posteriorly, apex expanded (Fig. 8).

Female (Figs 1–3): Resembling male but pronotum with prominent suprahumeral horns, subtriangular, projecting dorsolaterally (Figs 1, 28).

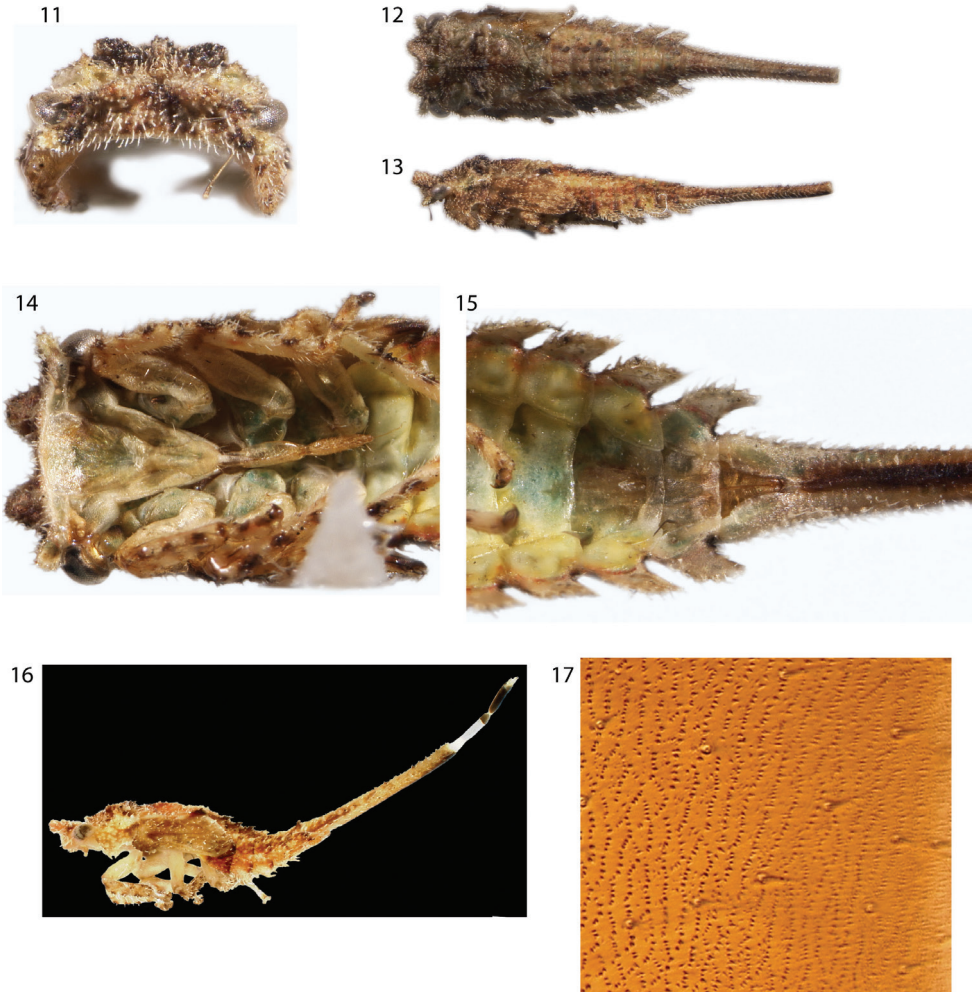
Nymph (Figs 11–16): Fifth instar length 6.2 mm. Densely pilose and dorsoventrally compressed throughout. Head with subtriangular projections directed anteriorly as in adult, in anterior view ventral margin carinate, excavated, with ventrolateral lobes, in lateral view posterolaterally emarginate. Thoracic nota lacking scoli. Forewing ventrally emarginate. Abdominal terga IV-VII with large lateral lamellae directed posterolaterally, smaller on IV and subequal on V-VIII; tergum IX fused ventrally, forming 'anal tube', length subequal to remaining terga combined in last instar, as long as remainder of abdomen and thorax combined in earlier instars. Terga III-VIII with 2 pairs of enlarged chalazae, the first near mid line and the second between the first and the abdominal lamellae. Tergum IX slightly wider at base, otherwise parallel-sided, completely fused ventrally. Nascent genitalia barely exceeding posterior limit of tergum VIII lamellae (Fig. 15).

**Material examined.** Holotype male (USNM), Puerto Rico, municipio Maricao, km 63.1 rt. 120, ca. 4 air km S Maricao. 18°08.429N; 66°58.322W, 777m, 2 May 2005. S. McKamey & B. V. Brodbeck. Paratypes (USNM, NCSU): 3 females, 11 nymphs, same locality as holotype. 3 early instar, mun. Patillas-San Lorenzo, km 5 rt.7740 nr. jxn. rt. 181, 18.10002°N; 66.01812°W, 664 m, 27 Feb 2007, S. McKamey & L.L. Deitz. 2 males, 2 females, 3 nymphs, mun. Guayama, km. 0.7 rt. 742 off rt. 7741 nr. El Chino, ca. 6 air km N Guayama, 18.05422°N; 66.10001°W, 632 m, 27 Feb 2007, S. McKamey & L.L. Deitz. 2 females, 1 nymph, mun. Cayey, rt. 7737, 1.5 air km SE Cayey, 18.08516°N; 66.17194°W, 730 m, 27 Feb 2007, S. McKamey & L.L. Deitz. 1 male, 2 nymph, mun. Cayey, rt. 184 just S jxn. 173, nr. Carite Recreational Area, 18.13181°N; 66.07427°W, 497 m, 2 March 2007, S. McKamey.

**Host.** All specimens collected from *Myrica splendens* (Sw.) DC., Myrtaceae, a weedy species of the West Indies, Mexico, Central and South America.

**Habitat.** Moist highlands of Puerto Rico.

**Remarks.** Based on our series of 11 adults and over 20 immatures, the venation and nymphal characters coded ambiguously in phylogenetic estimates of the family




**Figures 11–17.** *Antillotolania myricae* sp. n. **11–15** fifth instar in anterior, dorsal, lateral and detail ventral views, respectively **16** third instar, with proportionately longer 'anal tube' (ventrally fused tergum IX) **17** surface vestiture of adult abdominal tergum IV.

have been determined, as discussed below. No adults of the new species were obtained from rearing, but both adults and nymphs were repeatedly obtained from the same host at the same time, at a variety of localities, without finding any other membracids. Note that the male of *A. extrema*, if discovered, may have smaller suprahumeral horns, as evidenced by the strong sexual dimorphism exhibited by the new species. The first couplet in the key provided by Cryan and Bartlett (2002) divides species by the presence or absence of developed suprahumeral horns, hence the males and females of the new species would key out separately. The following table enables identification of adults of all species in the genus.

| **Characters** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|
| *A. doramariae* | 0 | 0 | 0 | 0 | 0 |
| *A. extrema* | 1 | 1 | 1 | 1 | 1 |
| *A. microcentroides* | 1 | 1 | 0 | 1 | 0 |
| *A. myricae* female | 1 | 0 | 1 | 1 | 0 |
| *A. myricae* male | 0 | 0 | 1 | 1 | 0 |

Characters and states:

1. Suprahumeral horns present only as carinae (0) or projecting from adjacent pronotal surface (1).

2. Forewing vein $R_{4+5}$ fused with $R_1$ basad (0) or distad (1) of fork of vein M.

3. Forewing crossvein m-cu3 originating basad (0) or distad (1) of fork of vein M.

4. Forewing vein $A_1$ smoothly merging with claval vein (0) or bent at a right angle and perpendicularly connecting to clavela vein (1).

5. Metathoracic tibia with cucullate setae in rows I, II, and III (0) or row II only (1).

## ***Deiroderes*** **Ramos**

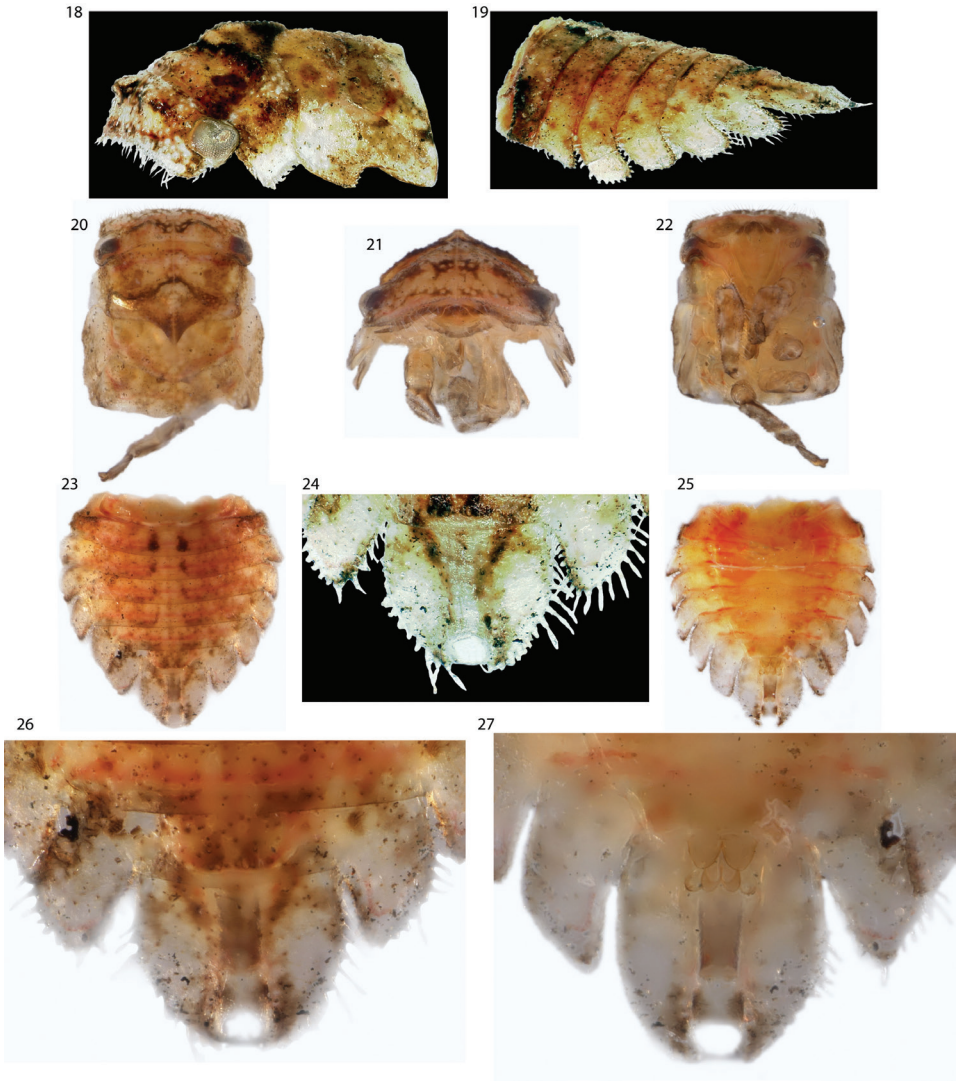
*Deiroderes* contains three species: *D. inermis* Ramos from Puerto Rico and nearby islands of the British West Indies, *D. inornatus* Cryan & Deitz from Jamaica, and *D. punctatus* Metcalf & Bruner from Cuba. These were represented by a total of 13 specimens, with nothing known of their biology except one host record for *D. inermis*: *Capparis indica* (L.) Fawc. & Rendle (Capparaceae) (but see Cryan & Deitz [2002] regarding a conflict with this host record).

### ***Deiroderes inermis*** **Ramos**

http://species-id.net/wiki/Deiroderes_inermis

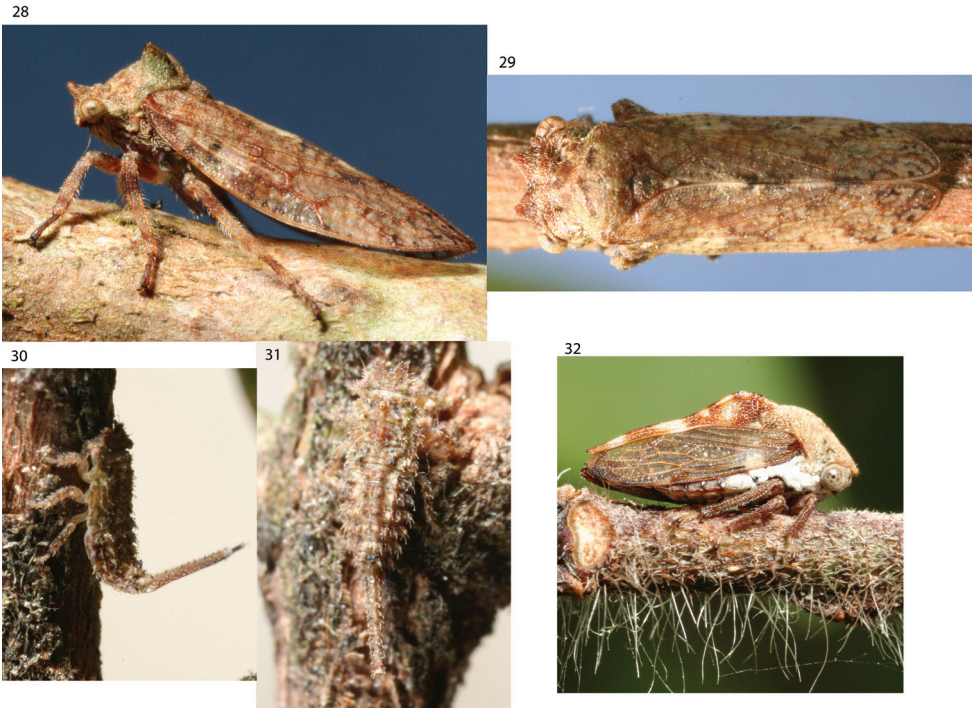
Figs 18–27

**Description.** Nymph (fifth instar): Length 3.5 mm. Glabrous throughout. Head with small protrusions (Fig. 18) in same placement as the large subtrianglar projections of *Antillotolania*, in anterior view ventral margin carinate, head ventrally excavated, with foliaceous ventrolateral lobes (Figs 20, 21), in dorsal view quadrate, in lateral view not emarginate. Thoracic nota lacking scoli. Forewing emarginate. Abdominal terga IV–VII with large lateral lamellae, directed posterolaterally, smallest on tergum IV and increasing in size posteriorly; tergum IX fused ventrally, forming short 'anal tube', length about 2 × longer than tergum VIII. Terga III–VIII each with 1 pair of enlarged chalazae near mid line. Tergum IX dorsoventrally compressed. Nascent genitalia barely exceeding posterior limit of tergum VII lamella .




**Figures 18–27.** *Deiroderes inermis* immature, bisected during capture. **18, 20–22** head and thorax in oblique, dorsal, anterior, and ventral views, respectively **19, 23–27** abdomen in oblique (**19**), dorsal (**23, 24, 26**) and ventral (**25, 27**) views. Head processes visible in **18**, anal tube opening visible in **24**, and nascent genitalia visible in **27**.

**Remarks.** Caught sweeping a uniform stand of *Capparis indica*, a recorded host of *D. inermis*, adjacent to Guánica State Forest, which is the type locality of *D. inermis*. The Guánica area of Puerto Rico is arid and other membracids were previously unknown from there until L.L. Deitz (North Carolina State University) and SHM discovered *Nessorhinus abbreviatus* Ramos (Fig. 32) in February, 2007, on a different, unidentified host in February, 2007. Nymphs of *N. gibberulus* Stål are known (McKamey unpubl.) and the fifth instars are several millimeters longer than that of *D. inermis*.




**Figures 28–32.** Photographs of live Puerto Rican Membracidae. **28–31** *Antillotolania myricae*, sp. n. adult female (**28**), adult male (**29**), third instar (defensive position) (**30**), and fifth instar (**31**), all on *Myrica splendens* (Myrtaceae) **32** *Nessorhinus abbreviatus* Ramos in same xeric habitat of *Deiroderes inermis* type locality (Guánica) on an unidentified host.

## Discussion

The anal tube (a ventrally fused abdominal segment IX, from which the anal segments protrude when defecating) present in nymphs of both *Antillotolania* and *Deiroderes* is a diagnostic feature of Membracidae. The nymphs of both genera display many features characteristic of other cryptic membracid nymphs: a flattened body and large abdominal lamellae that break up their body outline and an emarginate forewing pad providing a space for the mesothoracic tibia to rest, increasing their crypsis, suggesting that the two genera are correctly placed in that family. In some other membracid immatures with emarginate forewing pads, the tibiae are also flattened, but this is not the case in *Antillotolania* or *Deiroderes*. Instead, these have a pronotum that is posterolaterally emarginate, providing a resting place for the prothoracic tibia as well, as also occurs in some other membracids, such as some Darninae.

Placing *Antillotolania* and *Deiroderes* to subfamily and tribe is more problematic. The two possible subfamilies (with short pronotum) are Nicomiinae and Stegaspidinae. There are few nicomiine immatures known and all have been associated indirectly with adults due to the solitary nature of the species and difficulty of rearing adults. An illustration of a *Tolania* Stål nymph, which lacks any trace of abdominal lamellae, was provided by Dietrich et al. (2001). Thus, as far as known, nicomiine immatures lack

abdominal lamellae. In contrast, all stegaspidines whose immatures are known, encompassing both Stegaspidini and Microcentrini, have well developed abdominal lamellae (Cryan and Deitz 1999a, 1999b, 2000; Cryan et al. 2003). The presence of foliaceous ventrolateral lobes on the head of both *Antillotolania* and *Deiroderes* also allies them with Stegaspidinae. The surface vestiture of the adult abdomen in *Antillotolania* and *Deiroderes* is shared with *Microcentrus*. This feature should not be construed as additional supporting evidence for their inclusion in Microcentrini or even Stegaspidinae because, firstly, other Membracoidea inside and outside the family Membracidae have the same character state and, secondly, the vestiture of *Antillotolania* and nicomiids were not examined in Dietrich's (1989) survey. The only known membracid nymphs with elongate, ventrally fused 'anal tubes' (Figs 12–16) are *Tolania* and *Antillotolania*, suggesting that this feature may be a synapomorphy and thus evidence of a nicomiine relationship.

In a phylogenetic study, Dietrich et al. (2001) recovered *Deiroderes* in Stegaspidinae and correctly predicted character states of the immatures, including the synapomorphy of the subfamily (head with foliaceous ventrolateral lobes, Figs 18, 20–22). In contrast, *Antillotolania* was recovered as a sister-group to [Nicomiinae + Centronodinae], but the analysis incorrectly predicted several character states: the anal tube is cylindrical, not ventrolaterally angulate, there are two rows, not one, of enlarged chalazae on each side of the abdomen (Fig. 12) and the head has foliaceous ventrolateral lobes (Figs 11, 14) again, a synapomorphy of Stegaspidinae). Based on these findings the subfamily placement of the two genera treated here remains unclear.

It may be that the head processes and emarginate forewing pads (Figs 13, 16) found in *Antillotolania*, *Deiroderes*, and some other cryptic membracids (but not in stegaspidine immatures) are homologous, giving morphological support to the hypothesis of Cryan et al. (2000) that these two enigmatic Antillean genera are sister-taxa.

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## References

Cryan JR, Bartlett CR (2002) A redescription of the Caribbean treehopper genus *Antillotolania* Ramos (Hemiptera: Membracidae), with two new species. Annals of the Entomological Society of America 95(3): 302–308. doi: 10.1603/0013-8746(2002)095[0302:AROTCT]2.0.CO;2

Cryan JR, Deitz LL (2000) Review of the New World treehopper tribe Stegaspidini (Hemiptera: Membracidae: Stegaspidinae): III: *Flexocentrus* Goding, *Stylocentrus* Stål, and *Umbelligerus* Deitz. Proceedings of the Entomological Society of Washington 102: 82–98.

Cryan JR, Deitz LL (1999a) Review of the New World treehopper tribe Stegaspidini (Hemiptera: Membracidae: Stegaspidinae): I: *Bocydium* Latreille, *Lirania* Stål, and *Smerdalea* Fowler. Proceedings of the Entomological Society of Washington 101: 469–489.

Cryan JR, Deitz LL (1999b) Review of the New World treehopper tribe Stegaspidini (Hemiptera: Membracidae: Stegaspidinae): II: *Lycoderes* Germar, *Oeda* Amyot and Serville, and *Stegaspis* Germar. Proceedings of the Entomological Society of Washington 101: 760–778.

Cryan JR, Deitz LL (2002) Enigmatic Treehoppers (Hemiptera: Membracidae): *Deiroderes* Ramos, *Holdgatiella* Evans, and *Togotolania*, New Genus. Proceedings of the Entomological Society of Washington 104(4): 867–882.

Cryan JR, Robertson JA, Deitz LL (2003) The New World treehopper tribe Microcentrini (Hemiptera: Membracidae: Stegaspidinae): Monographic revision and phylogenetic position. Thomas Say Publications in Entomology: Monographs, Entomological Society of America (Lanham, Maryland). *iii* + 108 pp.

Cryan JR, Wiegmann BM, Deitz LL, Dietrich CH (2000) Phylogeny of the treehoppers (Insecta: Hemiptera: Membracidae): Evidence from two nuclear genes. Molecular Phylogenetics and Evolution 17(2): 317–334. doi: 10.1006/mpev.2000.0832

Cryan JR, Wiegmann BM, Deitz LL, Dietrich CH, Whiting MF (2004) Treehopper trees: Phylogeny of Membracidae (Hemiptera: Cicadomorpha: Membracoidea) based on molecules and morphology. Systematic Entomology 29: 441–454. doi: 10.1111/j.0307-6970.2004.00260.x

Deitz LL (1985) Placement of the genera *Abelus* Stål and *Hemicentrus* Melichar in the subfamily Centrotinae (Homoptera: Membracidae). Proceedings of the Entomological Society of Washington 87: 161–170.

Deitz LL, Dietrich CH (1993) Superfamily Membracoidea (Homoptera: Auchenorrhyncha). I. Introduction and revised classification with new family-group taxa. Systematic Entomology 18: 287–296. doi: 10.1111/j.1365-3113.1993.tb00667.x

Dietrich CH (1989) Surface sculpturing of the abdominal integument of Membracidae and other Auchenorrhyncha (Homoptera). Proceedings of the Entomological Society of Washington 91(2): 143–152.

Dietrich CH, Deitz LL (1993) Superfamily Membracoidea (Homoptera: Auchenorrhyncha). II. Cladistic analysis and conclusions. Systematic Entomology 18: 297–311. doi: 10.1111/j.1365-3113.1993.tb00668.x

Dietrich CH, McKamey SH, Deitz LL (2001) Morphology-based phylogeny of the treehopper family Membracidae (Hemiptera: Cicadomorpha: Membracoidea). Systematic Entomology 26: 213–239. doi: 10.1046/j.1365-3113.2001.00140.x

McKamey SH (1998) Taxonomic catalogue of the Membracoidea (exclusive of leafhoppers). Second supplement to fascicle 1--Membracidae of the general catalogue of the Hemiptera. Memoirs of the American Entomological Institute 60: [1]–377.

Metcalf ZP, Wade V (1965) General Catalogue of the Homoptera. A Supplement to Fascicle 1 – Membracidae of the General Catalogue of Hemiptera. Membracoidea. In Two Sections. North Carolina State University, Raleigh. 1552 pp.

Ramos JA (1957) A review of the auchenorhynchous [sic] Homoptera of Puerto Rico. Journal of Agriculture the University of Puerto Rico 41(1): 38–117.

Shcherbakov DE (1992) The earliest leafhoppers (Hemiptera: Karajassidae n. fam.) from the Jurassic of Karatau. Neues Jahrbuch für Geologie und Paläontologie Monatshefte 1992(1): 39–51.

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# *Cardiocondyla pirata* sp. n. – a new Philippine ant with enigmatic pigmentation pattern (Hymenoptera, Formicidae)

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## Abstract

A new species of the ant genus *Cardiocondyla* Emery, 1869 – *Cardiocondyla pirata* **sp. n.** – is described from the Philippines. The species belongs to an Indo-Malayan group of six species that is characterized by workers having a strongly bilobate postpetiolar sternite and a thickset mesosoma with strongly convex dorsal profile as well as wingless, ergatoid males with sickle-shaped mandibles. The female castes show a pigmentation pattern not known from any ant worldwide. If having any adaptive value, a possible function of this structure is supposed to be visual dissolution of body shape in order to irritate predators.

## Keywords

*Cardiocondyla,* ergatoid males, Indo-Malayan region

## Introduction

105 available names are listed in the ant genus *Cardiocondyla* Emery, 1869 and 68 of these are currently considered to designate bona species (Bolton 2012). While there is a rather good taxonomic knowledge of the species groups distributed in the Palaearctic (Seifert 2003), the situation in the Oriental, Indo-Malayan and Australasian faunal regions is poorly known. This is indicated by the fact that there is a minimum of 15 morphologically well-separated, but yet undescribed species from this region in the collection of the Senckenberg Museum of Natural History Goerlitz (unpublished protocols of the senior author).

During a field study of ants in the Hortarium of the Los Baños University / Philippines, one of the authors collected two nest samples of a *Cardiocondyla* species that shows a pigmentation pattern unknown in any ant worldwide. The new species belongs to a species group that is distributed from Thailand across the whole Indo-Malayan region and contains a minimum of six yet undescribed species. This species group is characterized by a strongly bilobate postpetiolar sternite, a thickset mesosoma with strongly convex dorsal profile and wingless, ergatoid males with sickle-shaped mandibles.

## Methods

### Recording of morphological data

Nineteen morphometric characters were investigated. In bilaterally recorded characters, arithmetic means of both body sides were calculated. All measurements were made on mounted and dried specimens using a pin-holding stage, permitting full rotations around X, Y, and Z axes. A Leica M165C high-performance stereomicroscope equipped with a 2.0 planapochromatic objective (resolution 1050 lines/mm) was used at magnifications of 120–384×. The mean relative measuring error over all magnifications was 0.3%. A Schott KL 1500 cold–light source equipped with two flexible, focally mounted light–cables, providing 30°–inclined light from variable directions, allowed sufficient illumination over the full magnification range and a clear visualization of silhouette lines. A Schott KL 2500 LCD cold–light source in combination with a Leica coaxial polarized–light illuminator provided optimum resolution of tiny structures and microsculpture at highest magnifications. Simultaneous or alternative use of the cold-light sources depending upon the required illumination regime was quickly provided by regulating voltage up and down. A Leica cross-scaled ocular micrometer with 120 graduation marks ranging over 52 % of the visual field was used. To avoid the parallax error, its measuring line was constantly kept vertical within the visual field (Seifert 2002). Measurements of body parts always refer to real cuticular surface and not to the diffuse pubescence surface.

Z-stack photographs were made with a Leica Z6 APO photomicroscope equipped with 2.0× planapochromatic objective and the automontage software Leica application suite version 3.

**Definition of numeric characters**

More detailed explanations of the character recording are given in Seifert (2003). Here we repeat the verbal definitions:

**CL** maximum cephalic length in median line; the head must be carefully tilted to the position yielding the true maximum; excavations of hind vertex and/or clypeus reduce CL.

**CW** maximum cephalic width; in *Cardiocondyla*, the maximum is found usually across and including the eyes, exceptionally posterior of the eyes.

**CS** cephalic size; the arithmetic mean of CL and CW, used as a less variable indicator of body size.

**dFOV** mean inner diameter of foveolae or mesh-like surface structures on vertex at about half way between the median line of head and the inner eye margin. These structures are either real foveolae or meshes of a reticulum and usually have the base of a decumbent pubescence hair in their centre. In species whose foveolae or mesh-like structures are reduced (e.g. in the *C. stambuloffii* group) the mean diameter of the small punctures or tubercles at hair bases is measured as dFOV. At least seven measurements are averaged.

**EYE** eye-size: the arithmetic mean of the large (EL) and small diameter (EW).

**FRS** distance of the frontal carinae immediately caudal of the posterior intersection points between frontal carinae and the lamellae dorsal of the torulus. If these dorsal lamellae do not laterally surpass the frontal carinae, the deepest point of scape corner pits may be taken as reference line. These pits take up the inner corner of scape base when the scape is fully switched caudad and produce a dark triangular shadow in the lateral frontal lobes immediately posterior of the dorsal lamellae of scape joint capsule.

**MpG** Depth of metanotal groove or depression, measured from the tangent connecting the dorsalmost points of promesonotum and propodeum.

**ML** mesosoma length in the alates; measured in lateral view from the caudalmost portion of propodeum to the frontalmost point of the anterior pronotal slope (i.e., not to the frontalmost point of the whole pronotum that is usually concealed by the occiput!).

**MW** maximum mesosoma width of alates frontal of the tegulae.

**PEH** maximum petiole height. The straight section of ventral petiolar profile at node level is the reference line perpendicular to which the maximum height of petiole node is measured at node level.

**PEL** diagonal maximum length of petiole in lateral view, measured from anterior corner of subpetiolar process to dorsocaudal corner of caudal cylinder.

**PEW** maximum width of petiole.

**PLG** mean length of pubescence hairs on dorsum of first gaster tergite as arithmetic mean of 6 measurements at least.

**PPH** maximum postpetiole height; the lateral suture of dorsal and ventral sclerites is the reference line perpendicular to which the maximum height of postpetiole is measured.

**PPW** maximum width of postpetiole.

**PoOc** postocular distance. Use a cross-scaled ocular micrometer and adjust the head to the measuring position of CL. Caudal measuring point: median occipital margin; frontal measuring point: median head at level of posterior eye margin. Note that many heads are asymmetric; therefore average the left and right postocular distance.

**SL** maximum straight line length of scape excluding the articular condyle given as the arithmetic mean of both scapes.

**SPBA** the smallest distance of the lateral margins of the spines at their base. This should be measured in dorsofrontal view, since the wider parts of the ventral propodeum do not interfere the measurement in this position. If the lateral margins of spines diverge continuously from the tip to the base, a smallest distance at base is not defined. In this case, SPBA is measured at the level of the bottom of the interspinal meniscus.

**SP** maximum length of propodeal spines; measured in dorsofrontal view along the long axis of the spine, from spine tip to a line, orthogonal to the long axis, that touches the bottom of the interspinal meniscus. Left and right SP are averaged. This mode of measuring is less ambiguous than other methods but yields higher spine length values in species with reduced spines.

**sqPDG** square root of pubescence distance on dorsum of first gaster tergite. The number of pubescence hairs n crossing a transverse measuring line of length L is counted; hairs just touching the line are counted as 0.5. The pubescence distance PDG is then given by L/n. In order to normalize the positively skewed distributions, the square root of PDG is calculated. Exact counts are promoted by clean surfaces and flat, reflection-reduced illumination directed slightly skew to the axis of the pubescence hairs. Counting is performed at a magnification of 384×. Tergite pubescence is easily torn-off in *Cardiocondyla*. An effort should be made to evaluate undamaged surface spots. In specimens with mostly removed pubescence, PDG can be calculated from the mean distance of hair base pits (BD) and PLG using the formula $PDG = BD^2 / PLG$.

## Results

***Cardiocondyla pirata* sp. n.**
urn:lsid:zoobank.org:act:C1BA401A-3510-494E-B66F-CC5FCCF030A1
http://species-id.net/wiki/Cardiocondyla_pirata

**Etymology.** The species epithet refers to the black ribbon across the eye reminiscent of a pirate's blindfold.

**Type material.** Holotype worker labeled "PHI: 14.1643°N, 121.2375°E, Los Banos, University Park, 58 m, Hortarium, Frohschammer 2008.07.23 #39" and "Holotype *Cardiocondyla pirata* Seifert, 2013"; 4 workers, 3 dealate gynes and 1 ergatoid male labeled "PHI: 14.1643°N, 121.2375°E, Los Banos, University Park, 58 m, Hortarium, Frohschammer 2008.07.23 #39" and "Paratype *Cardiocondyla pirata* Seifert, 2013"; 3 workers labeled "PHI: 14.1643°N, 121.2375°E, Los Banos, University Park, 58 m, in hole of a stone at riverside, Frohschammer 2008.07.23 #32" and "Paratype *Cardiocondyla pirata* Seifert, 2013"; all material in Senckenberg Museum of Natural History Goerlitz.

**Description and differential diagnosis.** Measurements and indices in square brackets are arithmetic mean (see also Table 1).

**Worker** (Figs 1–2, Table 1): Unmistakable pigmentation pattern for an ant worldwide. Lateral head at horizontal level of eye with an extended, longitudinal, dark brown ribbon that is as broad as the eye; this ribbon is flanked below and above by broad bands without any pigment (as result appearing whitish). Vertex, scape, postpetiole, gaster, procoxae, tibiae and femora except their proximal and distal portions light yellowish brown. Mesosoma light orange brown. Petiole, meso- and metacoxae, clypeus, spines, funiculus as well as proximal and distal portions of femora without pigmentation (appearing whitish). Very small size [CS 397 μm]. Head moderately elongated [CL/CW 1.132]. Postocular distance relatively small [PoOc/CL 0.408]. Eye rather small [EYE/CS 0.226]. With maximum CL and CW in visual plane, outlines of head roughly heart-shaped, with strongly concave posterior margin and an almost straight anterior clypeal margin (a distinct concavity appears after a tilt to frontodorsal viewing position when the three clypeal macrosetae become fully visible). Frontal carinae much more closely spaced than in any related species [FRS/CS 0.242], subparallel and slightly diverging frontal of the FRS level. Mesosoma thickset, its dorsal profile evenly convex. Anterior pronotum in dorsal view rounded, without pronounced corners. Propodeal spines straight and much shorter than in any related species [SP/CS 0.208], in dorsal view slightly diverging, in lateral view straight and with their axis deviating by 40° from longitudinal axis of mesosoma. Petiole in lateral view rather massive, clearly higher than postpetiole, with a short peduncle, a slightly concave anterior profile and a convex dorsal node that steeply slopes down to the caudal cylinder; the node in dorsal view semiglobular and slightly wider than long. Postpetiole in dorsal view with a straight or slightly concave anterior margin, rounded sides and much wider than long; its sternite with pronounced anterolateral corners that are formed by bilateral lobes which strongly protrude compared to anteromedian level. Whole surface of head, mesosoma and petiole with a very fine (mesh diameter on vertex only 8-9 μm) but deeply sculptured reticulum, thus appearing at lower magnifications perfectly matt. Postpetiole less deeply sculptured. Scapes, coxae, femora and tibiae with fine microreticlum and appearing matt at lower magnifications. First gaster tergite very finely microreticulate-shagreened, also appearing matt at lower magnifications. All cuticular surfaces including those of the appendages with decumbent, dilute pubescence. Pubescence on 1st gaster tergite much longer and denser than in any related species [PLG/CS 7.21%,

**Table 1.** Morphometric data of workers, gynes and a male of *Cardiocondyla pirata* sp. n. Worker data of five undescribed, most closely related species are given - the strings in capitals are code designations of these species in the files of B. Seifert. Arrangement of data: arithmetic mean ± standard deviation [lower extreme, upper extreme]. Measurements of *C. pirata* workers radically differing from those of related species are given in bold.

| | **sp.: ARGE, ARGY, ARPI, LATI, MISE** | ***Cardiocondyla pirata* sp. n.** | | |
|---|---|---|---|---|
| | **worker (n=174)** | **worker (n=6)** | **gyne (n=3)** | **male (n=1)** |
| CS [μm] | 423 ± 45<br>[358,556] | 397 ± 4<br>[392,402] | 437 ± 3<br>[433,440] | 341 |
| CL/CW | 1.113 ± 0.027<br>[1.040,1.182] | 1.132 ± 0.010<br>[1.120,1.147] | 1.152 ± 0.005<br>[1.146,1.155] | 1.070 |
| SL/CS | 0.829 ± 0.018<br>[0.785,0.892] | 0.807 ± 0.005<br>[0.800,0.816] | 0.792 ± 0.011<br>[0.782,0.804] | 0.707 |
| PoOc/CL | 0.418 ± 0.011<br>[0.389,0.455] | 0.408 ± 0.005<br>[0.404,0.416] | 0.401 ± 0.002<br>[0.398,0.402] | 0.420 |
| EYE/CS | 0.228 ± 0.009<br>[0.204,0.247] | 0.226 ± 0.002<br>[0.223,0.229] | n.r. | 0.210 |
| dFov [μm] | 16.4 ± 1.8<br>[10.9,20.0] | 8.6 ± 0.3<br>[8.2,9.0] | 13.7 ± 2.8<br>[10.9,16.5] | n.r. |
| FRS/CS | 0.325 ± 0.020<br>[0.263,0.357] | **0.242** ± 0.007<br>[0.235,0.254] | 0.248 ± 0.006<br>[0.242,0.254] | 0.347 |
| MW/CS | n.r. | n.r. | 0.797 ± 0.016<br>[0.784,0.815] | 0.789 |
| ML/CS | n.r. | n.r. | 1.301 ± 0.005<br>[1.297,1.306] | 1.161 |
| MGr/CS | 0.38 ± 0.36<br>[0.0,1.48] | 0.0 ± 0.0<br>[0,0] | n.r. | 0.0 |
| SPBA/CS | 0.358 ± 0.020<br>[0.303,0.414] | 0.373 ± 0.005<br>[0.364,0.378] | 0.438 ± 0.015<br>[0.422,0.452] | 0.351 |
| SP/CS | 0.366 ± 0.062<br>[0.232,0.476] | **0.208** ± 0.004<br>[0.204,0.214] | 0.229 ± 0.005<br>[0.223,0.232] | 0.161 |
| PEW/CS | 0.310 ± 0.020<br>[0.267,0.362] | 0.359 ± 0.004<br>[0.355,0.367] | 0.392 ± 0.002<br>[0.391,0.394] | 0.419 |
| PPW/CS | 0.459 ± 0.028<br>[0.397,0.531] | 0.468 ± 0.004<br>[0.462,0.475] | 0.532 ± 0.007<br>[0.524,0.537] | 0.582 |
| PEH/CS | 0.355 ± 0.018<br>[0.315,0.422] | 0.343 ± 0.006<br>[0.335,0.354] | 0.391 ± 0.006<br>[0.386,0.398] | 0.387 |
| PPH/CS | 0.299 ± 0.031<br>[0.231,0.359] | 0.320 ± 0.008<br>[0.308,0.328] | 0.361 ± 0.005<br>[0.358,0.366] | 0.372 |
| sqPDG | 5.34 ± 1.04<br>[3.42,8.25] | 3.92 ± 0.13<br>[3.74,4.12] | 2.63 ± 0.07<br>[2.55,2.68] | 3.66 |
| PLG/CS [%] | 4.37 ± 1.21<br>[2.14,6.75] | **7.21** ± 0.26<br>[6.87,7.54] | 7.68 ± 0.24<br>[7.49,7.95] | 9.53 |

sqPDG 3.92], on anterior surface directed caudad and on posterior one caudomediad. For morphometric data of 6 workers (three from each sample) see Table 1.

**Gyne** (Figs 3, 4, Table 1): Unmistakable pigmentation pattern most similar to that described in the worker. Very small size [CS 437 μm]. Head shape comparable to

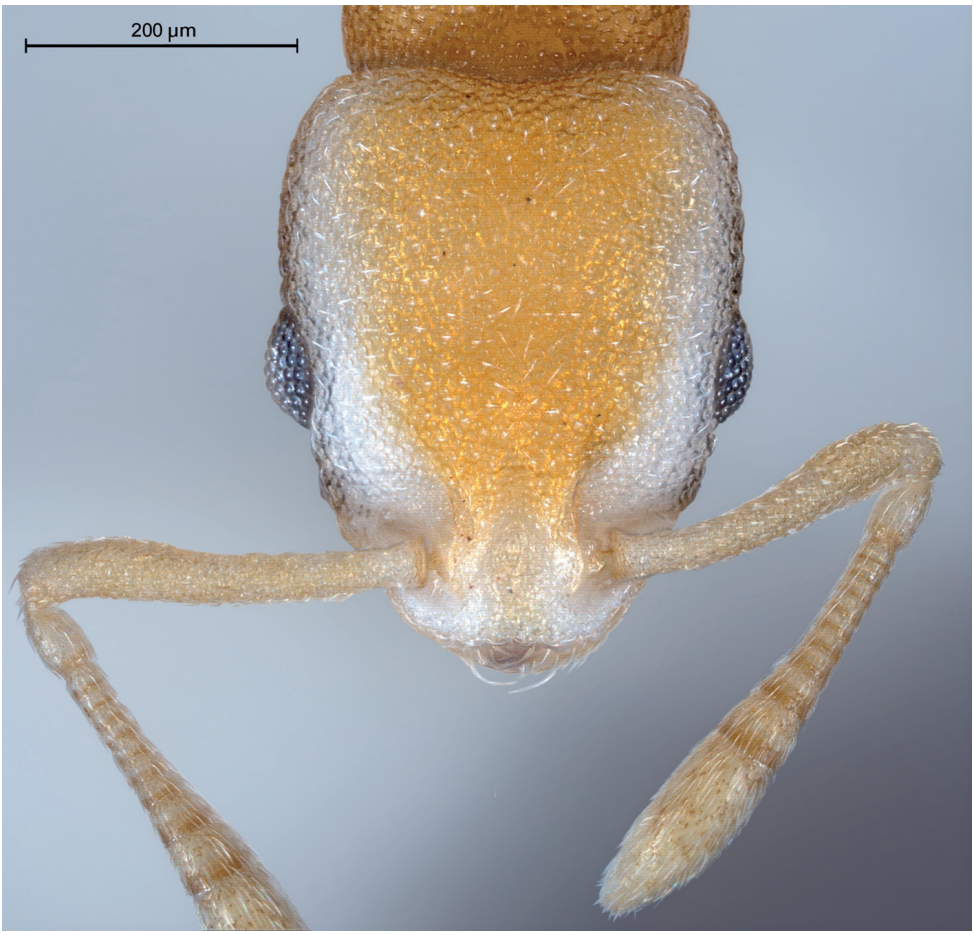


**Figure 1.** Head of holotype worker in dorsal view.

worker but head more elongated, CL/CW 1.152. Postocular distance relatively small [PoOc/CL 0.401]. Frontal carinae much more closely spaced than in any related species [FRS/CS 0.248], subparallel and slightly diverging frontal of the FRS level. Mesosoma shorter than in the next related species [ML/CS 1.301]. Propodeal spines straight and much shorter than in any related species [SP/CS 0.229], in dorsal view slightly diverging, in lateral view straight and with their axis deviating by 30° from longitudinal axis of mesosoma. Petiolar and postpetiolar shape comparable to worker but with the usual gyne-specific shape transformation: increased segment width and height relative to their length and postpetiole in dorsal view with a more concave anterior margin. All body surfaces appearing matt at lower magnification. Cuticular sculpture on all body surfaces similar to worker but several larger foveolae of 15–21 µm diameter, showing a central tubercle as basis of a pubescence hair, are interspersed within the fine reticulum of head and mesosoma. All cuticular surfaces, including those of the appendages, with decumbent, dilute pubescence. Pubescence on 1st gaster tergite much longer and

**Figure 2.** Lateral aspect of holotype worker.

denser than in any related species (PLG/CS 7.68%, sqPDG 2.63), on anterior surface directed caudad and on posterior one caudomediad. For morphometric data of 3 gynes see Table 1.

**Male** (Figs 5, 6, Table 1): Ergatoid. With exception of the blackish eyes, whole body concolorous pale yellowish. Nanitic size [CS 341 μm]. Antennae with 11 segments. Mandibles long and sickle-shaped, toothless. Head short [CL/CW 1.070]. Postocular distance relatively small [PoOc/CL 0.420]. Eye small [EYE/CS 0.210]. With maximum CL and CW in visual plane, outlines of head roughly trapezoid, with only weakly concave posterior margin and sides of head converging frontad. Anterior clypeal margin with a broad angular excision forming an angle of about 145°. Clypeus strongly extending caudad to about half length of frontal carinae. Frontal carinae much more distant than in female castes [FRS/CS 0.347] and almost parallel. Mesosoma very thickset and short, its dorsal profile evenly convex. With mesosoma in dorsal view, anterior pronotum rounded, without pronounced corners; pronotum and anterior mesonotum nearly twice as wide than the distance between the parallel sides of dorsal propodeum. Propodeal spines short, reduced to triangular dents. Petiole in lateral view more elongated, with a distinct peduncle, a concave anterior face and a high and short node that shows a rounded dorsum and falls almost perpendicularly down to the caudal cylinder. Petiolar node in dorsal view nearly 2.5fold wider than long, in anterior view strongly diverging dorsad and with an emarginate dorsal crest. Postpetiole in dorsal view 1.7 fold wider than its median length, with a slightly concave anterior margin and rounded sides; its sternite with pronounced anterolateral corners that are formed by bilateral lobes which strongly protrude compared to anteromedian level. Sculpture on all body surfaces similar to worker but sculpture and microsculpture on postpetiole and 1$^{st}$ gaster tergite less developed - as result these surfaces moderately shining. All cuticular surfaces including those of the appendages with decumbent, dilute pubescence.

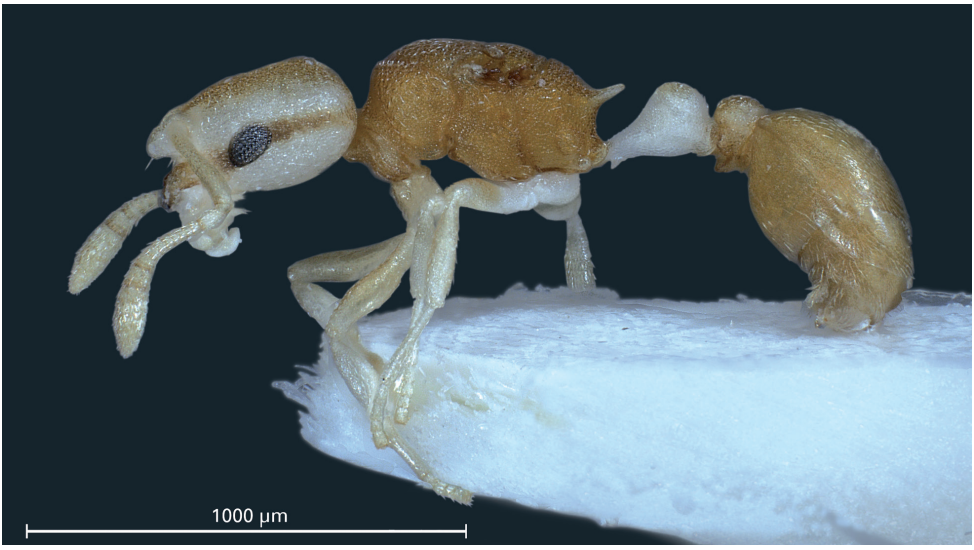


**Figure 3.** Lateral aspect of a paratype gyne. Postpetiole and gaster are distorted to a ventrolateral viewing position making visible both lobes of postpetiolar sternite.


**Figure 4.** Dorsolateral aspect of a paratype gyne. Only one lobe of postpetiolar sternite is visible.

Pubescence on 1st gaster tergite much longer than in worker [PLG/CS 9.53%, sqPDG 3.66], on anterior surface directed caudad and on posterior one caudomediad. For morphometric data of the single investigated male see Table 1.

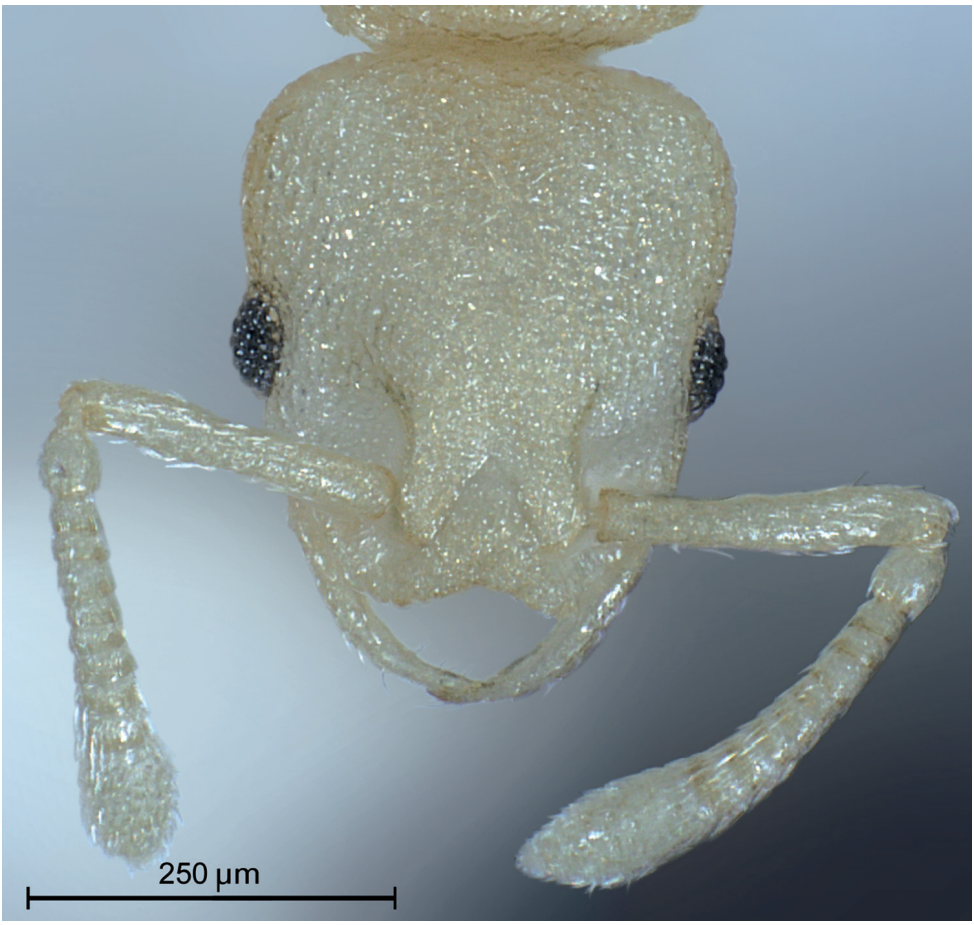


**Figure 5.** Head of the paratype male in dorsal aspect.

**Comments.** *Cardiocondyla pirata* sp. n. cannot be confused with any ant worldwide because of its unique pigmentation pattern. This clear identification is supported by diagnostic structural and shape characters: there is no overlap with the five other undescribed species of this species group in the characters FRS/CS, SP/CS and PLG/CS and there is little overlap in PEW/CS and sqPDG (Table 1).

One complete colony consisting of three dealate queens, 15 workers and brood was collected in the field. From a second colony, only a sample was taken in EtOH. The first colony produced over 20 female sexuals and one ergatoid male in the lab, but thereafter died. Hence, there are no long-term observations on the life history of this interesting species. Considering the situation in related species of the Oriental and Indo-Malayan region (Heinze et al. 2010, Oettler et al. 2010), we may predict for *C. pirata* sp. n. the following biological traits: (a) there are only ergatoid males - winged males, which are an ancestral trait in *Cardiocondyla*, are no longer developed, (b) ergatoid males are long-lived, mate always inside the nest and try to kill rivals using


**Figure 6.** Lateral aspect of the paratype male. The head is distorted to a dorsolateral viewing position.

their sickle-shaped mandibles in order to monopolize the matings and (c) nests should contain 1–4 queens.

The adaptive significance of the extraordinary pigmentation pattern of these tiny ants remains a puzzle. The poor resolution of the visual system (workers and males have only 50–65 ommatidiae per eye) and the dominance of chemical and tactile recognition cues in these ants as well as the fact that mating happens in darkness of the nest certainly exclude a function as an intraspecific recognition signal. A possible function could be visual dissolution of body shape by alternating dark and light pigment in order to escape the attention of a predator. The unpigmented petiole in particular, being in living condition rather translucent, permits the visual impression that anterior and posterior body are separate objects. Remains the question: Which predator with a high-performance visual system could consume these tiny ants?

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## References

Bolton B (2012) New general catalogue of the ants of the world - Online version of 1 January 2012. http://gap.entclub.org/archive/Bolton_NGC_2012_JAN.pdf

Heinze J, Schmidt CV, Nugroho H, Seifert B (2010) Wingless fighter males in the Wallacean ant *Cardiocondyla nigrocerea* (Insecta: Formicidae) – The Raffles Bulletin of Zoology 58(2): 323–328.

Oettler J, Suefuji M, Heinze J (2010) The evolution of alternate reproductive tactics in male *Cardiocondyla* ants. – Evolution 64/11: 3310–3317. doi: 10.1111/j.1558-5646.2010.01090.x

Seifert B (2002) How to distinguish most similar insect species - improving the stereomicroscopic and mathematical evaluation of external characters by example of ants -The Journal of Applied Entomology 126 (9): 445–454. doi: 10.1046/j.1439-0418.2002.00693.x

Seifert B (2003) The ant genus *Cardiocondyla* (Hymenoptera: Formicidae) - a taxonomic revision of the *elegans*, *bulgarica*, *batesii*, *nuda*, *shuckardi*, *stambuloffii*, *wroughtonii*, *emeryi*, and *minutior* species groups. - Annalen des Naturhistorischen Museums Wien, Serie B, 104: 203–338.

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RESEARCH ARTICLE

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# Subgeneric division of the genus *Orcula* Held 1837 with remarks on Romanian orculid data (Gastropoda, Pulmonata, Orculidae)

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## Abstract

The genital anatomy of *Orcula jetschini* (Romania), *O. zilchi* (Bulgaria) and *O. wagneri* (Albania) is described. Based on anatomical features (morphology of the penial caecum), shell characters (sculpture and shape) and unpublished molecular data, the genus *Orcula* is subdivided into three subgenera. *O. zilchi* was classified within the monotypic subgenus *Orcula* (*Hausdorfia*) **subgen. n.**; *O. jetschini*, *O. wagneri* and *O. schmidtii* were classified to *Orcula* (*Illyriobanatica*) **subgen. n.** (type species: *Pupa Schmidtii*), whereas the other *Orcula* species remain in the nominotypical subgenus. *Orcula* (*Hausdorfia*) is known from South-Eastern Bulgaria and North-Western Turkey, *Orcula* (*Illyriobanatica*) inhabits Western Romania, North-Western Greece, Albania, Macedonia, Kosovo and Montenegro. The nine species of *Orcula* (*Orcula*) are known mainly from the Alps and the Western Carpathians (from Eastern France to Eastern Hungary and Slovakia).

The occurrence of only one *Orcula* species, namely *O. jetschini* is verified from Romania. Available information suggests that data on the Romanian occurrence of *Orcula dolium* and *O. gularis* were based on wrongly identified specimens. *Sphyradium dobrogicum* (=*Orcula dobrogica*) is considered as a synonym of *S. doliolum*.

## Keywords

Anatomy, taxonomy, Alpine, Banatic, Illyric distribution

## Introduction

*Orcula* Held 1837, the type genus of the family Orculidae is a group of small (5–10 mm), pulmonate land snails with ovate–cylindrical shells and 3–4 lamellae within the aperture and the body whorl. Taxa are primarily found in mountainous regions in relatively humid habitats, most commonly in deciduous forests. There are at least 50 names described within the genus and 14 of them are considered as valid on species level (Harl et al. 2011). The Alps are inhabited by eight *Orcula* species, and this area is considered as the centre of the diversity of the genus. The type species, *Orcula dolium* (Draparnaud 1801), has the widest distribution within the genus, occurring from Eastern France to Eastern Slovakia and North-Eastern Hungary and several subspecies are recognized (Klemm 1967, Gittenberger 1978, Harl et al. 2011). Other Alpine *Orcula* species have much narrower areas and occur in the Alps of Austria, Italy and Slovenia only. Non-Alpine species include *O. jetschini* (Kimakowicz 1883) from Romania (Banat, Transylvania, Crişana), *O. schmidtii* (Küster 1843) from Montenegro, Albania and northwestern Greece, *O. wagneri* Sturany 1914 from Albania, Macedonia (FYROM) and Kosovo and *O. zilchi* Urbański 1960 is distributed from South-Western Bulgaria to North-Western Turkey.

The anatomy of the Alpine and the Illyric *Orcula* species is well-known (see Gittenberger 1978 and Schileyko 2012). On the other hand, the reproductive anatomy of the two Eastern European species (*jetschini* and *zilchi*) remained unpublished.

Gittenberger (1978) presented compelling data regarding the utility of the epiphallus and penial caecum (= ''Flagellum'' or ''Penisflagellum'') in taxonomic studies in *Orcula*. Gittenberger (1983) noted that extra-Alpine species had much stronger shell sculpture than Alpine species. These conchological and anatomical data, however, did not provide the resolution required to properly subdivide the genus.

Recently, Schileyko (2012) evaluated the taxonomic positions of most *Orcula* species. He concluded that the genus can be divided into two groups based on the morphology at the epiphallus–vas deferens transition. The transition is abrupt in *O. conica* (Rossmässler 1837), *O. fuchsi* Zimmermann 1931, *restituta* (Westerlund 1887), *spoliata* (Rossmässler 1837) and *O. dolium*, whereas it is gradual in *gularis* (Rossmässler 1837), *austriaca* Zimmermann 1932, *tolminensis* Wagner 1912, *wagneri* and *schmidtii*. It is not possible to assign some *O. dolium* specimens to one group or another. Independent of these two groups, Schileyko (2012) delineated five ''clusters'' (species groups) on the basis of anatomical and conchological characters (1: *conica*, 2: *fuchsi*, 3: *dolium* (s. l.) + *spoliata*, 4: *austriaca* (s. l.) + *tolminensis* + *gularis*, 5: *schmidtii* + *wagneri*). In Schileyko's phylogenetic scheme *O. conica* (unique shell shape and peculiar position of the penial caecum) and *O. fuchsi* (unique structure of the epiphallus) are the most basal members of the genus.

Recently, living specimens of *O. jetschini* and *O. zilchi* were made available for study. Anatomical investigation of these species allowed us to fully evaluate the taxonomic relationships within *Orcula*. We present data here that establishes subgenera

within *Orcula* based on shell and genital characters. These divisions are further supported by unpublished molecular data (Harl et al. in prep.).

Furthermore, we discuss the orculid species reported from Romania. Two species, namely *Pupa* (*Orcula*) *jetschini* Kimakowicz 1883 and *Sphyradium dobrogicum* Grossu 1986 were originally described from Romania. Two other species (*O. dolium* and *O. gularis*) were also reported from Romania by Bielz (1863) and later by other authors. Distributions of the last two species (see Welter-Schultes 2012), unreliable data sources and inaccessible or lost voucher material make Romanian occurrence data questionable.

## Material and methods

The comprehensive map (Fig. 9) showing the distribution of *Orcula dolium*, Alpine endemic *Orcula* spp., *O. schmidtii–wagneri*, *O. jetschini* and *O. zilchi* were compiled by literature sources (Banak et al 2012, Grossu 1986, Hausdorf 1996, Hlaváč 2002, Klemm 1973, Ložek 2006, Marković et al. 2004; Mitrović 2007, Mitrović and Jovanović 2000, Moine et al. 2005, Negrea 1962, 1966, Pintér and Suara 2004, Vavrova 2009, Páll-Gergely 2010, Stossich 1880, 1899), museum collections (HNHM, MMM, NHMW, SMF) and personal communications: O. Gargominy (France), W. de Mattia (Italy), P. Subai (Greece, Montenegro, France, Germany). Records of shells from deposits of the Tisza River (Pintér and Suara 2004) were excluded because of the unreliability of their origin.

Photographs of several focal planes were made with a Wild Makroskop M420 and a Nikon DS Camera Control Unit DS-L2. The different layers were combined with Helicon Focus 4.75 Pro to obtain one completely focused image.

Shells were directly observed without coating under a low vacuum SEM (Miniscope TM-1000, Hitachi High-Technologies, Tokyo). Teleoconch sculpture was noted on the dorsal or dorsolateral area of the penultimate whorl.

## Abbreviations

| | |
|---|---|
| **HNHM** | Magyar Természettudományi Múzeum (Budapest, Hungary) |
| **MMM** | Munkácsy Mihály Múzeum (Békéscsaba, Hungary) |
| **MNINGA** | Muzeul Național de Istorie Naturală “Grigore Antipa” (Bucharest, Romania) |
| **NHMSB** | Natural History Museum, Sibiu (Romania), Bielz collection |
| **NHMSK** | Natural History Museum, Sibiu (Romania), Kimakowicz collection |
| **NHMW** | Naturhistorisches Museum Wien (Vienna, Austria) |
| **SMF** | Senckenberg Forschungsinstitut und Naturmuseum (Frankfurt am Main, Germany). |
| **SP** | Collection Péter Subai (Aachen, Germany) |

## Results

### Systematics

### Family Orculidae Pilsbry 1918

### Genus *Orcula* Held 1837

http://species-id.net/wiki/Orcula

1837 *Orcula* Held, Isis: 919.

**Type species.** *Pupa dolium* Draparnaud 1801, by subsequent designation Gray: 1847: 176.

**Diagnosis.** Shell yellowish–greenish to dark brown; cylindrical to conical and elongated; 8–10 weakly convex whorls; sculpture of first 0.5–1.0 protoconch whorl usually smooth, but may be of fine spiral lines, which may be extremely weak; teleoconch axial sculpture variable, ranging from irregular growth lines to equally spaced, conspicuous radial structure; apertural barriers: one parietal and 1–3 columellar lamellae; palatal side of the aperture smooth or with strong tooth or thickening parallel to the apertural lip; parietal callus weak, subangularis sometimes present; palatalis plicae missing.

Penis cylindrical, penial caecum of variable length and shape; penial appendix absent; interior of penis, epiphallus and caecum with longitudinal folds; retractor muscle attaches to the penis-epiphallus junction on the opposite side of the penial caecum; diverticulum absent; distal part of vas deferens sometimes slightly swollen, entering epiphallus terminally; bursa copulatrix long, club-like.

**Habitat.** *Orcula* species occur in humid limestone areas, usually forests, or rocky boulder fields at high altitudes. Animals live under stones, leaf litter or decaying wood, or at the base of large rocks.

**Remarks.** Detailed anatomical and conchological diagnoses were provided by Gittenberger (1978) and Schileyko (1998). According to Hausdorf (1996), the genera *Orcula*, *Orculella* Steenberg 1925 and *Schileykula* Gittenberger 1983 cannot be distinguished from each other based on conchological characters alone.

Some African genera, such as *Fauxulus* Schaufuss, *Fauxulella* Pilsbry and *Anisoloma* Ancey have very similar genital tracts but usually possess sinistral shells with several apertural lamellae and denticles (see Schileyko 1998, 2012).

In general, species of *Schileykula* and *Orculella* usually inhabit dry limestone areas in the Mediterranean. The only exceptions known are the closely related *Orculella bulgarica* (Hesse) and *Orculella aragonica* (Westerlund) which both prefer very humid, marshy stream banks (Garrido et al. 2005, Arrébola et al. 2012).

### Subgenus *Orcula*

**Diagnosis.** Shell smoothish with irregular growth lines; apex somewhat conical, not blunt; aperture with 2–3 columellar lamellae; penial caecum simple and usually longer than half the length of the penis; its base often not conspicuously thickened.

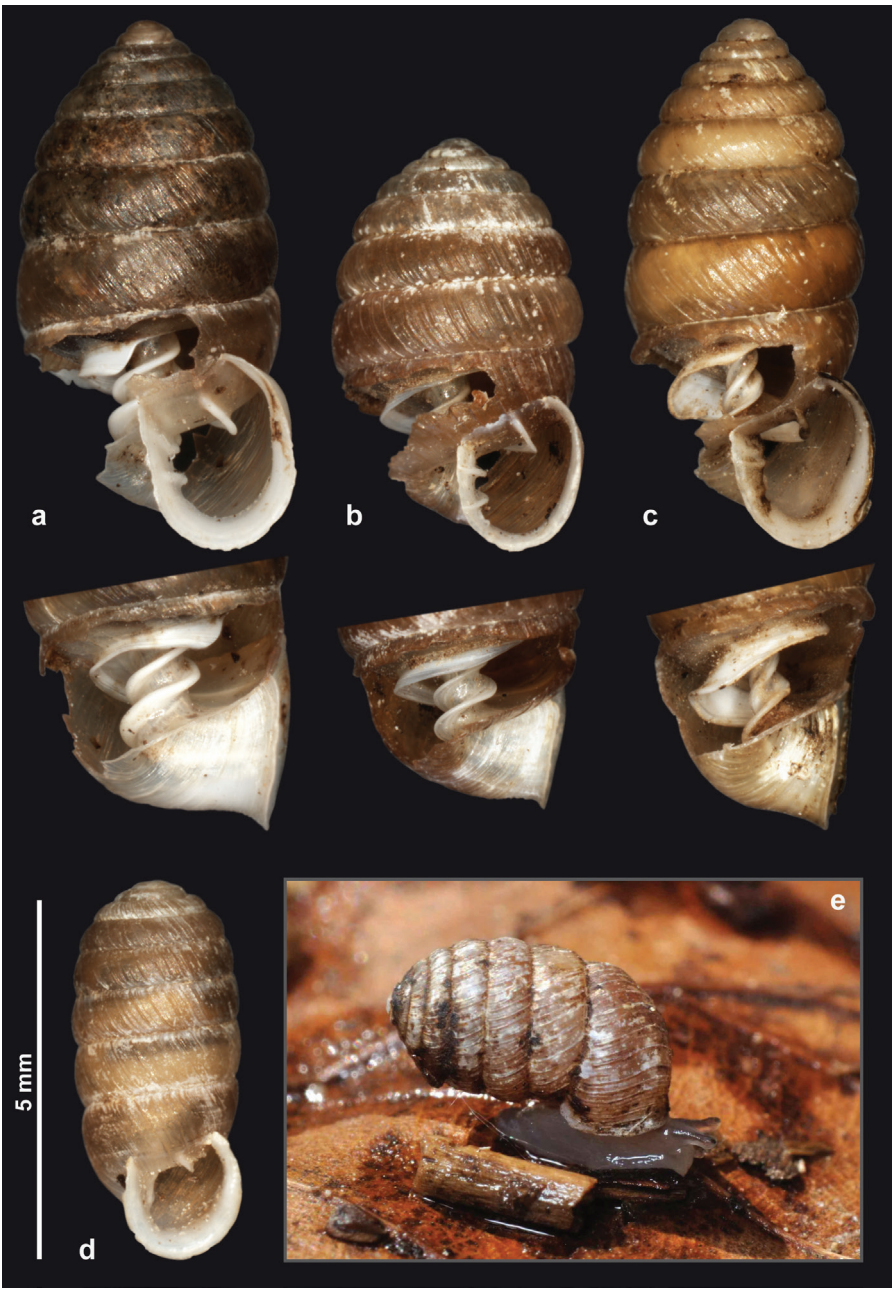


**Figure 1.** Shells and a living specimens of Orculidae species. **a** *Orcula* (*O.*) *dolium* (Draparnaud 1801), Hungary, Bükk Mts., Farkasnyak, Vöröskő, leg. Németh, L., 21.07.1984 **b** *O.* (*I.*) *jetschini* (Kimakowicz 1883), Romania, Jud. Bihor, Munții Pădurea Craiului, Șuncuiuș, Valley of Crișul Repede, in front of Peștera Vantului (cave), limestone, leg. Bata, Danyik, Deli, 11.04.2011. **c** *O.* (*H.*) *zilchi* Urbański 1960, Turkey, Vil. Bursa, between Bozüyük and İnegöl, by the "Mezit 7" bridge, limestone rocks and beach forest next to the road, 580 m, 39°55.724'N, 29°43.939'E, leg. Páll-Gergely, B., 30.09.2007 **d** *Sphyradium doliolum* (Bruguière 1792), Romania, Jud. Tulcea, Forest near the Cocoș Monastery, 145 m, 45°12.835'N, 28°24.415'E Leg: Németh, L. & Páll-Gergely, B. 26.05.2011 **e** same locality as b. Photos: J. Harl (**a**–**d**) and T. Deli (**e**).

**Content.** *austriaca*, *conica*, *dolium*, *fuchsi*, *gularis*, *pseudodolium* Wagner 1912, *restituta*, *spoliata*, *tolminensis*.

**Remarks.** The soft anatomy of various *Orcula* taxa has been described in the following papers: *austriaca* (Gittenberger 1978, Schileyko 2012), *austriaca faueri* Klemm 1967 (Gittenberger 1978, Schileyko 2012), *austriaca pseudofuchsi* Klemm 1967 (Gittenberger 1978, Schileyko 2012), *conica* (Soós 1925, Gittenberger 1978, Schileyko 2012), *dolium* (Soós 1917, 1925, Steenberg 1925, Gittenberger 1978, Varga 1986, Grossu 1987, Reischütz 1995, Schileyko 1984, 1998, 2012), *dolium brancsikii* Clessin 1887 (Reischütz 1995), *dolium edita* Ehrmann, 1933 (Schileyko 2012), *dolium gracilior* Zimmermann 1932 (Gittenberger 1978, Schileyko 2012) *dolium infima* Ehrmann, 1933 (Schileyko 2012), *dolium pseudogularis* A. J. Wagner, 1912 (Gittenberger 1978), *fuchsi* (Gittenberger 1978, Schileyko 2012), *gularis* (Soós 1925; republished by Grossu 1987, Gittenberger 1978, Schileyko 2012), *pseudodolium* (Gittenberger 1978), *restituta* (Gittenberger 1978), *spoliata* (Gittenberger 1978, Schileyko 2012), *tolminensis* (Gittenberger 1978).

The penial caecum of *Orcula* (*Orcula*) *restituta* is very short compared to other *Orcula* (*Orcula*) species, but the shell is similar to that of *Orcula* (*Orcula*) *gularis*. Prior to Klemm (1967), *restituta* was considered a subspecies of *gularis*.

A third columellar lamella is rarely present, but can occur in a small percentage of individuals within a population. Brancsik (1888: 84) noted a third columellar fold in only one individual of thousands in each *O. dolium titan* (Brancsik 1888) and *O. dolium dolium*.

**Distribution.** Most species have limited distributions in the Alps (mainly Austria). *O. dolium* is widely distributed in Central Europe, in the Alps (eastern France, Switzerland, Southern Germany, Northern Italy, Austria, Slovenia, Northern Croatia, and Slovenia) and the Western Carpathians (Northern Hungary, Slovakia, Eastern Czech Republic). The Croatian records of *O. dolium* and *O. gularis* (Stossich 1880, 1899, Zimmermann, 1932) have not been verified by recent investigations.

Our knowledge of the distribution of *O. dolium* is distorted due to misidentified material. Probably all reports of this species (living and fossil) from Spain (e.g. Llamas et al. 1995) refer to *Orculella aragonica* (see Arrébola et al. 2012). Italian (Toscana) records (Zanchetta et al. 2004, 2006) refer to a yet unknown *Orculella* species (see photo in Zanchetta et al. 2006). Damjanov and Likharev (1975) reported *O. dolium* from the Balkan Peninsula, South, Central and West Europe, the Crimea, Western Ukraine, Central Asia, Tunisia, Ethiopia and northen Iran. This distribution is much broader than that of *O. dolium* and probably refers to the distribution of the family Orculidae. Likharev and Rammelmejer (1952) and Sysoev and Schileyko (2009) speculated that *O. dolium* occurs in Ukraine. This supposition has been included in distribution maps (Welter-Schultes, 2012), but to date the taxon's occurrence in Ukraine has not been verified data (Balashov and Gural-Sverlova 2012). Soós (1943) mentioned that during careful collections around Munkács (Mukachevo, southwest Ukraine), Traxler was not able to find the species.

*Orcula dolium* was more widely distributed during the Pleistocene. The northernmost localities were published by Ložek (2006) (Czech Republic, ca, 30 km north

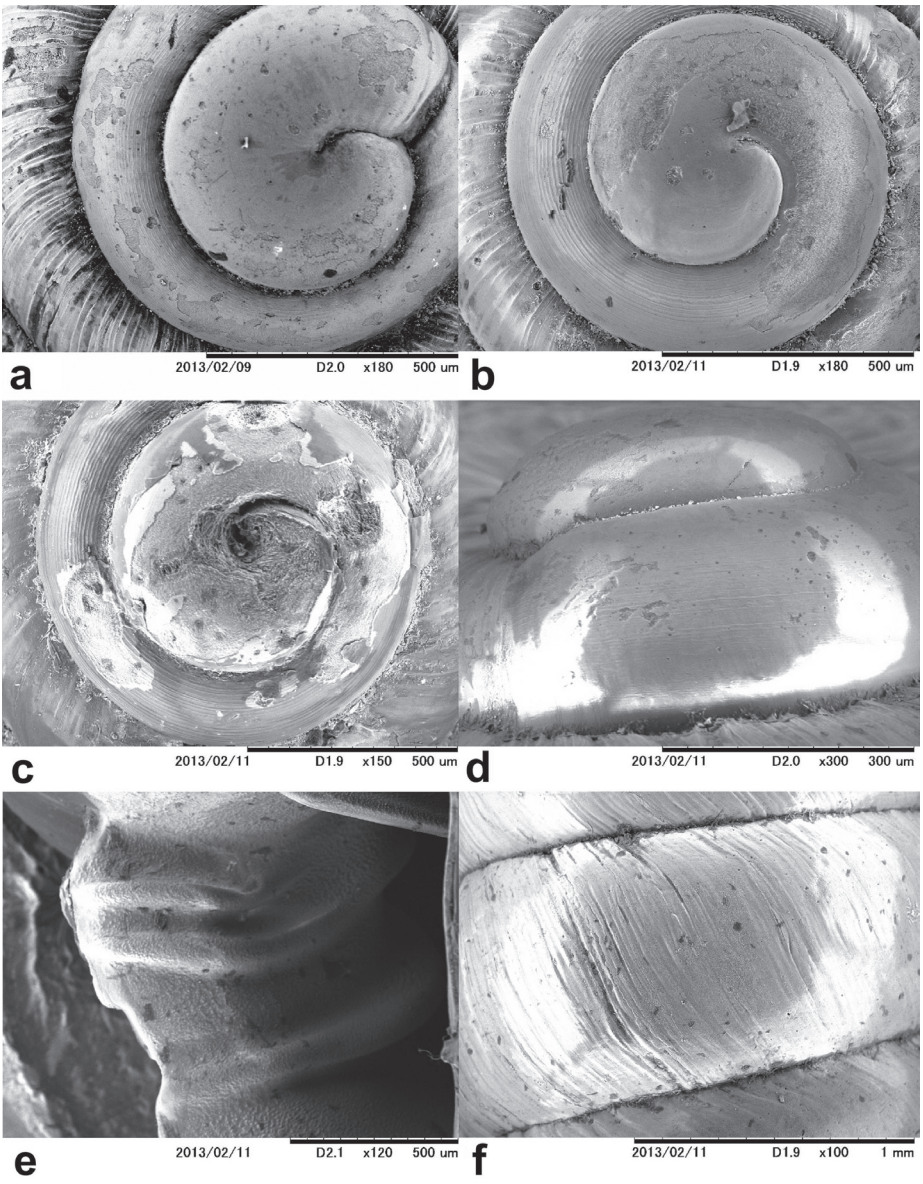


**Figure 2.** SEM of shells of various *Orcula* taxa. **a** protoconch of *Orcula* (*O.*) *dolium* (Draparnaud, 1801), Hungary, Bükk Mts., Farkasnyak, Vöröskő, leg. Németh, L., 21.07.1984 **b** protoconch of *O.* (*I.*) *schmidtii* (Küster 1843), Albania,Mirditë Mts., 1 km NE of Ndërshenë, beneath the Gurit te Çikut peak, 1350 m, 41°49.952'N, 20°06.034'E, leg. Erőss, Fehér, Kontschán, Murányi, 21.10.2002 **c** protoconch of *O.* (*H.*) *zilchi* Urbański 1960, Turkey, Vil. Bolu, Abant Gölü N, 1030 m, 40°38.756'N, 31°21.531'E, leg: Páll-Gergely, B., 17.05.2006 **d** protoconch of *O.* (*O.*) *austriaca* Zimmermann 1932, Austria: Niederösterreich, Piestingtal, Waldegg, 412 m, 47°52.293'N, 16°2.722'E, Duda, M., Haring, E., Harl, J., Kruckenhauser, L., Sattman, H, 10.09.2009 **e** columellar lamellae of *O.* (*H.*) *zilchi*, locality: see figure **2c f** sculpture of *O.* (*O.*) *tolminensis* Wagner 1912, Austria, Kärnten, Karawanken, Eisenkappel, Kupitzklamm, 674 m, 46°27.979'N, 14°36.915'E, leg. Duda, M., Haring, E., Harl, J., Kruckenhauser, L., Sattman, H., 29.07.2009.

of Prague) and Moine et al. (2005) (Germany, northern Baden-Württemberg). The southernmost locality was reported by Mitrović (2007) from the Serbian Kisiljevo.

Sacco (1897) described *Orcula dolium* var. *pliopedemontana* from the middle Pliocene sediments at Ceresole d'Alba (Italy: ''Villafranchiano''). The description is unfortunately insufficient and the taxonomic position of this form is uncertain (Ferrero-Mortara et al. 1984, Pilsbry 1922). More recently, Ciangherotti et al (2007) made no mention of the species from the same sediment layers.

### *Orcula* (*Illyriobanatica*) Páll-Gergely & Deli, subgen. n.

**Type species.** *Pupa* (*Orcula*) *jetschini* M. von Kimakowicz 1883.

**Diagnosis.** Shell usually with strong axial sculpture (irregular ribs), with two columellar lamellae, apex rather rounded, not attenuate. The penial caecum usually consists of two parts (''tubercles'') and its length is less than half that of the penis.

**Etymology.** The name of this new subgenus refers to its distribution in the Illyrian and Banatic biogeographical regions. It is feminine.

**Content.** *jetschini*, *schmidtii* and *wagneri*.

**Distribution.** Montenegro, Albania, Northwestern Greece, Kosovo, Macedonia (*O. wagneri* and *O. schmidtii*) and the western part of Romania (*O. jetschini*).

**Remarks.** The reproductive anatomy of *O. schmidtii transversalis* (Westerlund 1894) was described by Hausdorf (1987) and Reischütz and Sattmann (1990). According to Hausdorf (1987), the penial caecum of *O. schmidtii transversalis* is short, but simple. The caecum appears double in the illustration provided by Reischütz and Sattmann (1990).

### *Orcula* (*Illyriobanatica*) *jetschini* (Kimakowicz 1883)

http://species-id.net/wiki/Orcula_jetschini

1863 *Pupa* (*Pupilla*) *dolium*, Bielz, Fauna der Land- und Süsswasser-Mollusken Siebenbürgens, 89.

1867 *Pupilla dolium*, — Bielz, Fauna der Land- und Süsswasser-Mollusken Siebenbürgens: 94–95.

1883 *Pupa* (*Orcula*) *jetschini* Kimakowicz, M. von. — Verhandlungen und Mittheilungen…, 33: 44–46.

1922 *Orcula jetschini*, — Pilsbry: Manual of Conchology…: 5, 17., Plate 2, Fig. 10–11. [''Transylvania, restricted to the southwestern part: Vajda-Hunyad and Bad Gyogy (Kimakowicz), Judenberg near Zalatna (Jickeli). Cerna valley at Mehadia in the Banat (Jetschin)'']

1943 *Orcula Jetschini*, — Soós: A Kárpát-medence Mollusca faunája: 155–156, plate 6, fig. 18.

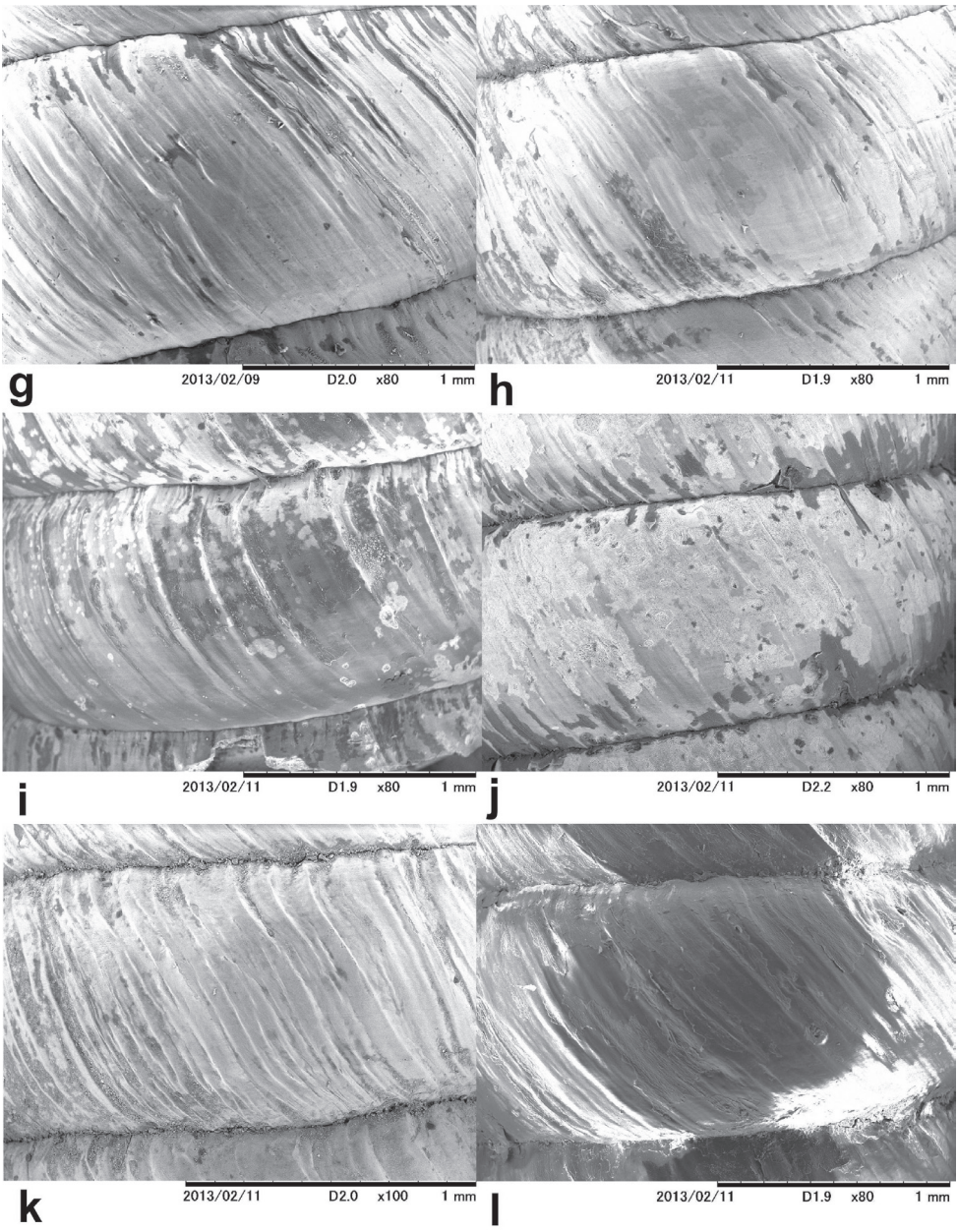


**Figure 3.** SEM of the shell sculpture of various *Orcula* taxa. G *O.* (*O.*) *dolium* **H** *O.* (*O.*) *austriaca* **I** *O.* (*I.*) *jetschini*, Romania, Jud. Bihor, Munții Pădurea Craiului, Şuncuiuş, Valley of Crişul Repede, in front of Peştera Vantului (cave), limestone, leg. Bata, Danyik, Deli, 11.04.2011. **J** *O.* (*I.*) *wagneri* Sturany 1914, Albania, Malësia e Madhe, 11 km from Bogë, north of Tërthorës pass, 1800 m, 42°23.537'N, 19°43.782'E, leg. Erőss, Fehér, Kontschán, Murányi, 20.10.2002. **K** *O.* (*I.*) *schmidtii*, locality: see figure **2b L** *O.* (*H.*) *zilchi*, locality: see figure **2c**.

1983 *Orcula jetschini*, — Kerney et al. Die Landschnecken Nord- und Mitteleuropas: 102–103.
1987 *Orcula* (*Orcula*) *dolium* (partim: citation of Bielz 1863), — Grossu, Gastropoda Romaniae 2: 221–223.
1987 *Orcula* (*Orcula*) *jetschini*, — Grossu, Gastropoda Romaniae 2.: 223–224.
2011 *Orcula jetschini*, — Harl et al. Archiv für Molluskenkunde, 140 (2): 184, Plate 4, fig. J.
2012 *Orcula jetschini*, — Welter-Schultes, European non-marine molluscs…:145.

**Material.** RO, Jud. Bihor, Munţii Pădurea Craiului, Şuncuiuş, Valley of Crişul Repede, in front of Peştera Vantului (cave), limestone, leg.: Bata, Danyik, Deli, 11.04.2011. (anatomically examined); RO, Gyalui-havasok (Munţii Gilăului), Runki szakadék (gulch of Runk), leg. Papp, J., 22.07.1959, HNHM 73030/3; RO, Bihar Mts (Munţii Apuseni)., Felsőgirda (Gârda de Sus), Ordincus valley., leg. Kovács, Gy., 30.05.1985, HNHM 68284/2; RO, Muntii Bihorului, Baita, Piatra Graitoare, environment of the Crisu Baitei River, leg. Kovács, Gy., 23.08.1974, HNHM 68283/2; Černath. (Chernathal) bls Badern (?) v. Mehadia, leg. Jetschin 1882, NHMSK 4874/5; Forstgra (Forstgartens) bei im Černathal, Banat, leg. Jetschin 1882, NHMSK 4875/2; Klausenburg, Györgyfalvaer Wald, leg. Marzlof 1891, NHMSK 7470/8; Zalathna gegen den Judenberg, leg. Barth 1866–1906, NHMSK 7468/8; Banat, Herkulesbad, leg. Deubel 1895 May–Juni, NHMSK 7469/6; Steierdorf bis zur Höhle Panur, leg. Jetschin 1885, NHMSK 4876/4; Černathal b. Mehadia, leg. Jetschin 1885, NHMSK 4877/4 ("*mut. albina*"); Gyógybad nächst Broos. Orm. (?) 1887, NHMSK 4873/3; Hideg-Szamos, NHMSB 51/72, 50136–50137; Györgyfalvaer Wald b. Klausenburg, NHMSB 51/82, 50389–50391; Unter-Grohob bei Körösbánya NHMSB 51/92, 50713; Klausenburg, Bükk, NHMSB 51/13, 48225–48226; Klausenburg ?? (not legible on label) Wald, NHMSB 51/23, 48500; RO, Bihor Mts., Valea Boghii (valley), 46°36.610'N, 22°39.542'E, leg. Páll-Gergely, B. 09.08.2007.; RO, Jud. Bihor, Bălnaca Groşi, cliffs at Bíró Lajos cave., leg. Domokos, T. 18.04.2004, MMM 04503/1; Munţii Pădurea Craiului, Şuncuius valley of Crişul-Repede, under shrubs., leg. Domokos, T. & Deli, T., 08.07.2005, MMM 04505/2; Munţii Pădurea Craiului, Şuncuiuş valley of Mişid-brook near brook-Alnetum., leg. Domokos, T.& Deli, T., 08.07.2005, MMM 04506/3; Munţii Apuseni, Gârda de Sus, Ordincus valley., leg. Domokos, T. & Kovács, Gy., 30.05.1985, MMM 04501/2; Munţii Apuseni, Gârda de Sus, Ordincus valley., leg. Domokos, T. & Deli, T., 30.11.2009, MMM 92488/1; Munţii Zărandului, Troaş, Pietroasia, floating debris., leg. Domokos, T., 07.06.2002, MMM 04502/10; Munţii Zărandului, Troaş, Valea Galsa floating debris, leg. Domokos, T. et al., 27.05.2005, MMM 04504/11; Jud. Arad, above Obârşia (Munţii Metaliferi) (1.9 km W of Arad-Hunedoara board), forest clearing (*Corylus*), 700 m, leg. Deli, T. & Domokos, T, 07.03.2007, MMM 90866/2; Jud. Arad, between Pojoga and Căprioara (7 km SE Săvârsin), in gorge–forest, 120 m, leg: Deli, T., Domokos, T., Páll-Gergely, B., Subai, P., 15.04.2007, MMM 91092/2; Jud. Arad, between Pojoga and Căprioara (7 km SE Săvârsin), in gorge–forest, 120 m., leg: Deli, T., 12.06.2007,

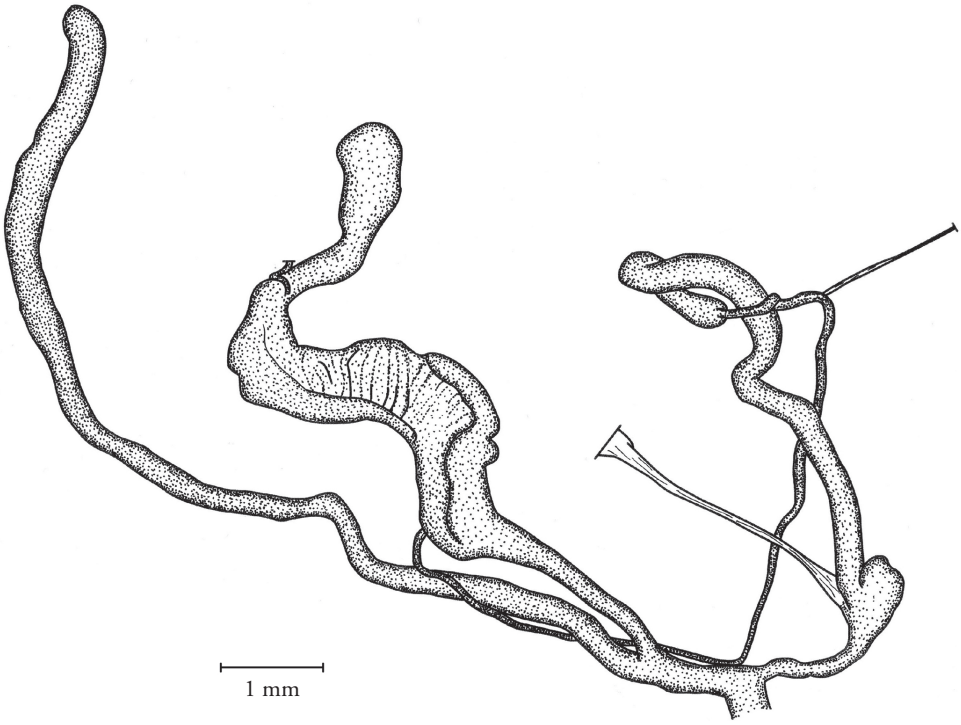


**Figure 4.** Genital anatomy of *O.* (*I.*) *jetschini* (Kimakowicz 1883), locality: see figure **1b**.

MMM 90814/1; Jud. Caraș-Severin, between Moldova Nouă and Padina Mate, forest (*Fagus*, *Caprinus*, *Ruscus*) with limestone rocks, 300 m, leg. Boldog, G., Deli, T., Kóra, J., 04.07.2007, MMM 92489/1; Mehadia Mts. (Munții Mehedinți), Cerna valley, Jelărăului gorge, above Băile Herculane, large flotsam deposit, leg. Boldog, G., Deli, T., Kóra, J., 08.07.2007, MMM 92494/6; Munții Mehedinți, Cerna valley, Jelărăului gorge, above Băile Herculane, large flotsam deposit, leg. Deli T., Horváth, É., Lennert, J., Páll-Gergely, B., Subai, P., 04.05.2008, MMM 92490/5; Munții Vâlcan, N Tismana, near Monastery Tismana, bank of Tismana brook, flotsam deposit., leg. Deli, T., Domokos, T., Páll-Gergely, B., Subai, P., 15.04.2007, MMM 92491/1; Munții Vâlcan, Piscuri-valley, 1,4km N Vâlcele (NE Tismana), flotsam deposit., leg. Deli T., Domokos T., Páll-Gergely B., Subai, P., 17.04.2007, MMM 92492/1; Munții Vâlcan, N of Runcu, Cheile Sohodol, 4.5 km upstream of the gorge entrance, limestone walls., leg. Boldog, G., Deli, T., Kóra, J., 06.07.2007, MMM 92493/1.

**Description of the genitalia.** Two specimens were anatomically examined. Penis slim, with the retractor muscle attached at its distal end; penial caecum very small, vestigial, consisting of two "tubercles"; epiphallus very long and cylindrical; there is clear distinction between the vas deferens and the epiphallus; vas deferens long and relatively thick; a slender retractor muscle is attached near the proximal end. Vagina short and thick, but pedunculus relatively long; bursa copulatrix extremely long, with

the distal end slightly expanded. In one specimen an elongated, simple spermatophore was found with the apical portion slightly thickened.

**Distribution.** *Orcula* (*I.*) *jetschini* is known only from western part of Romania (Banat, Crişana and Western Transylvania). The Hungarian record (Pintér and Suara 2004) is apparently based on a flotsam specimen so its origin is suspect (Varga, 2009). Negrea (1966) reported the species from Moldova Nouă, which lies close the Serbian border and, therefore, it is expected to occur in Serbia. The Pleistocene distribution of *Orcula dolium* included the ''Požarevac Danube Area'' (Mitrović 2007), which is just on the other bank of the Danube River, but temporal and spatial sympatry of *O.* (*I.*) *jetschini* and *O.* (*O.*) *dolium* is not verified.

**Ecology.** The species inhabits deciduous forests. It is found most commonly between small stones and leaf litter on the forest floor or under hazelnut (*Corylus*) bushes. The species is known from non-limestone bedrock, such as the Zarand Mountains.

**Conservation status.** Least concern (LC) according to IUCN criteria (Fehér 2011).

**Remarks.** All living specimens found were covered in mud, causing them to appear like tiny grains of soil. The ribbed shell is possibly an adaptation for camouflaging. The photographs herein are of cleaned shells.

### *Orcula* (*Illyriobanatica*) *wagneri* Sturany 1914

http://species-id.net/wiki/Orcula_wagneri

1914 *Orcula wagneri* Sturany in Sturany and Wagner, — Denkschriften der Kaiserlichen Akademie der Wissenschaften, mathematisch-naturwissenschaftliche Klasse 91: 45, Plate 15, fig. 82b.

2011 *Orcula wagneri*, — Harl et al., Archiv für Molluskenkunde, 140 (2): 186, Plate 5, fig. A–G, J.

2011 *Orcula wagneri*, — Audibert, Folia Conchyliologica 14: 21–25. Figure 1: habitat, figure 2, and Figure 1, 2, 4, 5: shells with possible signs of parasites.

2012 *Orcula wagneri*, — Schileyko, Ruthenica, 22 (2): 152-253, 156, figure 17 (genitalia)

2012 *Orcula wagneri*, — Welter-Schultes, European non-marine molluscs…:146.

**Material.** Albania, Bjeshkët e Nemuna (Prokletije Mts), above village Okol, near pass Qafa e Pejës, W slope of Mt. Maja e Popluks, at a spring on limestone, 1660 m, 42°27.343'N, 19°46.478'E, leg. Barina, Z., Puskás, G., Sárospataki, B., 16.07.2010., HNHM 98841.

**Description of the genitalia.** One specimen was dissected. Penis cylindrical and slim, with a short, but thick penial caecum, the proximal portion broader than the short and slimmer distal portion; retractor muscle attaches at the penis–epiphallus transition; epiphallus more than twice as long as the penis and much thicker, its transition to the vas deferens is gradual, barely discernable; there is a slim retractor muscle attached to the proximal portion of the epiphallus; proxim\al portion of the vas deferens thicker than the distal part. Vagina and free pedunculus extremely

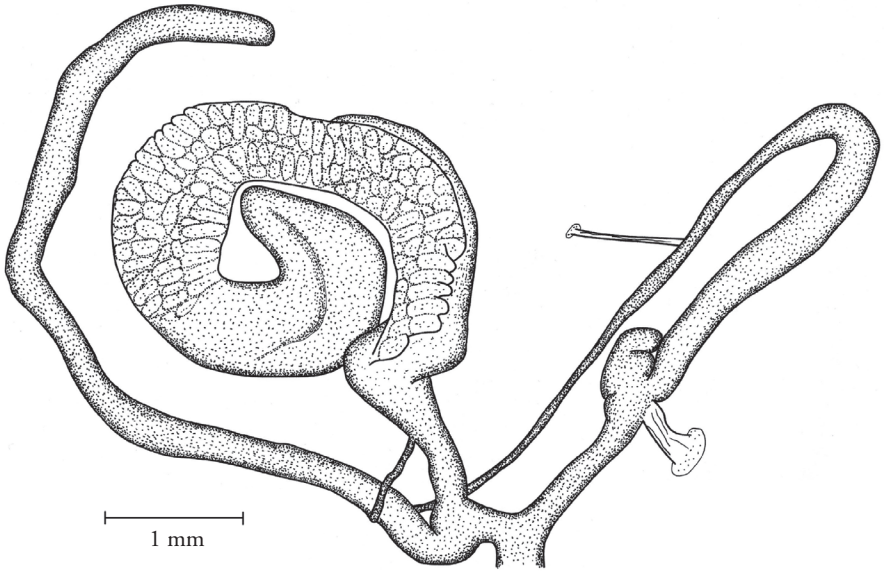


**Figure 5.** Genital anatomy of *O.* (*I.*) *wagneri*. Albania, Bjeshkët e Nemuna (Prokletije Mts), above village Okol, near pass Qafa e Pejës, W slope of Mt. Maja e Popluks, at a spring on limestone, 1660 m, 42°27.343'N, 19°46.478'E, leg. Barina Z, Puskás G, Sárospataki B, 16.07.2010.

short; bursa copulatrix almost twice as long as the combined length of the penis–epiphallus complex.

**Conservation status.** *Orcula* (*O.*) *wagneri* is listed as Near Threatened (NT), being close to the criteria threshold for Vulnerable (Pall-Gergely 2011a).

**Remarks.** Our observations on the genitalia agree with that of Schileyko (2012), who investigated the anatomy of *O. wagneri* from the Tomor Mountains (''Maja e Tomorit Mt., S Albania''). A partially reabsorbed, elongated, spermatophore was located in the bursa copulatrix (Fig. 8B).

### *Orcula* (*Hausdorfia*) Páll-Gergely & Irikov, subgen. n.

**Type species.** *Orcula zilchi* Urbański 1960 (by monotypy).

**Diagnosis.** Shell with conical apex and strong axial sculpture (irregular axial growth lines), with three columellar lamellae (columellar, supracolumellar and one short lamellae above), palatalis reaches its maximum height on the dorsolateral side. Penial caecum very long with thickened base, canal connecting the proximal end of the epiphallus to the penial caecum.

**Etymology.** The new subgenus is named in honour of Dr Bernhard Hausdorf (University of Hamburg), who first noted the unusual shell characters of *Orcula zilchi* and questioned its generic status (Hausdorf 1996). It is feminine.

**Distribution.** See under *O.* (*H.*) *zilchi*.

**Remarks.** According to Schileyko (2012), the penial caecum of *Orcula fuchsi* is long and slender, with a thickened base, making it similar in morphology to *O. zilchi*. However, the characteristic canal connecting the proximal end of the epiphallus with the penial caecum of *O. zilchi* is lacking in *O. fuchsi*. The long caecum of this species is also illustrated by Gittenberger (1978), but its base is not conspicuously thickened. This may vary between populations or during an individual's life history.

### *Orcula* (*Hausdorfia*) *zilchi* Urbański 1960

http://species-id.net/wiki/Orcula_zilchi

1960 *Orcula zilchi* Urbański, J., Bulletin de la Société des Amis des Sciences et des Lettres de Poznan (Série D) 1: 57. [''Am rechten Ufer des Ropotamo, etwa 3 km vor seiner Mündung (etwa 30 km südlich von Burgas)'']

1975 *Orcula zilchi*, — Damjanov and Likharev, Fauna Bulgarica, Gastropoda terrestria, vol. IV: 115.

1996 *Orcula* (?) *zilchi*, — Hausdorf, Archiv für Molluskenkunde 125 (1/2): 14, Plate1, fig. 1. [''Westanatolien: V. Kütahya, Safa 2 km R Domaniç'']

2010 *Orcula zilchi*, — Páll-Gergely, Zoology in the Middle East, 50: 91.

2011 *Orcula zilchi*, Harl et al. — Archiv für Molluskenkunde, 140 (2): 186–187, Plate 4, fig. F, G.

2012 *Orcula zilchi*, — Welter-Schultes, European non-marine molluscs…:146.

**Material.** Bulgaria, Strandzha Mts., Kondolovo village, 42°6.150'N, 27°39.896'E, leg. Irikov, A., 28.04.2012. (anatomically examined); Bulgaria, Silkosiya Reserve, near Kosti Village, 23.06.2001, leg., A. Irikov; Turkey, Vil. Bolu, Abant Gölü N, 1030 m, 40°38.756'N, 31°21.531'E, leg. Páll-Gergely, B., 17.05.2006.; Turkey, Vil. Bursa, between Bozüyük and İnegöl, by the ''Mezit 7'' bridge, limestone rocks and beach forest next to the road, 580 m, 39°55.724'N, 29°43.939'E, leg. Páll-Gergely, B., 30.09.2007; Bulgaria, floating debris 6 km N of Malko Tarnovo, 210 m, UTM NG 45, 42°5.028'N, 27°25.698'E, leg. Dedov & Subai 8.5.2008, SP 22168/2 (juv.)

**Description of the genitalia.** Two specimens were dissected. Penis cylindrical, relatively long; retractor muscle short, attaches on the proximal portion; penial caecum very long, with a thickened base and a cylindrical distal portion; an additional canal (?) connects the proximal end of the epiphallus with the penial caecum; epiphallus long, with a thickened distal part; the separation between the vas deferens and epiphallus is distinct; vas deferens relatively thick. Vagina cylindrical and relatively short; bursa copulatrix extremely long with a pointed end.

A developing egg covered with small calcareous crystals was found in the uterus of the figured specimen. In the other specimen, an elongated, simple bursa copulatrix was found with a slightly thickened apical part.

**Distribution.** South-Eastern Bulgaria and North-Western Turkey.

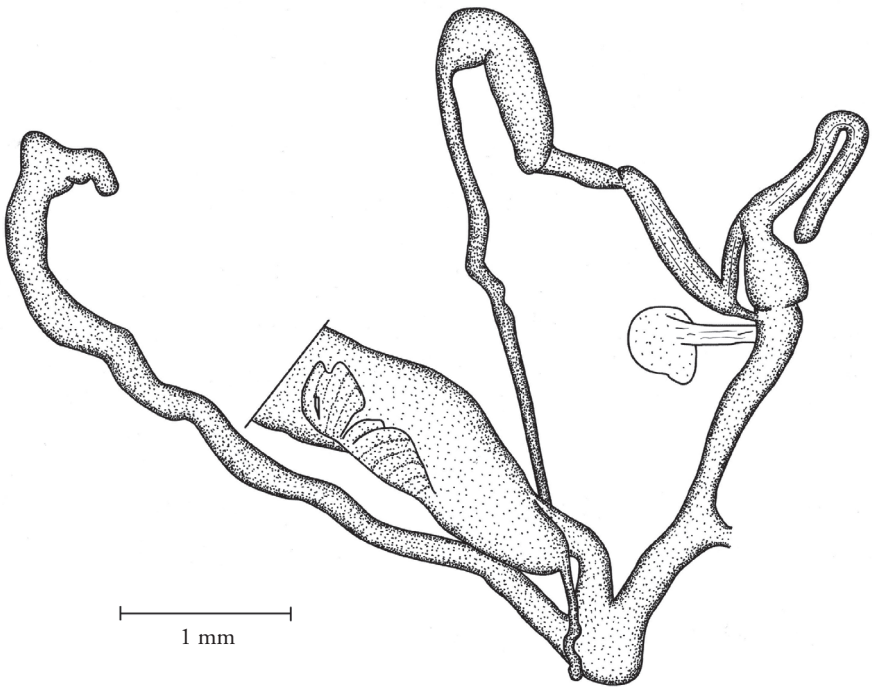


**Figure 6.** Genital anatomy of *O.* (*H.*) *zilchi* Urbański 1960. Bulgaria, Strandzha Mts., Kondolovo village, 42°6.150'N, 27°39.896'E, leg. Irikov A, 28.04.2012.

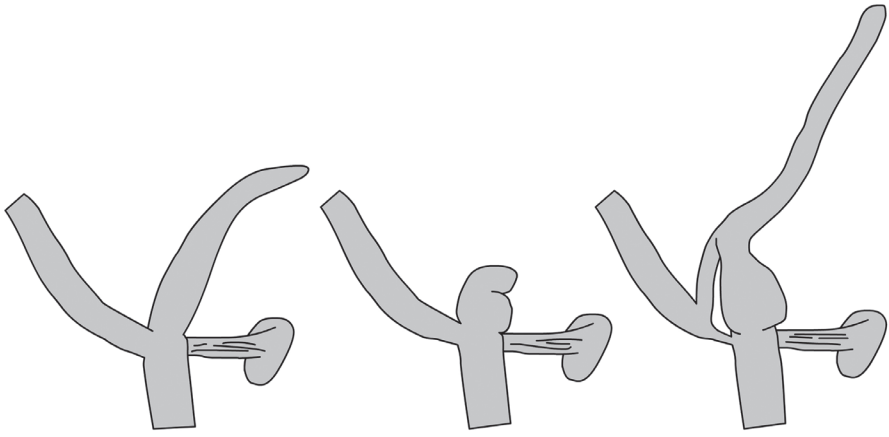

**Figure 7.** Schematic drawings of the penial caecum of *Orcula* subgenera. left: *Orcula* (*Orcula*), middle: *Orcula* (*Illyriobanatica*), right: *Orcula* (*Hausdorfia*).

**Ecology.** The type series (12 shells) of *Orcula zilchi* was collected by Urbański on the floodplain of the Ropotamo River in leaf litter and under decaying wood. It was found in association with *Sphyradium doliolum* (Bruguière 1792), *Oxychilus deilus rumelicus*

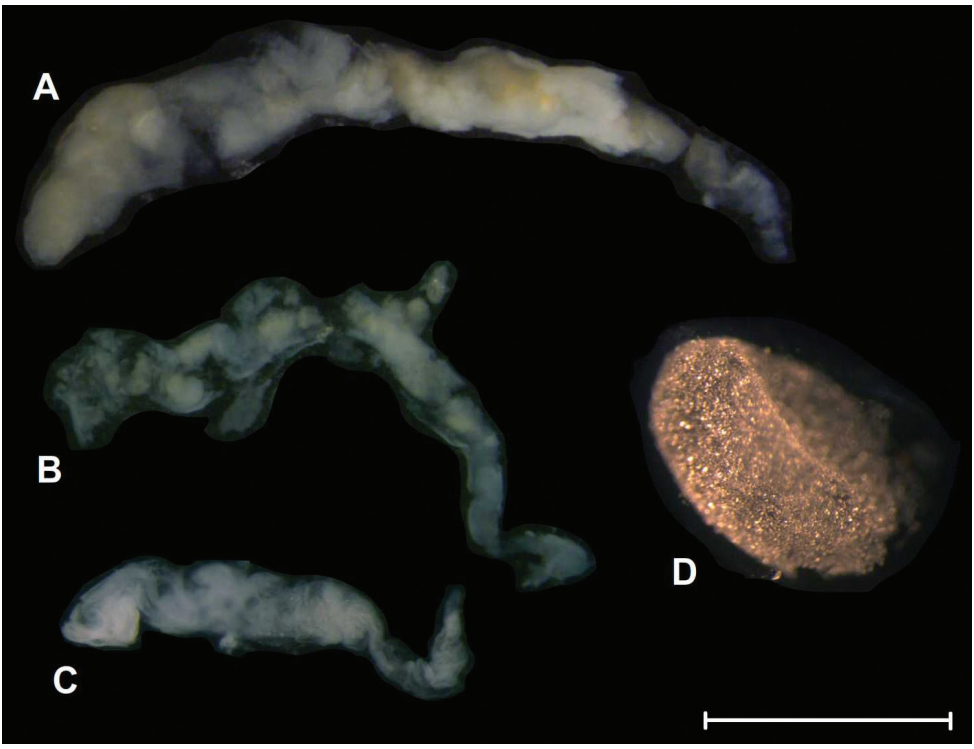


**Figure 8.** Spermatophores. **A** *O.* (*I.*) *jetschini* (Kimakowicz 1883) **B** *O.* (*I.*) *wagneri* and **C** *O.* (*H.*) *zilchi* **D** egg. *O.* (*H.*) *zilchi*; spermatophore and egg from different individuals. Scale = 1 mm.

Hesse, *Laciniaria plicata* (Draparnaud), *Bulgarica denticulata thessalonica* (Rossmässler), *Euxina persica paulhessei* (Lindholm), *E. circumdata* (L. Pfeiffer), *Cochlodina laminata* (Montagu). Atanas Irikov visited the type locality (very humid forest with rocks along the river) on two occasions, with collection time totalling 6–8 hours. Besides *O. zilchi* he collected all other species previously reported from the Ropotamo area.

We were able to find *O. zilchi* only in deciduous forests. In Bulgaria (near Kondolovo village), living specimens were collected in an oriental beech (*Fagus orientalis*) forest in shady and moist microhabitats between the leaf litter and soil. These conditions were very similar to the Abant Gölü locality (Turkey). The other Turkish locality (between Bozüyük and İnegöl) was slightly different, with a deciduous forest at the base of a large limestone rock, on a slope covered with smaller stones and larger rocks.

The species is very rare wherever it has been encountered yet, especially in Turkey. On two occasions, in 2007 and 2010, Barna Páll-Gergely spent about 4–5 hours at the locality in vil. Bursa, but found only one specimen in 2007. The other locality (Vil. Bolu) was visited in 2005 and 2006 for similar lengths of time and only one specimen was found in 2006. Atanas Irikov collected 9 living specimens and about 10 empty shells in an hour near Kondolovo in Bulgaria.

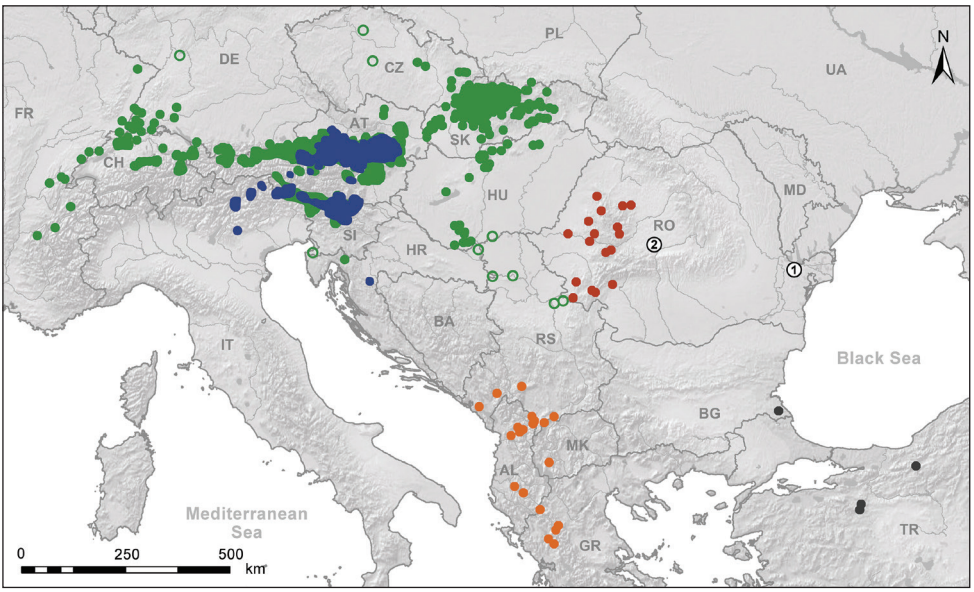


**Figure 9.** Distribution map of *Orcula*. Subgenus *Orcula*: *O.* (*O.*) *dolium* (green) (green circles indicate fossil records), Alpine endemic species (blue); subgenus *Illyriobanatica*: *O.* (*I.*) *wagneri* and *O.* (*I.*) *schmidtii* (orange), *O.* (*I.*) *jetschini* (red); subgenus *Hausdorfia*: *O.* (*H.*) *zilchi* (black). Number **1**: type locality of *Sphyradium dobrogicum* Grossu 1986; Number **2** locality of *Orcula gularis* (Rossmässler 1837) according to Bielz (1863).

**Conservation status.** Listed as Vulnerable (V) under IUCN criteria (Pall-Gergely 2011b). Deforestation and disturbance of the forests are the main threat to this species.

**Remarks.** Two of four living specimens had beetle (possibly drilid beetle) larvae in the body whorl.

The dissected specimens were collected about 23 km south-southwest of the type locality. The Strandzha Mountains (incl. the collecting site) belongs to the drainage of the Ropotamo River. It is reasonable to suppose that Urbański's population was "washed down" from somewhere in the Strandzha Mts. and settled a temporary subpopulation in the Ropotamo floodplain. This might be a reasonable explanation why A. Irikov could not find this species in the type locality.

## Genus *Sphyradium* Charpentier 1837

http://species-id.net/wiki/Sphyradium

*Sphyradium doliolum* (Bruguière 1792)

1792 *Bulimus doliolum* Bruguière Encyclopédie méthodique: 351.

1986 *Sphyradium dobrogicum* Grossu, **new synonym** Travaux du Muséum d'Histoire Naturelle ''Grigore Antipa" 28: 7–13. Bucureşti. [Dobrogea, département de Tulcea, près du Monastère Cocoş de la Forêt Luncaviţa.]

1987 *Sphyradium dobrogicum*, — Grossu: Gastropoda Romaniae 2…: 228–230, Fig. 120. [‘’pădurea Luncavița în apropierea Mănăstirei Cocoş, jud. Tulcea”]
2012 *Orcula dobrogica*, — Welter-Schultes, European non-marine molluscs…:143.

**Remarks.** *Sphyradium dobrogicum* was described based on a single shell. The holotype could not be located in the collection of the Grigore Antipa National Museum of Natural History (Bucharest) during a recent search (2012). It could still be in Grossu’s house (Oana Popa, pers. comm., 2011) but, at present, the holotype seems to be lost.

Bank (2011) and Welter-Schultes (2012) assigned the species to *Orcula* without supporting evidence. *S. dobrogicum* has a domed apex, a ribbed shell and very weak lamellae (see original description and drawing), indicating that it may represent a dwarf specimen of *S. doliolum*. We visited the type locality of *S. dobrogicum* in 2011 but found only *Sphyradium doliolum*.

Based on available information we suggest using *Sphyradium dobrogicum* as a synonym of *S. doliolum*.

### *Orcula gularis* and *O. dolium* in Romania

***Orcula gularis***: Bielz (1863, 1867) reported *Pupa* (*Pupilla*) *gularis* from Guşteriţa, which is presently part of Sibiu. Grossu (1987, 1993) cited this record in his account of *Sphyradium gularis*. Grossu (1986) discussed Bielz’s specimens housed in the museum in Sibiu, but specimens were not located in the collection of Bielz in the NHMS. Although Bank (2011) reports the species from Romania, recent authors consider this record as erroneous (Falkner et al 2011) or simply ignore it (Welter-Schultes 2012). Indeed, the occurrence of *O. gularis* in Romania, more than 650 km from its main distribution area is very unlikely. However, to our knowledge, no one has searched for the species at the respective Romanian locality which was well-defined by Bielz. Nevertheless, despite intensive collecting efforts by competent malacologists over the last 150 years, *O. gularis* has not been encountered in Transylvania.

*O. gularis* is a very characteristic species with a strong palatal tooth in the aperture. Today, with literature available it is very difficult to misidentify *O. jetschini* as *O. gularis* Based on recent available literature, these two species easily can be distinguished from each other. Bielz also had non-Romanian comparative material of *O. gularis* at his disposal: Krain (NHMSB 139634–139635), Oberkrain (NHMSB 139636–139639), Karnthen (NHMSB 139640–139641), Hohewand (NHMSB 139642–139644) and Austria (NHMSB 139645–139646) (Ana Mesaroş, pers. comm.). On the other hand, the understanding of the Orculidae was insufficient at that time. For example, Bielz confused *O. jetschini* with *dolium* (see below). Perhaps, a thickening behind the aperture lip of the examined specimens led Bielz to misidentify them as *O. gularis* instead of *O. jetschini*, the species inhabiting that area.

***Orcula dolium***: *Orcula dolium* has been recorded from Romania by several authors. Bielz (1863) reported it from ‘’Vajda-Hunyad am Kaczanyas’’ (Hunedoara),

''Valea-Ordinkusi bei Skerisora'' (Ordâncuşa valley at Scărişoara), ''nördlich von Unter-Grohot bei Körösbánya'' (Baia de Criş), ''Vormága'' (Vărmaga) and ''Collegium-wald von Nagy-Enyed'' (Aiud). In the collection of Bielz (NHMS) we only found the sample from Körösbánya, one sample from ''Hideg-Szamos'' and more samples from Klausenburg (Cluj Napoca). Kertész (1901) reported *O. dolium* from a few localities in the Bihor Mountains, and Grossu (1987) most recently from a number of localities, namely from northern Oltenia and the Banat area, and a remote locality in Tulcea County (Luncavița, around the Cocoş Monastery).

Soós (1943) speculated that records of *Orcula dolium* by Bielz and Kertész (1901) from the Apuseni Mountains should be assigned to *O. jetschini*. In fact, Bielz revised his original labels from *Pupa dolium* to *jetschini* (NHMS).

Two Romanian samples of Grossu in the collection of MNINGA are labelled as *O. dolium*: MNINGA GST/923, Horezu, Valcea, leg. Grossu (3 shells) and MNINGA 28142, Bucegi, ''Sertarul 114'', ex Licherdopol (''*Orcula dolium* var. *implicata*'', 3 shells). Both samples are actually *Sphyradium doliolum*. We cannot explain the Luncavița locality (see remarks under *Sphyradium dobrogicum*). We collected near the localities mentioned by Grossu (Oltenia and Banat) and found only *O. jetschini*. Mitrović (2007) reported *O. dolium* from the Pleistocene of the Serbian Kostolac, very close to Grossu's localities. It is possible that some of the specimens Grossu examined are Pleistocene fossils, but it seems unlikely that *O. dolium* still lives in the Banat-Oltenia area in Romania. Soós (1943) marked Torna (southeast Slovakia) as the easternmost locality of *O. dolium*.

## Discussion

In this paper we describe the genitalia of the Eastern European *Orcula jetschini* and *O. zilchi* for the first time. We also examine and describe the anatomy of *O. wagneri* from a locality that lies 200 km north of populations examined by Schileyko (2012). This additional information and data published by other authors (mainly Gittenberger 1983 and Schileyko 2012) allows us to review the taxonomic relationships of the entire genus.

The genus can be subdivided into three subgenera (*Orcula*, *Illyriobanatica* subgen. n. and *Hausdorfia* subgen. n.) based on the shell characters and the morphology and size of the penial caecum, which serves as the primary diagnostic character. Unpublished results of molecular phylogenetic analysis (Harl et al. in prep.) of most *Orcula* species and subspecies indicate the monophyly of these three groups. This subdivision is in good agreement with biogeographic information.

Three species included herein have some shell and anatomical characters which differ from characters used to the features mentioned in the diagnoses of certain subgenera: (1) the shell sculpture of many populations of *Orcula* (*Illyriobanatica*) *wagneri* is almost smooth, which is unusual in the subgenus. (2) The penial caecum of *Orcula* (*Orcula*) *restituta* is very short compared to other species assigned to the subgenus. (3)

The penial caecum of *O.* (*Illyriobanatica*) *schmidtii transversalis* is short, but simple (Hausdorf 1987), not ''tuberculated'' as the other forms of the subgenus. The caecum of *O. schmidtii transversalis* seems to be double in the illustration of Reischütz and Sattmann (1990).

Based on available literature, the occurrence of *Orcula* (*O.*) *dolium* and *O.* (*O.*) *gularis* in Romania is discussed. Most purported Romanian ''voucher specimens'' are lost or we were unable to examine them. As the published literature is based on possibly misidentified specimens, and the verified distributional ranges of *O. gularis* and *O. dolium* lie far from the Romanian records, we suggest deleting *O. gularis* and *O. dolium* from the Romanian faunal list. The occurrence of only one *Orcula* species, namely *O.* (*I.*) *jetschini* is verified from Romania.

## Acknowledgements

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## References

Arrébola J, Razkin O, Gómez-Moliner B, Páll-Gergely B (2012) Redescription of *Orculella aragonica* (Westerlund 1897), an Iberian species different from *O. bulgarica* (Hesse 1915) (Gastropoda: Pulmonata: Orculidae). North-Western Journal of Zoology 8 (2): 292–299. http://biozoojournals.3x.ro/nwjz/content/v8n2/nwjz.121126.Arrebola.pdf

Audibert C (2011) De conchyliis balkanicæ III. Un possible cas de castration parasitaire chez *Orcula wagneri* au mont Žlieb (Crna Gora et Kosovo). Folia Conchyliologica 14: 21–25. http://www.cernuelle.com/file/Folia_Conchyliologica_14.pdf

Balashov I, Gural-Sverlova N (2012) An annotated checklist of the terrestrial molluscs of Ukraine. Journal of Conchology. 41 (1): 91–109.

Banak A, Mandić O, Kovačić M, Pavelić D (2012) Late Pleistocene climate history of the Baranja loess plateau – evidence from the Zmajevac loess-paleosol section (northeastern Croatia). Geologia Croatica, 65 (3): 411–422. http://www.geologia-croatica.hr/ojs/index.php/GC/article/view/GC.2012.30/pdf

Bank RA (2011) Fauna Europaea: *Orcula dobrogica*. Fauna Europaea version 2.5, http://www.faunaeur.org/full_results.php?id=429997 (accessed in 02.04.2013)

Bielz EA (1863) Fauna der Land- und Süsswasser-Mollusken Siebenbürgens. Closius, Hermannstadt, 206 pp. http://biodiversitylibrary.org/item/18089#page/5/mode/1up

Bielz EA (1867) Fauna der Land- und Süsswasser-Mollusken Siebenbürgens. Zweite Auflage. Filtsch, Hermannstadt, 216 pp.

Brancsik K (1888) *Pupa brancsikii* Clessin keine Species. Jahresheft des Naturwissenschaftlichen Vereins des Trencsiner Komitates 10: 81–85.

Bruguière JG 1792 Encyclopédie méthodique. Histoire naturelle des vers. Tome premier. [ABECON]. Panckoucke, Paris, 1–18. http://biodiversitylibrary.org/item/105173#page/7/mode/1up

Charpentier J de (1837) Catalogue des mollusques terrestres et fluviatiles de la Suisse. Formant la seconde partie de la faune Helvétique. Neue Denkschriften der Allgemeinen Schweizerischen Gesellschaft für die Gesammten Naturwissenschaften (Nouveaux Mémoires de la Société Helvétique des Sciences Naturelles) 1 (2): 1–28. http://biodiversitylibrary.org/item/41729#page/3/mode/1up

Ciangherotti A, Esu D, Martinetto E, Giuntelli P (2007) The remarkable Middle Pliocene non-marine mollusc record from Ceresole d'Alba, Piedmont, north-west Italy: Biochronology, palaeobiogeography and palaeoecology supported by fossil plants. Geobios 40 (5): 573–587. http://www.em-consulte.com/en/article/129066 doi: 10.1016/j.geobios.2006.10.005

Clessin S (1887) Die Molluskenfauna Österreich-Ungarns und der Schweiz. Bauer & Raspe, Nürnberg, 858 pp.

Damjanov S, Likharev I (1975) Fauna Bulgarica, Gastropoda terrestria, vol. IV. Bulgarian Academy of Sciences, Sofia, 425 pp.

Draparnaud JPR (1801) Tableau des Mollusques Terrestres et Fluviatiles de la France. Renaud; Bossange, Masson & Besson, Montpellier, Paris, 116 pp. http://biodiversitylibrary.org/item/90698#page/11/mode/1up

Ehrmann P (1933) Molluksen (Weichtiere). In: Brohmer P, Ehrmann P, Ulmer G: Die Tierwelt Mitteleuropas. Quelle & Meyer, Leipzig, 264 pp.

Falkner G, Falkner, M, von Proschwitz T (2011) *Orcula gularis*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. www.iucnredlist.org [accessed 19 January 2013]

Fehér, Z. 2011. *Orcula jetschini*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. www.iucnredlist.org [accessed 19 January 2013] http://www.iucnredlist.org/details/156965/0

Fehér Z, Gubányi A (2001) The catalogue of the Mollusca Collection of the Hungarian Natural History Museum. Magyar Természettudományi Múzeum, Budapest, 466 pp.

Ferrero Mortara E, Montefameglio L, Novelli M, Opesso G, Pavia G, Tampieri R (1984) Catalogo dei tipi e degli esemplari figurati della collezione Bellardi e Sacco. Parte II. Museo Regionale di Scienze Naturali (Torino), Cataloghi 7: 1–484

Garrido, J.A., Arrébola, J.R., Bertrand, M. (2005): Extant populations of *Orculella bulgarica* (Hesse, 1915) in Iberia. Journal of Conchology 38(6): 653–662. http://www.conchsoc.org/node/4754

Gittenberger E (1978) Beiträge zur Kenntnis der Pupillacea VIII. Einiges über Orculidae. Zoologische Verhandelingen 163: 1–44. http://www.repository.naturalis.nl/document/149053

Gittenberger E (1983) Beiträge zur Kenntnis der Pupillacea. IX. Nochmals über Orculidae. Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen., (C) 86 (3): 325–342.

Gray JE (1847) A list of the genera of recent Mollusca, their synonyms and types. Proceedings of the Zoological Society London, 15: 129–219. http://biodiversitylibrary.org/item/46217#page/631/mode/1up

Grossu AV (1986) Nouvelles espèces de la famille Orculidae (Gastropoda, Pulmonata). Travaux du Muséum d'Histoire Naturelle ''Grigore Antipa'' 28: 7–13.

Grossu AV (1987) Gastropoda Romaniae 2. Subclasa Pulmonata. I Ordo Basommatophora. II Ordo Stylommatophora, Suprafamiliile: Succinacea, Cochlicopacea, Pupillacea. Editura Litera, Bucureşti, 443 pp.

Grossu AV (1993) The catalogue of the Molluscs from Romania. Travaux du Muséum d'Histoire Naturelle ''Grigore Antipa'' 33: 291–366.

Harl J, Sattmann H, Schileyko A (2011) Types of the extant taxa of the landsnail genus *Orcula* Held 1837 (Gastropoda: Stylommatophora: Orculidae). Archiv für Molluskenkunde 140 (2): 149–173.

Hausdorf B (1987) Zum Vorkommen der Gattung *Orcula* Held in Griechenland (Gastropoda: Orculidae). Archiv für Molluskenkunde 118 (1/3): 51–55.

Hausdorf B (1996) Die Orculidae Asiens (Gastropoda: Stylommatophora). Archiv fur Molluskenkunde 125 (1/2): 1–86.

Held F (1837) Notizen über die Weichthiere Bayerns. Isis (von OKEN), 12: 902–920.

Hlaváč JČ (2002) Molluscan fauna of the Javoříčský Karst (Czech Republic, central Moravia). Malakológiai Tájékoztató 20: 93–105. http://www.matramuzeum.hu/e107_files/public/docrep/2002_HLAVAC.PDF

Kerney MP, Cameron RAD, Jungbluth JH (1983) Die Landschnecken Nord- und Mitteleuropas: Hamburg & Berlin, 384 pp.

Kertész M (1901) Biharmegye állatvilága (Fauna). A Jászóvári Premontrei Kanonokrend Nagyváradi Főgimnázium 1900–1901, Nagyvárad.

Kimakowicz M von (1883) Beitrag zur Mollusken-Fauna Siebenbürgens. Verhandlungen und Mittheilungen des Siebenbürgischen Vereins für Naturwissenschaften in Hermannstadt 33: 11–83.

Klemm W (1967) Über ostalpine Orculae. Archiv für Molluskenkunde 96: 101–111.

Klemm W (1973) Die Verbreitung der rezenten Land-Gehäuse-Schnecken in Österreich. Denkschriften der Österreichischen Akademie der Wissenschaften 117: 1–503.

Küster HC (1843–1850) 5. Abtheilungen der Heliceen. Die Gattungen *Pupa, Megaspira, Balea* und *Tornatellina*. In: Martini FHW, Chemnitz JH: Systematisches Conchylien-Cabinet, Bauer und Raspe, Nürnberg 1 (15): 1–194.

Likharev IM, Rammelmejer ES (1952) Nazemnye mollyuski fauny SSSR. Opredeliteli po Faune SSSR, Izdavaemye Zoologicheskim Institutom Akademii Nauk SSSR 43. Israel Program for Scientific Translations, Moskva, Leningrad, 511 pp.

Llamas J, Torres T, Canoira L, García Alonso P, García Cortés A, Hoyos M, Mansilla H, Meyer V, Nodal T (1995) Aminocronología de los depósitos del Pleistoceno Medio de Redueña, Madrid. Geogaceta 17: 43–45. http://www.sociedadgeologica.es/archivos/geogacetas/Geo17/Art11.pdf

Ložek V (2006) Last Glacial paleoenvironments of the West Carpathians in the light of fossil malacofauna. Journal of Geological Sciences 26: 73–84.

Marković SB, Oches EA, Gaudenyi T, Jovanović M, Hambach U, Zöller L, Sümegi P (2004) Palaeoclimate record in the Late Pleistocene loess-paleosol sequence at Miseluk (Vojvodina, Serbia). Quaternaire 15: 361–368. doi: 10.3406/quate.2004.1781

Mitrović B (2007) Pleistocene malacofauna of the Požarevac Danube Area (Ne Serbia). Geološki anali Balkanskoga poluostrva 68: 81–89. http://www.doiserbia.nb.rs/img/doi/0350-0608/2007/0350-060807010 81M.pdf

Mitrović B, Jovanović G (2000) Quaternary malacofauna of Topolovnik and Golubac (northeastern Serbia). Geologica Carpathica 51 (1): 3–6. http://www.geologicacarpathica.sk/src/abstract.php?id=2000005100010003

Moine O, Rousseau DD, Antoine P (2005) Terrestrial molluscan records of Weichselian Lower to Middle Pleniglacial climatic changes from the Nussloch loess series (Rhine Valley, Germany): the impact of local factors. Boreas 34: 363–380. doi: 10.1080/03009480510013060

Negrea A (1962) Contribuţii la studiul moluştelor din peşterile din R.P. Română (nota II). Comunicările Academiei Republicii Populare Române 12 (1): 37–43.

Negrea A (1966) Gasteropodele (Mollusca - Gastropoda) din pesterile Romaniei. Lucrarile Institutul de Speologie ''Emil Racovita'' 5: 125–139.

Páll-Gergely B (2010) New and little-known land snails from Turkey (Gastropoda: Pulmonata). Zoology in the Middle East 50: 89–94. http://www.kasparek-verlag.de/PDF%20Abstracts/PDF50%20Abstracts/089-094%20Pall-Gergely.pdf doi: 10.1080/09397140.2010.10638416

Páll-Gergely B (2011a) *Orcula wagneri*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. www.iucnredlist.org [accessed 19 January 2013] http://www.iucnredlist.org/details/156852/0

Páll-Gergely B (2011b) *Orcula zilchi*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. www.iucnredlist.org [accessed19 January 2013] http://www.iucnredlist.org/details/156819/0

Pilsbry HA (1916–1918) Manual of Conchology. Second Series: Pulmonata, Vol. 24, Pupillidæ (Gastrocoptinæ). Conchological Department, Academy of Natural Sciences of Philadelphia, Philadelphia, 380 pp.

Pilsbry HA (1922–1926) Manual of Conchology. Vol. XXVII. Pupillidae (Orculinae, Pagodulinae, Acanthinulinae, etc.). Academy of Natural Sciences of Philadelphia, Philadelphia, 369 pp.

Pintér L, Suara R (2004) Magyarországi puhatestűek katalógusa hazai malakológusok gyűjtései alapján. Hungarian Natural History Museum, Budapest, 547 pp.

Reischütz PL (1995) Zur Kenntnis der Genitalmorphologie von *Orcula brancsikii* Clessin 1887 (Gastropoda: Stylommatophora: Pupillacea). Nachrichtenblatt der Ersten Vorarlberger

Malakologischen Gesellschaft 3: 30–33. http://www.landesmuseum.at/pdf_frei_remote/NachErstMalaGes_3_0030-0033.pdf

Reischütz PL, Sattmann H (1990) Beiträge zur Molluskenfauna des Epirus, II. Annalen des Naturhistorischen Museums in Wien 91B: 253–272. http://www.landesmuseum.at/pdf_frei_remote/ANNA_91B_0253-0272.pdf

Rossmässler EA (1835–1837) Iconographie der Land- und Süßwasser-Mollusken, mit vorzüglicher Berücksichtigung der europäischen noch nicht abgebildeten Arten. Arnold, Dresden and Leipzig, 1–70. http://biodiversitylibrary.org/item/80434#page/7/mode/1up

Sacco F. (1897). I Molluschi dei terreni terziari del Piemonte e della Liguria. Parte XXII Gasteropoda (fine) (Pleuromariidae, Scissurellidae, Haliotidae, Fissurellidae, Tecturidae, Patellidae, Oocorythidae, Cyclophoridae, Cyclostomidae, Aciculidae, Truncatellidae, Acteonidae, Tornatinidae, Scaphandridae, Bullidae, Cylicnidae, Philinidae, Umbrellidae). Pulmonata (Testacellidae, Limacidae, Vitrinidae, Helicidae, Pupidae, Stenogyridae, Succineidae, Auriculidae, Limnaeidae, Physidae, Siphonaridae). - Amphineura (Chitonidae). Scaphopoda (Dentalidae). Carlo Clausen, Torino, 148 pp. http://biodiversitylibrary.org/item/46677#page/9/mode/1up

Schileyko AA (1984) Terrestrial molluscs of the suborder Pupillina of the USSR fauna (Gastropoda, Pulmonata, Geophila). Fauna USSR, N.S., N. 130. Mollusca. Vol. III, no 3. Nauka, Leningrad, 399 pp. (in Russian).

Schileyko AA (1998) Treatise on Recent Terrestrial Pulmonate Molluscs 1. Achatinellidae, Amastridae, Orculidae, Strobilopsidae, Spelaeodiscidae, Valloniidae, Cochlicopidae, Pupillidae, Chondrinidae, Pyramidulidae. Ruthenica, Supplement 2: 1–127.

Schileyko AA (2012) On the anatomy of Orculidae with special reference to the spermatophores (Gastropoda Pulmonata, Stylommatophora). Ruthenica, 22 (2): 141–158. http://www.ruthenica.com/documents/Vol22_Schileyko_141-158.pdf

Soós L (1917) Vizsgálatok a magyarországi Pulmonáták rendszertani anatomiája köréből. - Zur systematischen Anatomie der ungarischen Pulmonaten. Annales Historico-Naturales Musei Nationalis Hungarici 15: 1–165.

Soós L (1925) Weitere Beiträge zur Kenntnis des Genitalapparates von *Orcula*. Archiv für Molluskenkunde 57: 94–99.

Soós L (1943): A Kárpát-medence Mollusca faunája - Budapest: pp 478.

Steenberg CM (1925) Etudes sur l'anatomie et la systématique des maillots (fam. Pupillidae s. lat.). Videnskabelige Meddelelser fra Dansk Naturhistorisk Forening i København 80: 1–215.

Stossich A (1880) Il Carso Liburnico. Bollettino della Società Adriatica di Scienze Naturali in Trieste 5: 333–351. http://biodiversitylibrary.org/item/45356#page/389/mode/1up

Stossich A (1899) Contribuzione alla fauna malacologica terrestre e fl uviale del territorio di Trieste e in parte delle località contermini. Bollettino della Società Adriatica di Scienze Naturali in Trieste 19: 17–54. http://biodiversitylibrary.org/item/46056#page/59/mode/1up

Sturany R, Wagner AJ (1914) Über schalentragende Landmollusken aus Albanien und Nachbargebieten. Denkschriften der kaiserlichen Akademie der Wissenschaften, mathematisch-naturwissenschaftliche Klasse 91: 19–138. http://biodiversitylibrary.org/item/109887#page/41/mode/1up

Sysoev A, Schileyko A (2009) Land snails and slugs of Russia and adjacent countries. Pensoft, Sofia, 312 pp.

Urbański J (1960) Neue Landschnecken aus Bulgarien (Orculidae u. Pupillidae, Moll. Pulm.) (Systematische, zoogeographische und ökologische Studien über die Mollusken der Balkan-Halbinsel. IV.). Bulletin de la Société des Amis des Sciences et des Lettres de Poznan (Série D) 1: 57–67.

Varga A (1986) A magyarországi Stylommatophorák ivarszervanatómiai vizsgálata. I. Folia Historico Naturalia Musei Matraensis, 11: 71–109. http://www.matramuzeum.hu/e107_files/public/docrep/vol.11._1986.PDF

Varga A (2009) Régi anyagok a Mátra Múzeum (Gyöngyös) Mollusca-gyűjteményében. Folia Historico Naturalia Musei Matraensis 33: 25–51. http://www.matramuzeum.hu/e107_files/public/docrep/04_Varga_regi_anyagok.pdf

Vavrova L (2009) Ecosozological evaluation of molluscs of Slovakia by using Geographical Information System (GIS). PhD thesis, Zvolen, Slovakia: Institute of Forest Ecology of the Slovak Academy of Sciences.

Wagner AJ (1912) Beschreibungen neuer Land- und Süßwasserschnecken aus Südösterreich, Kroatien und Bosnien. Verhandlungen der kaiserlich-königlichen Zoologisch-Botanischen Gesellschaft in Wien 62: 246–260. http://biodiversitylibrary.org/item/47784#page/494/mode/1up

Welter-Schultes F (2012) European non-marine molluscs, a guide for species identification. Planet Poster Editions, Göttingen, 679 pp.

Westerlund CA (1887) Fauna der in der paläarctischen Region (Europa, Kaukasien, Sibirien, Turan, Persien, Kurdistan, Armenien, Mesopotamien, Kleinasien, Syrien, Arabien, Egypten, Tripolis, Tunesien, Algerien und Marocco) lebenden Binnenconchylien. III. Gen. *Buliminus*, *Sesteria*, *Pupa*, *Stenogyra* & *Cionella*. Håkan Ohlsson, Lund, 183 pp. http://biodiversitylibrary.org/item/41063#page/615/mode/1up

Westerlund CA (1894) Specilegium malacologicum. Neue Binnen-Conchylien aus der paläarktischen Region. V. Nachrichtsblatt der Deutschen Malakozoologischen Gesellschaft 26 (9/10): 163–177, 190–205. http://biodiversitylibrary.org/item/53280#page/403/mode/1up

Zanchetta G, Bonadonna FP, Marcolini F, Ciampalini A, Fallick AE, Leone G, Michelucci L (2004) Intra-Tyrrhenian cooling event deduced by a non-marine mollusc assemblage at Villa S. Giorgio (Livorno, Italy). Bollettino della Società Paleontologica Italiana 43: 331–343.

Zanchetta G, Becattini R, Bonadonna FP, Bossio A, Ciampalini A, Colonese A, Dall'Antonia B, Fallick AE, Leone G, Marcolini F, Lippi MM, Michelucci L (2006) Late middle Pleistocene cool non-marine mollusc and small mammal faunas from Livorno (Italy). Rivista Italiana di Paleontologia e Stratigrafia 112: 135–155. http://159.226.74.2/wxdata/En/Show.asp?id=7381

Zimmermann S (1931) *Orcula fuchsi* n. sp. Archiv für Molluskenkunde 63: 44–46.

Zimmermann S (1932) Ueber die Verbreitung und die Formen des Genus *Orcula* Held in den Ostalpen. Zeitschrift für Wissenschaftliche Zoologie, Abteilung B, Archiv für Naturgeschichte (Zeitschrift für Systematische Zoologie) (Neue Folge) 1: 1–56.

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# Notes on the scorpions (Arachnida, Scorpiones) from Xizang with the redescription of *Scorpiops jendeki* Kovařík, 2000 (Scorpiones, Euscorpiidae) from Yunnan (China)

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## Abstract

Until now, there are 26 scorpion species of 7 genera of 5 families recorded in Xizang (China). Xizang Autonomous Region (Tibet) is the scorpion biodiversity richest area in China (53 scorpion species of 12 genera of 5 families), also the highest altitude habitat of scorpions in the world. We present information of type specimens, an identification key of the scorpion species from Xizang, the distribution, updated feature pictures, and discussion on the disputed species. The redescriptions of *Scorpiops jendeki* Kovařík, 2000 (Yunnan) and *S. tibetanus* Hirst, 1911 (Xizang), comments and feature figures of species of genus *Scorpiops* are provided for identification.

## Keywords

Scorpions, *Scorpiops*, taxonomy, checklist, key, Tibet, Xizang

## Introduction

Xizang (Tibet) Autonomous Region is located in southwest China (26°52'–36°32'N, 78°24'–99°06'E), about 1,228,400 km$^2$ (≈12.5% of China), famous as the "Roof of the world". Xizang facing Xinjiang and Qinghai to the north, Sichuan and Yunnan to the east, while India, Myanmar, Bhutan, Sikkim, Nepal and Kashmir to the south

and west (Bai, 2004). It is the main part of the Qinghai-Tibet Plateau, with an average elevation of more than 4,000 m, its central part above 4,500 m.

*Scorpiops tibetanus* Hirst, 1911 (Euscorpiidae) was the first scorpion species established by Xizang (China) specimens. Hirst (1911) described this new species by comparing it with some relatives briefly. Almost ninety years later, Kovařík (2000a and b) reported 2 new species: *Chaerilus tryznai* Kovařík, 2000 (Chaerilidae); *Scorpiops margerisonae* Kovařík, 2000 and 1 new record: *Scorpiops hardwickii* (Gervais, 1843). Zhu, Qi and Song (2004) summarized the historical scorpion records in China: totally 19 species and subspecies of scorpion s belonging to 9 genera and 5 families according to the relevant literatures, and presented the distribution information on species from Xizang: *Heterometrus petersii* (Thorell, 1876) (Scorpionidae) and *Scorpiops petersii* Pocock, 1893. From 2005, much more work on Xizang was finished. Kovařík (2005) described *Euscorpiops novaki* Kovařík, 2005 (Euscorpiidae). After scientific expedition, Qi, Zhu and Lourenço (2005) published the first comprehensive report of scorpions from Xizang, discovered 6 new species belonging to Chaerilidae (*Chaerilus*) and Euscorpiidae (*Euscorpiops* and *Scorpiops*): *Scorpiops atomatus* Qi, Zhu & Lourenço, 2005; *Scorpiops langxian* Qi, Zhu & Lourenço, 2005; *Scorpiops luridus* Qi, Zhu & Lourenço, 2005; *Scorpiops pococki* Qi, Zhu & Lourenço, 2005; *Euscorpiops karschi* Qi, Zhu & Lourenço, 2005; and *Chaerilus tessellatus* Qi, Zhu & Lourenço, 2005. Lourenço, Qi and Zhu (2005) identified *Mesobuthus songi* Lourenço, Qi & Zhu, 2005 (Buthidae), and *Heterometrus tibetanus* Lourenço, Qi & Zhu, 2005. Lourenço and Qi (2006) established of a new genera by specimens from Xizang: *Tibetiomachus* Lourenço & Qi, 2006 (Hemiscorpiidae) and new species: *Tibetiomachus himalayensis* Lourenço & Qi, 2006. Bastawade (2006) reported 2 new species and 4 new records: *Chaerilus dibangvalleycus* Bastawade, 2006; *Chaerilus pictus* (Pocock, 1890); *Chaerilus tricostatus* Pocock, 1899; *Euscorpiops asthenurus* (Pocock, 1900); *Euscorpiops kamengensis* Bastawade, 2006; *Scorpiops leptochirus* Pocock, 1893 by the specimens from South Xizang (China). Lourenço and Zhu (2008) discovered a new species belonging to *Isometrus* (Buthidae): *I. (Reddyanus) tibetanus* Lourenço & Zhu, 2008, at the same time, *Isometrus* was a new recorded genus to Xizang. Zhu, Han and Lourenço (2008) summarized the chaerilid scorpions of China, and provided the redescriptions for *Chaerilus tessellatus* Qi, Zhu & Lourenço, 2005 and *Chaerilus triznai* Kovařík, 2000; pointed out that *Chaerilus pictus* (Pocock, 1890) which was described by Qi et al. (2005) was misidentified, and described one new species: *Chaerilus conchiformus* Zhu, Han and Lourenço, 2008, all of them from Xizang. Di and Zhu (2009a and b) established 2 new species: *Scorpiops lhasa* Di & Zhu, 2009 and *Chaerilus mainlingensis* Di & Zhu, 2009 successively. Di and Zhu (2009c) described the male of *Euscorpiops karschi* firstly. Di et al. (2009) analysed the genus *Chaerilus* Simon, 1877 (Scorpiones: Chaerilidae) from China, described the female *Chaerilus tricostatus* Pocock, 1899 firstly (*Chaerilus assamensis* Kraepelin, 1913 was a wrong record in this paper). Di and Zhu (2010) provided the redescription of *Scorpiops margerisonae* Kovařík, 2000, and reported the female for the first time. Sun, Zhu and Lourenço (2010) accommodated *Mesobuthus songi* Lourenço, Qi & Zhu,

2005 in the genus *Hottentotta*, as a new combination *Hottentotta songi* (Lourenço, Qi & Zhu 2005). In the meantime, Teruel and Rein (2010) transferred *Mesobuthus songi* Lourenço, Qi & Zhu, 2005 to the genus *Hottentotta* (Buthidae) too. Recently, Kovařík (2012) reported five new species of genus *Chaerilus*, including a Xizang species *Chaerilus wrzecionkoi* Kovařík, 2012.

Until now, twenty-six scorpion species of seven genera and five families were recorded in Xizang, all of them distribute in south and the north shores of Yarlung Zangbo Jiang. All of the eight species of *Chaerilus* from China found in Xizang, 10 of 11 species of *Scorpiops* from China living in Xizang (others: *Scorpiops jendeki* Kovařík, 1994 found in Yunnan, one unnamed species of *Scorpiops* in Hubei see Di et al. 2011a), 4 of 12 species of *Euscorpiops* from China found in Xizang (other 8 species in Yunnan; see Di et al. 2011b). The scientific expedition investigation of some areas of China has been finished basically which reflected in the papers (Qi et al, 2005; Shi et al, 2007; Zhang and Zhu, 2009; Di et al, 2009, 2010, 2011a and b, 2012; Sun and Sun, 2011). Followed these reports, Xizang is the richest area in China in scorpion diversity.

## Material and methods

Illustrations and measurements were produced using a Motic K-700L stereomicroscope with an Abbe drawing device and an ocular micrometer. Measurements follow Sissom (1990), and are given in mm. Trichobothrial notations follow Vachon (1974) and morphological terminology mostly follows Hjelle (1990). Terminology of metasomal carination follows Vachon (1952), Prendini (2000) and Soleglad and pedipalp chela carinae follow Sissom (2001) for. FKCP: private collection of F. Kovařík, Prague, Czech Republic; MHBU: Museum of the College of Life Sciences, Hebei University, Baoding, China; MNHN: Muséum national d'Histoire naturelle, Paris, France; NCZS: National Collections, Zoological Survey of India, Kolkata, India. NMPC: National Museum (Natural History), Prague, Czech Republic.

## Taxonomy

### Family Buthidae C. L. Koch, 1837

Buthidae: Fet & Lowe, 2000: 54–57; Soleglad & Fet, 2003: 89–91.

### Genus *Hottentotta* Birula, 1908

*Hottentotta*: Fet and Lowe, 2000: 134–135; Kovařík, 2007: 2–3, 8–10. Sun et al., 2010: 40.

***Hottentotta songi* (Lourenço, Qi & Zhu, 2005)**
http://species-id.net/wiki/Hottentotta_songi

*Mesobuthus songi* Lourenço, Qi & Zhu, 2005: 3–8, figs 1–17, tab. 1.
*Hottentotta songi*: Teruel & Rein, 2010: 7; Sun et al., 2010: 40–12, figs 25–29.

**Type specimens.** Holotype, male; Paratypes, 9 males and 9 females, China, Xizang, south region of Pulan, low valley of the river Kongque He, near to the border with Nepal, 7/1931. Male holotype, 7 male and 8 female paratypes deposited in MNHN. 2 male and 1 female paratypes deposited in MHBU.

**Distribution.** Burang County (Pulan Xian) (China).

**Genus *Isometrus* Ehrenberg, 1828**

*Isometrus*: Fet & Lowe, 2000: 146; Kovařík, 2003: 1–2, figs 1–8, tab. 1.

**Subgenus *Reddyanus* Vachon, 1972**

*Isometrus* (*Reddyanus*): Fet & Lowe, 2000: 151; Kovařík, 2003: 5.

***Isometrus (Reddyanus) tibetanus* Lourenço & Zhu, 2008**
http://species-id.net/wiki/Isometrus_tibetanus

*Isometrus* (*Reddyanus*) *tibetanus* Lourenço & Zhu, 2008: 268–270, figs 14–26, 32, tab. 1.

**Type specimens.** Holotype, male, China, Xizang Region of Chesu (?), 10/1970, Lindberg leg., deposited in MHBU.

**Distribution.** Chesu (?, China).

**Family Chaerilidae Pocock, 1893**

Chaerilidae: Fet, 2000a: 323. Kovařík, 2000a: 40–41; Soleglad & Fet, 2003: 92.

**Genus *Chaerilus* Simon, 1877**

*Chaerilus*: Fet, 2000a: 323; Kovařík, 2000a: 38; Kovařík, 2005: 1; Qi, Zhu & Lourenço, 2005: 29; Lourenço & Zhu, 2008: 462.

***Chaerilus conchiformus* Zhu, Han & Lourenço, 2008**
http://species-id.net/wiki/Chaerilus_conchiformus

*Chaerilus pictus*: Qi, Zhu & Lourenço, 2005:34–38, figs126–144.
*Chaerilus conchiformus* Zhu, Han & Lourenço, 2008: 38–44, figs1–21, tab.1.

**Type specimens.** Holotype, female, China, Xizang, Nyingchi County, Bayi Town, 29°41'N, 94°21'E, 17/8/2002, Ming-Sheng Zhu leg.(Ar.–MHU–XZ0201); Paratype, 1 female juvenile, China, Xizang, Nyingchi County, Bayi town, 6/8/2003, Feng Zhang leg. (Ar.–MHU–XZ0202); Paratypes, 6 females, China, Xizang, Nyingchi County, Baishuwang Town, 29°34'N, 94°30'E, 7/2006, Ming-Sheng Zhu, Xiao-Feng Yang and Long Liu leg.(Ar.–MHU–XZ0601-0606); Paratype,1 male, China, Xizang, Mainling County, Pai Town, 29°12'N, 94°06' E, 30/7/2006, Zhu Ming-Sheng, Yang Xiao-Feng and Liu Long leg. (Ar.–MHU–XZ0102)(deposited in MHBU).

**Habitat.** Under the stones in the farmland (highland barley) and forest (cypress).

**Distribution.** Mainling County and Nyingchi County (China).

***Chaerilus dibangvalleycus* Bastawade, 2006**
http://species-id.net/wiki/Chaerilus_dibangvalleycus

*Chaerilus dibangvalleycus* Bastawade, 2006: figs 1–16.

**Type specimens.** Holotype, male; Paratypes, 5 females, 5 males and 2 young ones, China, Xizang, Dibangvalley District, Mayodia, 1800 Mts (deposited in NCZS).

**Other materials reported.** 3 males and 4 females, 15/9/1991, D. B. Bastawade leg.; 1 male, 16/9/1991, K.Alia leg.; 2 males and 1 female and 2 young ones, 17/9/1991, D. B. Bastawade leg.

**Distribution.** Mêdog County (China).

***Chaerilus mainlingensis* Di & Zhu, 2009**
http://species-id.net/wiki/Chaerilus_mainlingensis

*Chaerilus mainlingensis* Di & Zhu, 2009a: 97–102, figs 1–16.

**Type specimens.** Holotype, female, China, Xizang, Mainling County, the Estate of Gongbuwang, 12/7/2008, Zhi-Yong Di and Guo-Dong Ren leg. (Ar.-MHU-XZML0801); 1 female paratype, same data as holotype (Ar.-MHU-XZML0802) (deposited in MHBU).

**Habitat.** Under the stones of mixed forest.

**Distribution.** Mainling County (China).

***Chaerilus pictus* (Pocock, 1890)**
http://species-id.net/wiki/Chaerilus_pictus

*Chaerilus pictus*: Fet, 2000a: 327; Kovařík, 2000a: 53–54; figs 21–22, 39, 42–43, tabs 1–2; Lourenço & Bernard, 2010: figs 30–31.

**Materials reported.** Specific locality see Bastawade, 2006.

**Distribution.** South Xizang (China); (Assam) India; (Silhet) Bangladesh.

***Chaerilus tessellatus* Qi, Zhu & Lourenço, 2005**
http://species-id.net/wiki/Chaerilus_tessellatus

*Chaerilus tessellatus* Qi, Zhu & Lourenço, 2005: 30, 34, figs 109–125; Zhu, Han & Lourenço, 2008: 44–47, figs 30–44, tab. 1.

**Type specimens.** Holotype, female, China, Xizang, Mêdog County, Beibeng Town, 29°02'N, 95°03'E, 22/8/2003, Feng Zhang leg.(MHBU, Ar.–MHU–XZ0301); 2 female paratypes, China, Xizang, Bomi County, 29°08'N, 95°07'E, 14/8/2002, Ming-Sheng Zhu leg.(MHBU, Ar.–MHU–XZ0203; another deposited in MNHN); 1 female paratype, China, Xizang, Mêdog County, 108K-8K, 17/8/2003, Feng Zhang leg. (MHBU, Ar.–MHU–XZ0302).

**Other materials reported.** 1 female, China, Xizang, Bomi County, Mt. Sela, 3/8/2002, Ming-Sheng Zhu leg.(MHBU, Ar.–MHU–XZ0204); 2 female juveniles. China, Xizang, Nyingchi County, Dongjiu villige, 21/9/2007, Fu-Ming Shi leg. (MHBU, Ar.–MHU–XZ0401-02).

**Distribution.** Bomê County (Bomi), Mêdog County and Nyingchi County (China).

***Chaerilus tricostatus* Pocock, 1899**
http://species-id.net/wiki/Chaerilus_tricostatus

*Chaerilus tricostatus*: Fet, 2000a: 327, Kovařík, 2000a: 61–62, figs 27–28, tabs 1–2; Di et al., 2009: 131–138; figs 1–18; tab. 1.

**Materials reported.** 3 females, 1 female immature and 3 juveniles, China, Xizang, Mêdog County, elevation 1146m, 29°20'N, 95°20'E, 14/8/2009, Liqing Fan leg. (Ar.-MWHU-XAMT0901–07; deposited in MWHU).

**Distribution.** Mêdog County, South Xizang (China); (Assam) India.

***Chaerilus tryznai* Kovařík, 2000**
http://species-id.net/wiki/Chaerilus_tryznai

*Chaerilus tryznai* Kovařík, 2000a: 65–66, figs 32–33, tabs 1–2.
*Chaerilus tryznai*: Zhu, Han & Lourenço, 2008: 47–51, figs 45–60, tab. 1.

**Type specimens.** Holotype, male; Allotype and Paratype (No. 1), 2 females; Paratypes Nos. 2–12, 10 females and 1 immature, China, Xizang, Bomi County, 29°52' N, 95°45'E, 3000m, M. Tryzna & O. Safranek, FKCP.

**Other materials reported.** China, Xizang, Mêdog County, 29°02' N, 95°03' E, Hanmi Village, 11/8/2006, 1 female, Zhi-Shun Song leg.(Ar.–MHU–XZ0607) (in MHBU); China, Xizang, Mêdog County, Hanmi Village, 10/8/2006, 1 female, Zhi-Shun Song leg. Zhi-Shun Song leg. (Ar.–MHU–XZ0608)(deposited in MHBU).

**Habitat.** Under the stones in the mixed forest.

**Distribution.** Bomê County, Mêdog County (China).

**Comments.** Five related species with close geographical distribution, *C. assamensis*: Kraepelin, 1913, *C. conchiformus, C. dibangvalleycus, C. mainlingensis,* and *C. tryznai*, all with 7–8 granulated cutting edges on the movable fingers of pedipalp (Bastawade, 2006; Di & Zhu, 2009; Kovařík, 2000a; Zhu, Han & Lourenço, 2008). *C. assamensis* was described by type specimen from Assam (India), its original description is poor (see Kraepelin, 1913). Kovařík (2000a: 69), who analysed the old reference, recorded three characters of *C. assamensis*: middle and lateral eyes present; 7–8 granulated cutting edges on the movable fingers of pedipalp; the anterior margin of carapace arched in males. Lourenço and Duhem (2010) thought *C. tryznai*, with few differences from *C. assamensis*, may prove to be conspecific. Both sexes of *C. conchiformus*, *C. dibangvalleycus* and *C. tryznai* have anterior margin truncated, but only females of *C. mainlingensis* have same anterior margin of carapace as *C. dibangvalleycus*. Except *C. assamensis* with poor information, other 4 species can be identified by the key provided in this paper.

***Chaerilus wrzecionkoi* Kovařík, 2012**
http://species-id.net/wiki/Chaerilus_wrzecionkoi

*Chaerilus wrzecionkoi* Kovařík, 2012b: 11–13, figs 62–77.

**Type specimens.** Holotype, allotype and paratypes, 2 males and 2 females, China, Xizang, Tomi (Tangmai), 30 km W of Donjung, 2075 m a.s.l., 23/6/2007, leg. A. Wrzecionko; FKCP.

**Distribution.** Tangmai (Tongmai?), Tomi (Bomê County?) (China).

**Comments.** *C. wrzecionkoi* are closest with *C. mainlingensis* Di & Zhu, 2009 and *C. tryznai* Kovařík, 2000. Both have manus and patella of pedipalp narrower and longer than other congeneric species. *C. mainlingensis* has four distinct carinae on the seventh sternite; *C. wrzecionkoi* has the seventh sternite granulated but without

carinae; manus of pedipalp in male narrow and long, chela length/width ratio in male higher than 3 in *C. tryznai* Kovařík, 2000, while manus of pedipalp in male robust and chela length/width ratio in adults lower than 2.6 in *C. wrzecionkoi* (see Kovařík, 2012).

### Family Euscorpiidae Laurie, 1896

Euscorpiidae: Fet & Sissom, 2000: 355; Soleglad & Fet, 2003: 105.
Scorpiopidae: Fet, 2000d: 487; Kovařík, 2000b: 154.

### Genus *Euscorpiops* Vachon, 1980

*Euscorpiops*: Fet & Sissom, 2000: 488. Kovařík, 2000b: 154; Kovařík, 2005: 1, 4; Kovařík, 2012a: 1, 3.

#### *Euscorpiops asthenurus* (Pocock, 1900)

http://species-id.net/wiki/Euscorpiops_asthenurus

*Euscorpiops asthenurus*: Fet, 2000d: 488.
*Scorpiops asthenurus*: Kovařík, 2000b: 167, figs 15, 28, 31, tabs 1–3.

**Other materials reported.** Specific locality see Bastawade, 2006.

**Distribution.** South Xizang (China); Bhutan; (Assam, West Bengal, Sikkim) India.

#### *Euscorpiops kamengensis* Bastawade, 2006

http://species-id.net/wiki/Euscorpiops_kamengensis

*Euscorpiops kamengensis* Bastawade, 2006: 454, 456, 457, figs 17–26.

**Type specimens.** Holotype, male; Paratype, 1 female immature, China, South Xizang, West Kameng, 7 Kms of Bomdilla, Sara village, 2500 mts. D. B. Bastawade leg. 18/9/1991 (deposited in NCZS).

**Distribution.** South Xizang (China).

#### *Euscorpiops karschi* Qi, Zhu & Lourenço, 2005

http://species-id.net/wiki/Euscorpiops_karschi

*Euscorpiops karschi* Lourenço, Zhu & Qi, 2005: 25, figs 94–108. Di & Zhu, 2009b: 11–15, figs 1–27, tab. 1.

**Type specimens.** Holotype, female, China, Xizang, Zayü district, Xia Zayü town (28°30'N, 97°00'E), 8/8/2002, Ming-Sheng Zhu leg. (MHBU, Ar.-MHBU-XZ-ZY0201). Paratypes: 2 females and 2 immature males, same data as holotype (one female in MHBU, Ar.-MHBU-XZZY0202); one female in MNHN, Ar.-MNBU-XZZY0203).

**Other materials reported.** 1 male, China, Xizang, Zayü district, Xia Zayü town (28°30' N, 97°00' E), 2/10/2007, Fu-Ming Shi leg. (MHBU, Ar.-MHBU-XZZY0701); 1female, China, Xizang, Zayü district, Shang Zayü town, 23/8/2005, Zhi-Shun Song leg. (MHBU, Ar.-MHBU-XZZY0501).

**Distribution.** Zayü County (Zayü district, Chayu district) (China).

***Euscorpiops novaki* Kovařík, 2005**
http://species-id.net/wiki/Euscorpiops_novaki

*Euscorpiops novaki* Kovařík, 2005: 4, 6, figs 8, 11, 15–16, tab. 1.

**Type specimens.** Holotype, male, China, Xizang, Bomi County (29°52' N, 95°45'E), ca 3000 m, 1988, P. Rojek leg., FKCP.

**Distribution.** Bomê County (China).

**Genus *Scorpiops* Peters 1861**

*Scorpiops*: Fet, 2000d: 491; Kovařík, 2000b: 162, 164, 166; Qi, Zhu & Lourenço, 2005: 2; Di & Zhu, 2009: 40; Di et al., 2011b, 1–2. Kovařík, 2009: 1.

***Scorpiops atomatus* Qi, Zhu & Lourenço, 2005**
http://species-id.net/wiki/Scorpiops_atomatus
Figures 1–21, Table 1

*Scorpiops atomatus* Qi, Zhu & Lourenço, 2005: 6–10, figs 16–31.

**Type specimens.** Holotype, male, China, Xizang, Lang district (29.02°N, 93.08°E), 7-8/2004, Ai-Min Shi and Yi-Bin Ba leg. (MHBU). Paratypes: 3 females, 1 male, same data as holotype (2 females in MHBU, 1 female and 1 male in MNHN); 1male, China, Xizang, Chayu district, Xia Zayü town (28.4°N, 97.0°E), 7/8/2002, Ming-Sheng Zhu leg. (MHBU?); 2 females, China, Xizang, Lang district (29.02°N, 93.08°E), 20 August 2002, Ming-Sheng Zhu leg. (MHBU?); 1 male, China, Xizang, Gyaca district (29.1°N, 92.7°E), 21/8/2002, Ming-Sheng Zhu leg. (MHBU?); 1 male, 1female, 22 August 2002, other data same as above (MHBU?).

**Table 1.** Measurements (in mm) of *Scorpiops atomatus*, *Scorpiops langxian* and *Scorpiops luridus*.

| Species / Contents | *Scorpiops atomatus* | | *Scorpiops langxian* | | *Scorpiops luridus* | |
|---|---|---|---|---|---|---|
| **Sex** | **Male HT(MHBU)** | **Female PT(MHBU)** | **Male HT(MHBU)** | **Female PT(MHBU)** | **Male HT(MHBU)** | **Female PT(MHBU)** |
| Total length | 42.1 | 40.4 | 63.0 | 58.5 | 86.7 | 75.1 |
| Carapace: | | | | | | |
| -Length | 6.2 | 6.4 | 7.7 | 7.3 | 11.7 | 10.2 |
| - Anterior width | 3.7 | 4.0 | 4.3 | 4.0 | 5.0 | 4.1 |
| - Posterior width | 6.5 | 6.2 | 8.4 | 7.9 | 10.6 | 9.2 |
| Metasomal segment I: | | | | | | |
| - Length | 2.4 | 2.3 | 4.1 | 3.9 | 4.3 | 4.1 |
| - Width | 2.4 | 2.4 | 3.8 | 3.5 | 4.5 | 4.1 |
| - Depth | 2.0 | 1.9 | 3.1 | 2.8 | 3.7 | 3.2 |
| Metasomal segment II: | | | | | | |
| - Length | 2.9 | 2.6 | 4.7 | 4.3 | 4.9 | 4.2 |
| - Width | 2.1 | 2.1 | 3.6 | 3.2 | 4.0 | 3.7 |
| - Depth | 1.8 | 1.9 | 2.9 | 2.8 | 3.7 | 3.1 |
| Metasomal segment III: | | | | | | |
| - Length | 3.1 | 2.9 | 5.2 | 4.9 | 5.7 | 5.1 |
| - Width | 2.0 | 2.0 | 3.3 | 3.1 | 3.8 | 3.2 |
| - Depth | 1.8 | 2.0 | 3.0 | 2.6 | 3.6 | 3.1 |
| Metasomal segment IV | | | | | | |
| - Length | 3.6 | 3.1 | 5.7 | 5.5 | 7.8 | 6.4 |
| - Width | 1.8 | 1.9 | 3.2 | 2.9 | 3.6 | 3.1 |
| - Depth | 2.0 | 2.0 | 3.0 | 2.6 | 3.7 | 3.1 |
| Metasomal segment V | | | | | | |
| - Length | 5.4 | 5.2 | 9.0 | 8.3 | 12.8 | 9.6 |
| - Width | 1.8 | 2.0 | 2.9 | 2.6 | 3.2 | 2.7 |
| - Depth | 1.8 | 1.9 | 2.9 | 2.4 | 3.3 | 2.8 |
| Telson: | | | | | | |
| - Length | 5.9 | 5.5 | 8.8 | 7.4 | 12.8 | 10.2 |
| - Width | 2.0 | 1.9 | 3.7 | 3.0 | 4.6 | 4.0 |
| - Depth | 2.0 | 1.8 | 3.4 | 2.7 | 4.6 | 3.8 |
| Pedipalp femur: | | | | | | |
| - Length | 5.6 | 5.6 | 6.1 | 6.1 | 10.2 | 8.9 |
| - Width | 2.6 | 2.4 | 2.6 | 2.7 | 3.8 | 3.7 |
| - Depth | 1.9 | 1.9 | 2.4 | 2.4 | 2.6 | 2.6 |
| Pedipalp patella: | | | | | | |
| - Length | 5.1 | 5.3 | 6.0 | 5.3 | 9.6 | 8.3 |
| - Width | 2.8 | 2.7 | 3.1 | 3.1 | 4.5 | 4.1 |
| - Depth | 2.3 | 2.3 | 3.1 | 3.2 | 3.8 | 3.8 |

| Species / Contents | *Scorpiops atomatus* | | *Scorpiops langxian* | | *Scorpiops luridus* | |
|---|---|---|---|---|---|---|
| **Sex** | **Male HT(MHBU)** | **Female PT(MHBU)** | **Male HT(MHBU)** | **Female PT(MHBU)** | **Male HT(MHBU)** | **Female PT(MHBU)** |
| Chela | | | | | | |
| - Length (chela) | 10.0 | 9.9 | 11.2 | 11.5 | 23.5 | 20.0 |
| - Length (manus) | 6.1 | 6.2 | 6.6 | 6.7 | 12.0 | 10.2 |
| - Width | 4.4 | 4.2 | 6.2 | 5.8 | 7.3 | 6.4 |
| - Depth | 3.0 | 2.8 | 4.6 | 4.2 | 5.7 | 4.6 |
| Movable finger-Length | 5.9 | 5.9 | 7.4 | 7.3 | 11.5 | 9.8 |
| Pectinal teeth (left/right) | 10/11 | 9/9 | 8/8 | 6/6 | 10/10 | 8/8 |

**Distribution.** Gyaca County, Nang County (Lang district, Langxian district), Zayü County (China).

**Comments.** Kovařík & Ahmed (2009: 10) provided a list of *S. hardwickii* (Gervais, 1843) "complex", which included 12 species, containing *S. atomatus*. Di et al. (2011a) summarized the characters of *S. hardwickii* "complex" and excluded *S. atomatus* with the reasons as followed: (1) pectinal teeth count is 9–11 in *S. atomatus*, and 4–8 in *S. hardwickii* (Kovařík, 2000: 178); (2) ventral trichobothria on patella number is 9 in *S. atomatus*, and 6–8 in *S. hardwickii* (Kovařík, 2000: 176); (3) fulcra are present in *S. atomatus* but absent in *S. hardwickii*. In addition, *S. atomatus* has clearly thinner chela than *S. pococki* and *S. langxian*.

***Scorpiops hardwickii* (Gervais, 1843)**
http://species-id.net/wiki/Scorpiops_hardwickii

*Scorpiops hardwickii*: Kovařík, 2000b: 175–179, figs 14, 46, 56, 57.
*Scorpiops hardwickii hardwickii*: Fet, 2000d: 492.

**Materials reported.** 1 male, 3 females and 3 juveniles, China, Xizang, Nyainqentangha Mts, Lhasa, 3800m, V. Major leg. FKCP.

**Distribution.** Lhasa, Xizang (China); (Himachal, Uttar, Jammu, Kashmir, Punjab) India; Nepal; Pakistan.

**Comments.** The list of *S. hardwickii* (Gervais, 1843) "complex", provided by Kovařík & Ahmed (2009: 10), containing 12 species widely distributed in Asia. Di et al. (2011a) summarized the characters of *S. hardwickii* "complex": (1) color red brown to dark brown; (2) total length about 45–80 mm in adults; (3) fingers of pedipalps very strongly flexed (curved) in males, slightly flexed (undulated) in females; (4) ventral trichobothria on patella number 6–8; (5) pectinal teeth number 4–9; (6) length/width ratio of chela about 1.8–2.1; (7) fulcra absent; (8) patella with two small spinoid granules on the internal aspect.

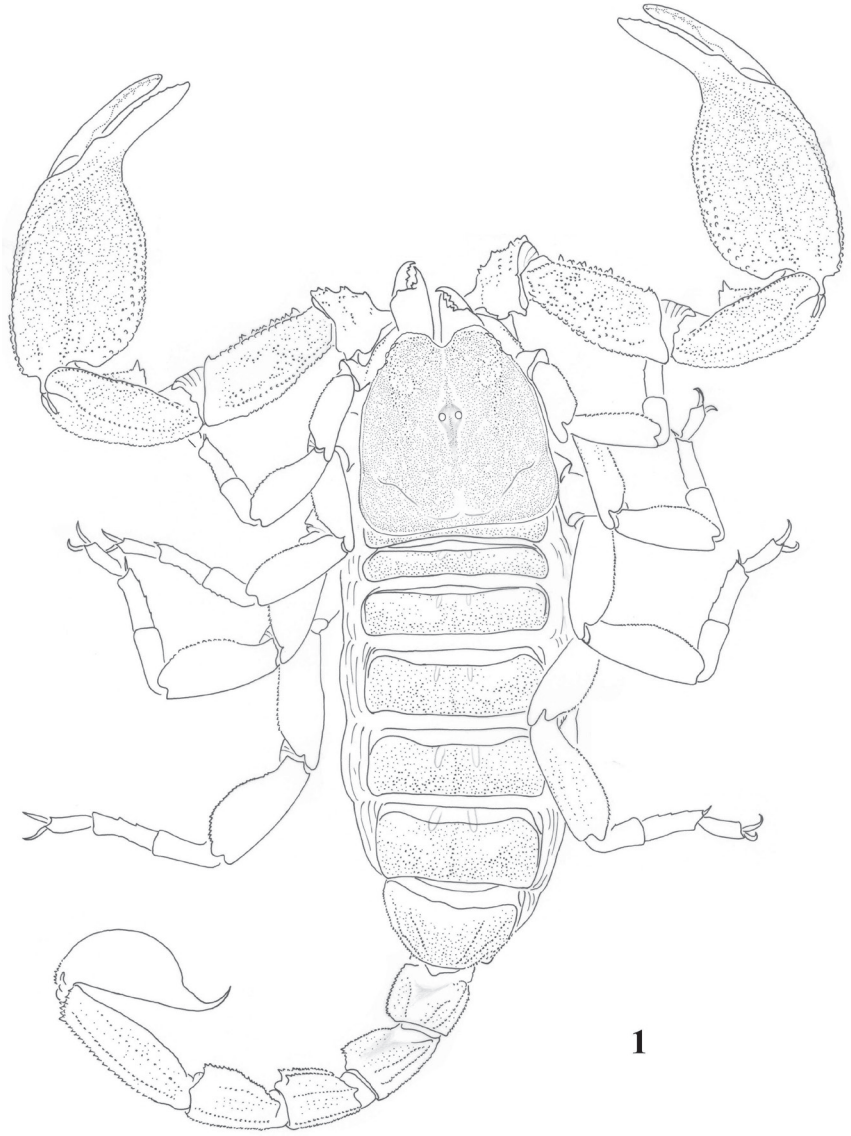
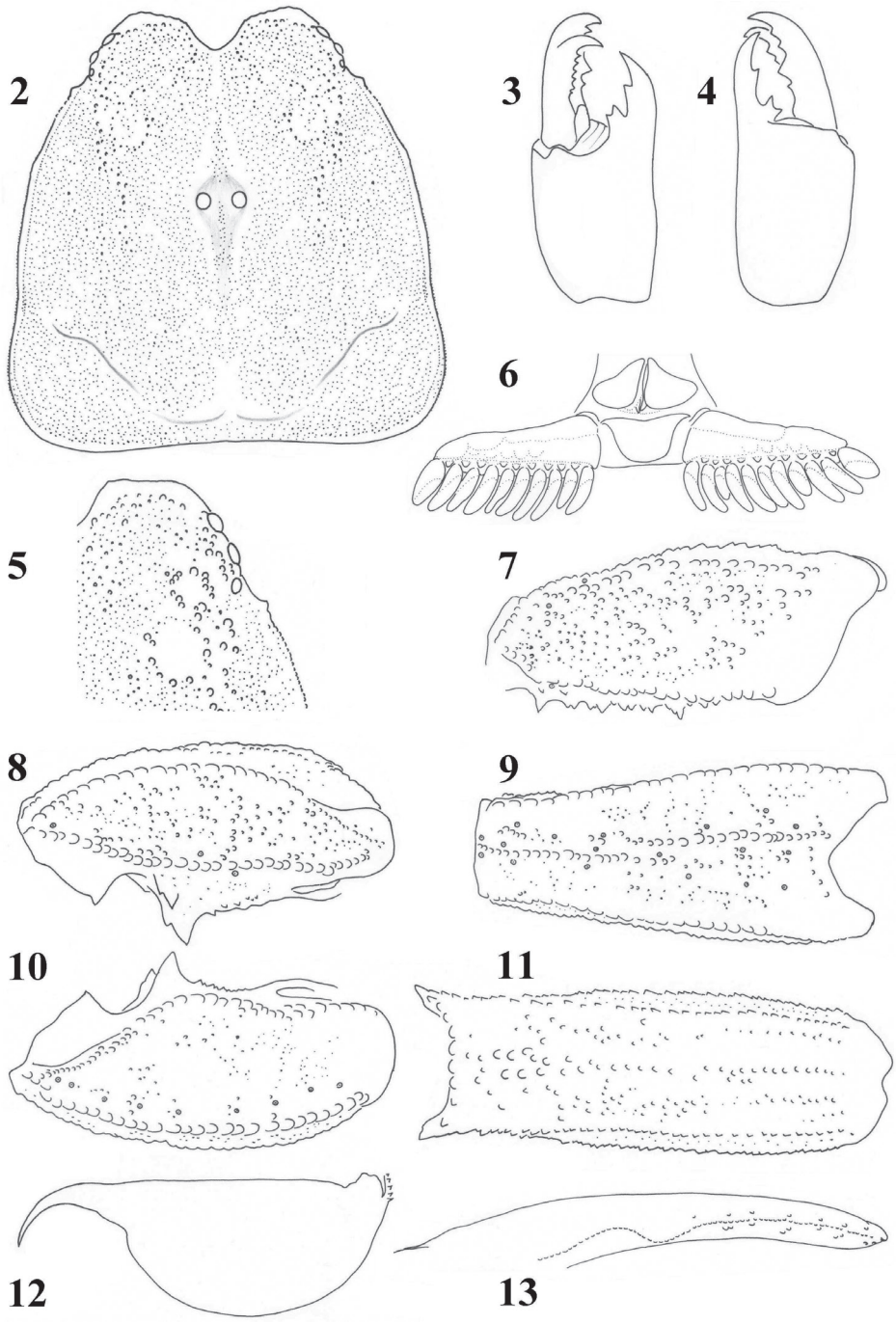



**Figure 1.** Habitus of *Scorpiops atomatus*, male, holotype, dorsal view.

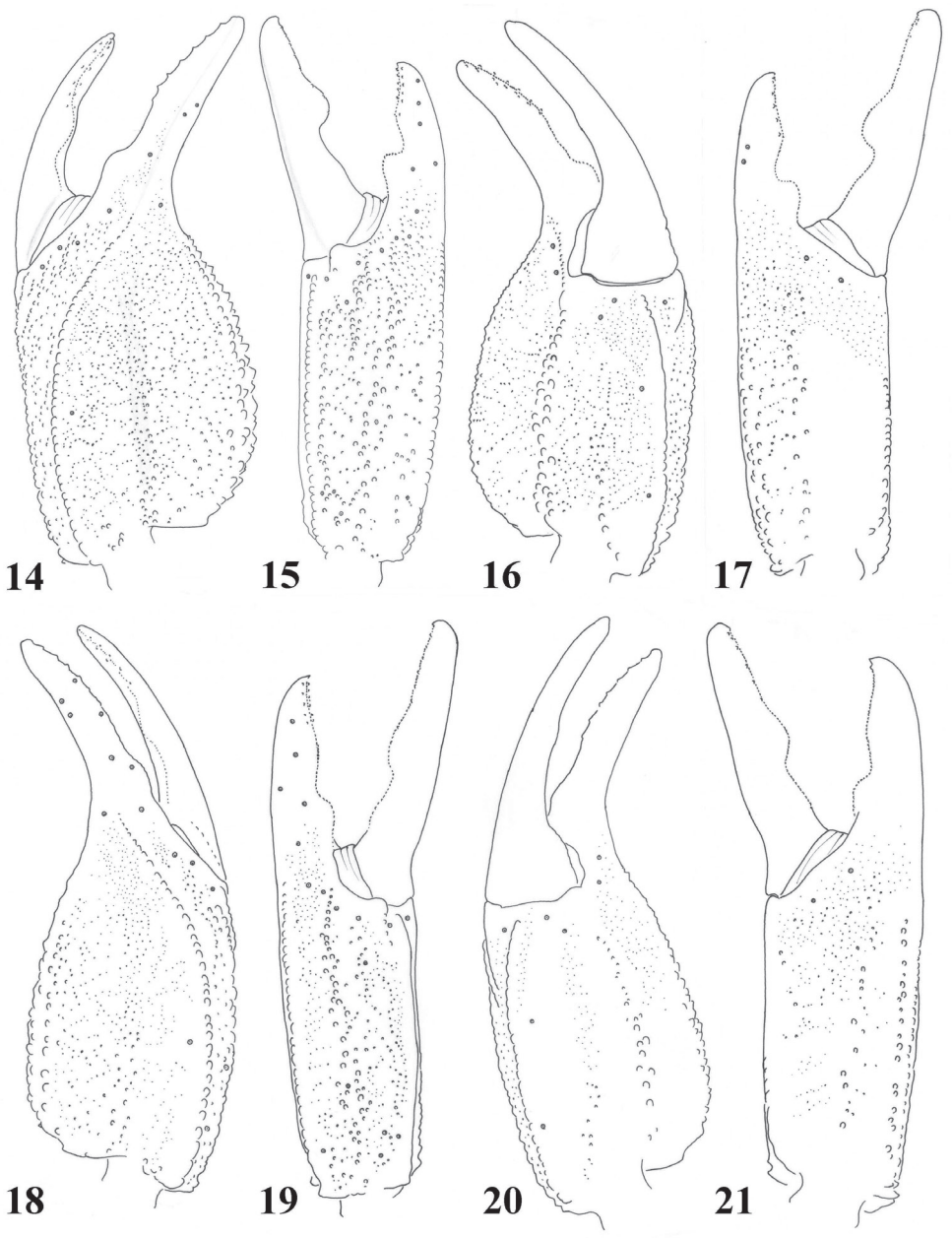
***Scorpiops langxian*** **Qi, Zhu & Lourenço, 2005**
http://species-id.net/wiki/Scorpiops_langxian
Figures 22–42, Table 1

*Scorpiops langxian* Qi, Zhu & Lourenço, 2005: 10–18, figs 32–46.

**Type specimens.** Holotype, male, China, Xizang, Lang district (29°02'N, 93°08'E), 7-8/2004, Ai-Min Shi and Yi- Bin Ba leg. (MHBU); Paratypes 1 female, 1 male same




**Figures 2–13.** *Scorpiops atomatus*, male, holotype. **2** Carapace **3–4** Chelicera, dorsal and ventral aspects **5** Lateral eyes **6** Genital operculum and pectines **7** Femur dorsal aspect **8–10** Patella dorsal, external and ventral aspects **11** Metasomal segment V, ventral aspect **12** Telson, lateral aspect **13** Dentate margin of movable finger, showing rows of granules.




**Figures 14–17.** *Scorpiops atomatus*, male, holotype. Chela (left) dorsal, external, ventral and internal aspects **18–21** *Scorpiops atomatus*, female, paratype. Chela dorsal, external, ventral and internal aspects.

data as holotype (MHBU); 1 female, China, Xizang, Nyingchi district (29°34'N, 94.30°E), Baishuwang town, 21/8/ 2003, Feng Zhang leg. (MNHN).

**Distribution.** Nang County, Nyingchi County (China).

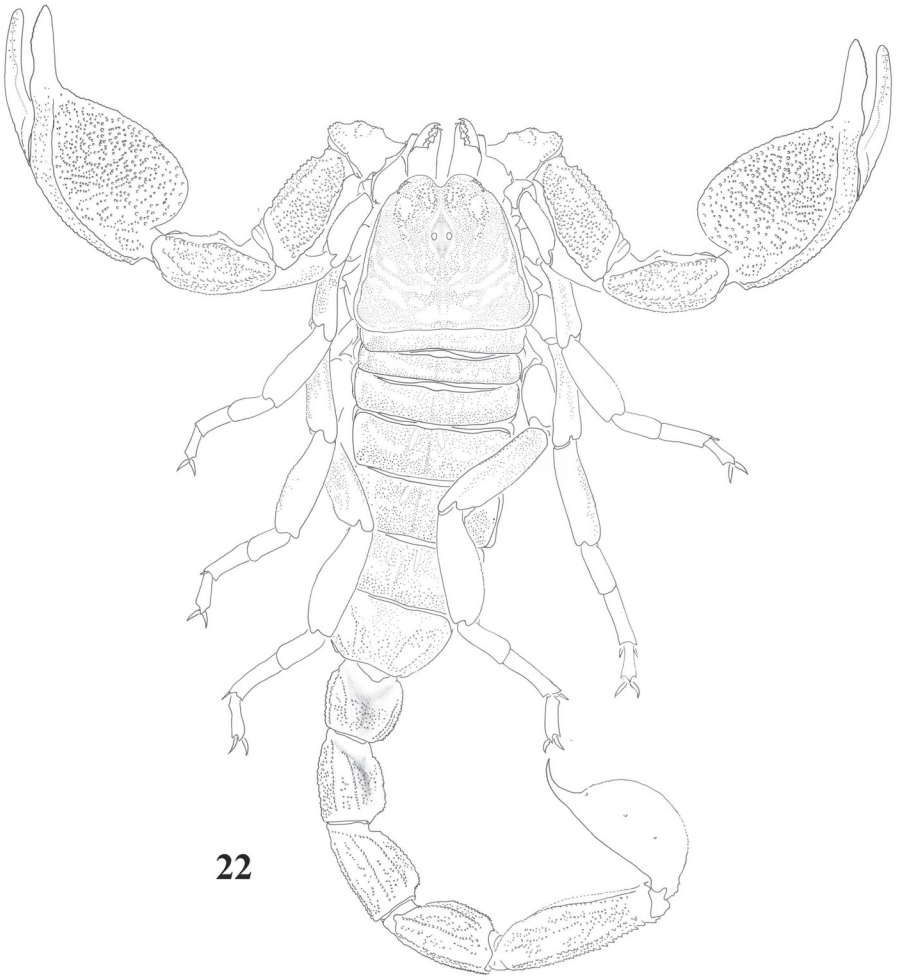



**Figure 22.** Habitus of *Scorpiops langxian*, male, holotype, dorsal view.

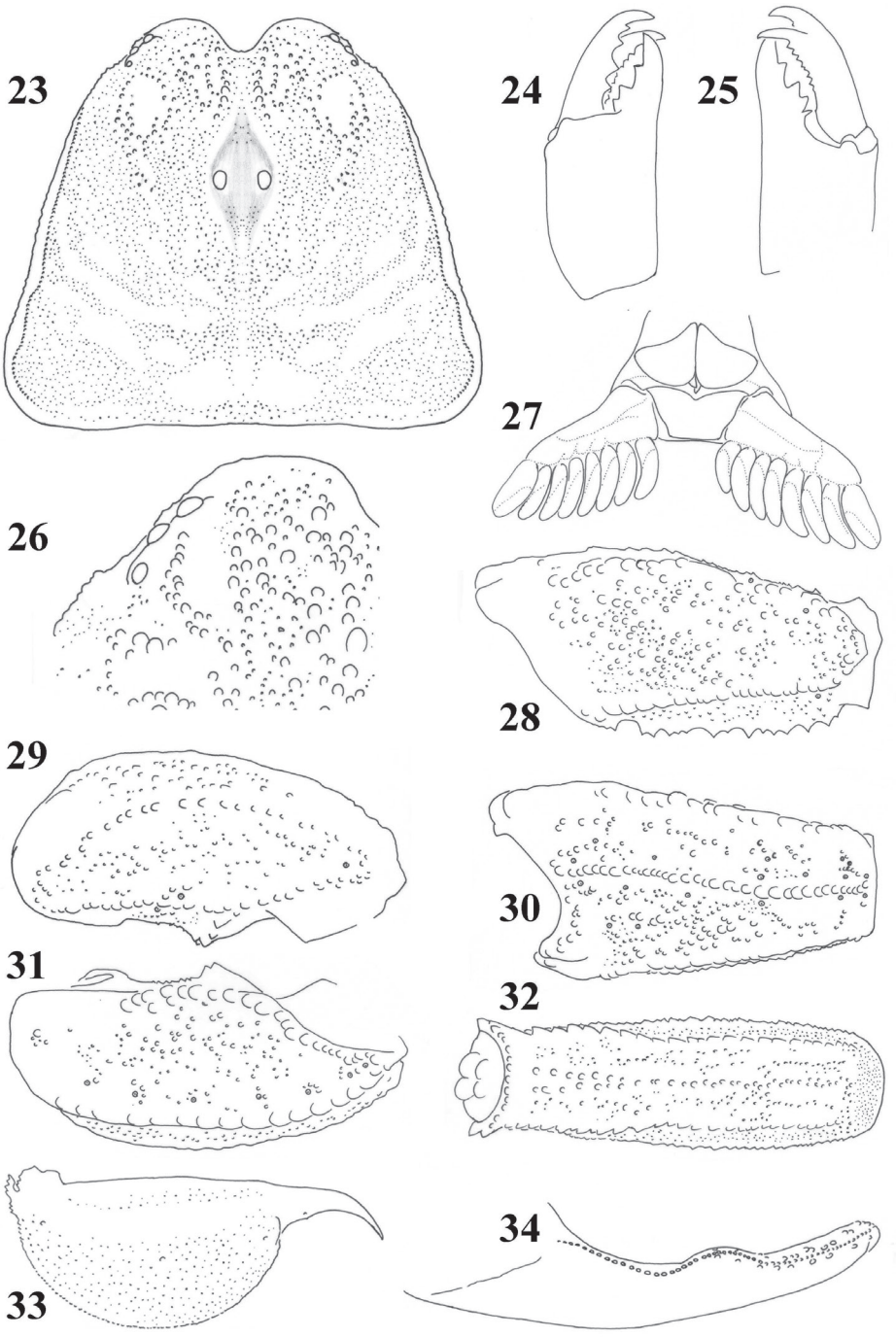
**Comments.** Kovařík & Ahmed (2009: 10) provided a list of *S. hardwickii* (Gervais, 1843) "complex", which contained 12 species, including *S. langxian*, and its features accord with the summary of Di et al (2011a).

***Scorpiops leptochirus* Pocock, 1893**
http://species-id.net/wiki/Scorpiops_leptochirus

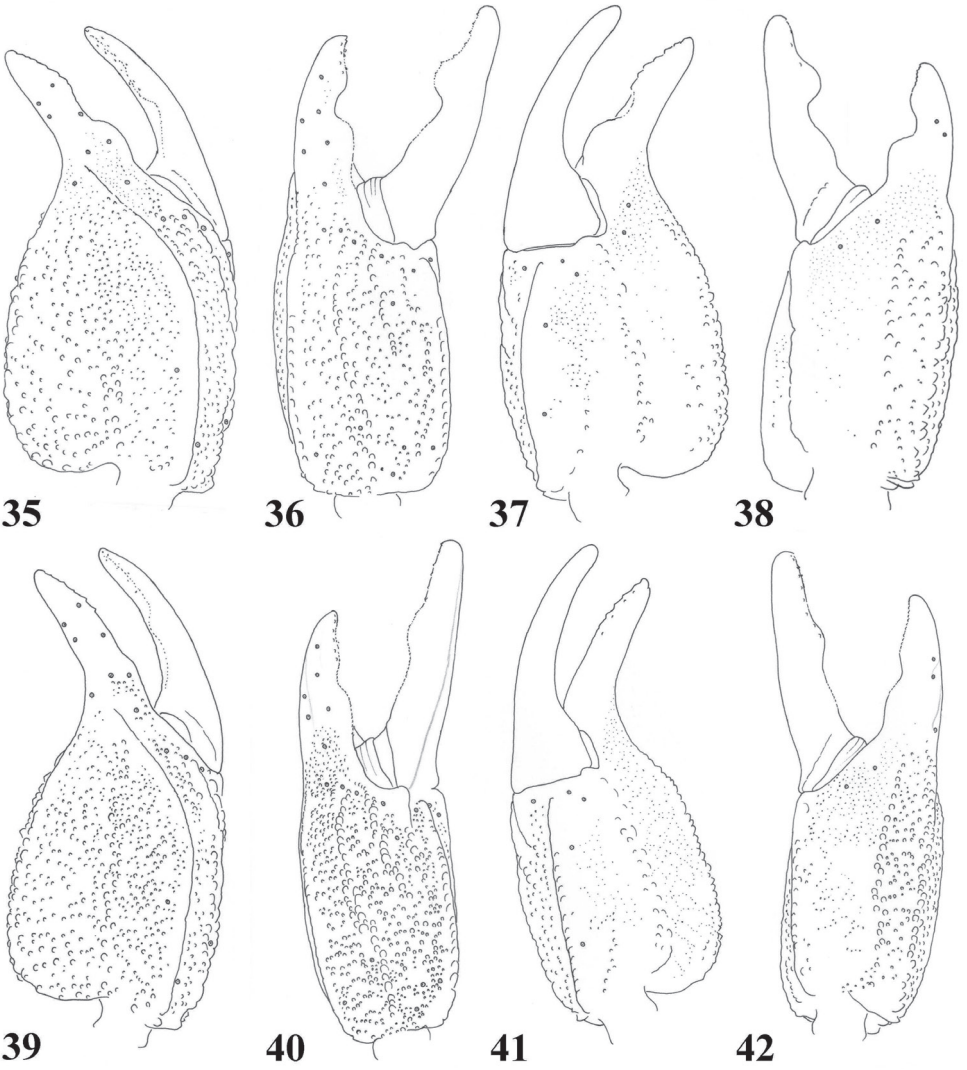
*Scorpiops leptochirus* Pocock, 1893: Fet & Sissom, 2000b: 493.

**Materials reported.** Specific locality see Bastawade, 2006.

**Distribution.** South Xizang (China); Bangladesh; (Meghalaya, Assam) India.




**Figures 23–34.** *Scorpiops langxian*, male, holotype. **23** Carapace **24–25** Chelicera, dorsal and ventral aspects **26** Lateral eyes **27** Genital operculum and pectines **28** Femur dorsal aspect **29–31** Patella dorsal, external and ventral aspects **32** Metasomal segment V, ventral aspect **33** Telson, lateral aspect **34** Dentate margin of movable finger, showing rows of granules.




**Figures 35–38.** *Scorpiops langxian*, male, holotype. Chela dorsal, external, ventral and internal aspects **39–42** *Scorpiops langxian*, female, paratype. Chela dorsal, external, ventral and internal aspects.

***Scorpiops lhasa* Di & Zhu, 2009**
http://species-id.net/wiki/Scorpiops_lhasa

*Scorpiops lhasa* Di & Zhu, 2009c: 40–47, figs 1–33, tab. 1.

**Type specimens.** Holotype, female, China, Xizang, Lhasa banlieue, elevation about 3700m, 10/7/2008, Zhi-Yong Di leg (Ar.-MHU-XZLS0801); paratypes: 1 female and

1 female juvenile, 2 males and 1 male juvenile, same data as holotype (Ar.-MHU-XZLS0802–0806) (deposited in MHBU).

**Habitat.** Under the stones of barren mountain.

**Distribution.** Lhasa (China).

***Scorpiops luridus* Qi, Zhu & Lourenço, 2005**

http://species-id.net/wiki/Scorpiops_luridus

Figures 43–63, Table 1

*Scorpiops luridus* Qi, Zhu & Lourenço, 2005: 2–6, figs 1–15.

**Type specimens.** Holotype, male, China, Xizang, Lang district (29°02' N, E.93°08' E), 2/8/2002, Ming-Sheng Zhu leg. (deposited in MHBU). Paratypes: 2 females, same data as holotype (One is deposited in MHBU, the other in MNHN).

**Habitat.** Under the stones of barren mountain.

**Distribution.** Nang County (China).

**Comments.** *S. luridus* is the absolute offbeat member of *Scorpiops*: large body, pale yellow color, strong chelas and swollen telson. We checked other specimens (1 male and 1 female, from Shannan Prefecture, Xizang) and the type specimens, confirmed the distinctive color of this species not because of the immature age after molting.

***Scorpiops margerisonae* Kovařík, 2000**

http://species-id.net/wiki/Scorpiops_margerisonae

*Scorpiops margerisonae* Kovařík, 2000b: 189, figs 66, 70, tabs 1–3; Di & Zhu, 2010: 1–8, figs 1–23, tabs 1–2.

**Type specimens.** Holotype, male, China, Xizang, FKCP.

**Other materials reported.** 1 male, 1 female (Ar.-MHBU-XZLX060137, Ar.-MHBU-XZLX060138) and 7 juveniles., Langxian District, China, Xizang, 4/8/2006, leg. Ming-Sheng Zhu; 5 males (Ar.-MHBU-XZND060188, Ar.-MHBU-XZND060218, Ar.-MHBU-XZLX060238, Ar.-MHBU-XZLX060245, Ar.-MHBU-XZLX060246), 4 females (Ar.-MHBU-XZND060189, Ar.-MHBU-XZND0 60219, Ar.-MHBU-XZLX060220, Ar.-MHBU-XZLX06 0247), 1 female (imm.) (Ar.-MHBU-XZLX060248) and 5 juveniles, Naidong District, China, Xizang, 9/8/2006, leg. Ming-Sheng Zhu.

**Habitat.** Found under stones.

**Distribution.** Nang County, Nêdong County (Naidong district) (China).

**Comments.** *S. margerisonae* was established by Kovařík (2000b) just using 1 male specimens. Its most important character provided by Kovařík (2000b) is the highest

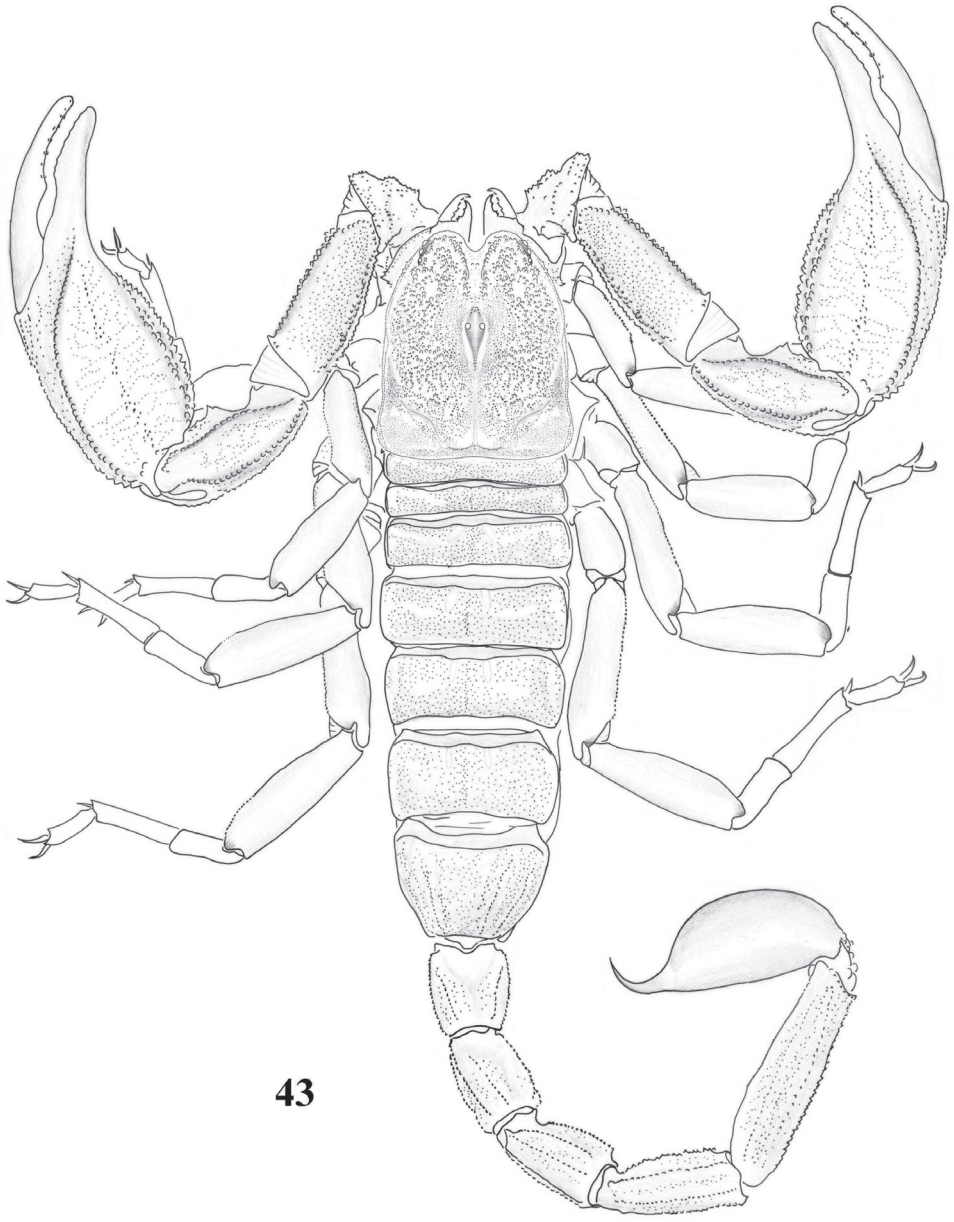
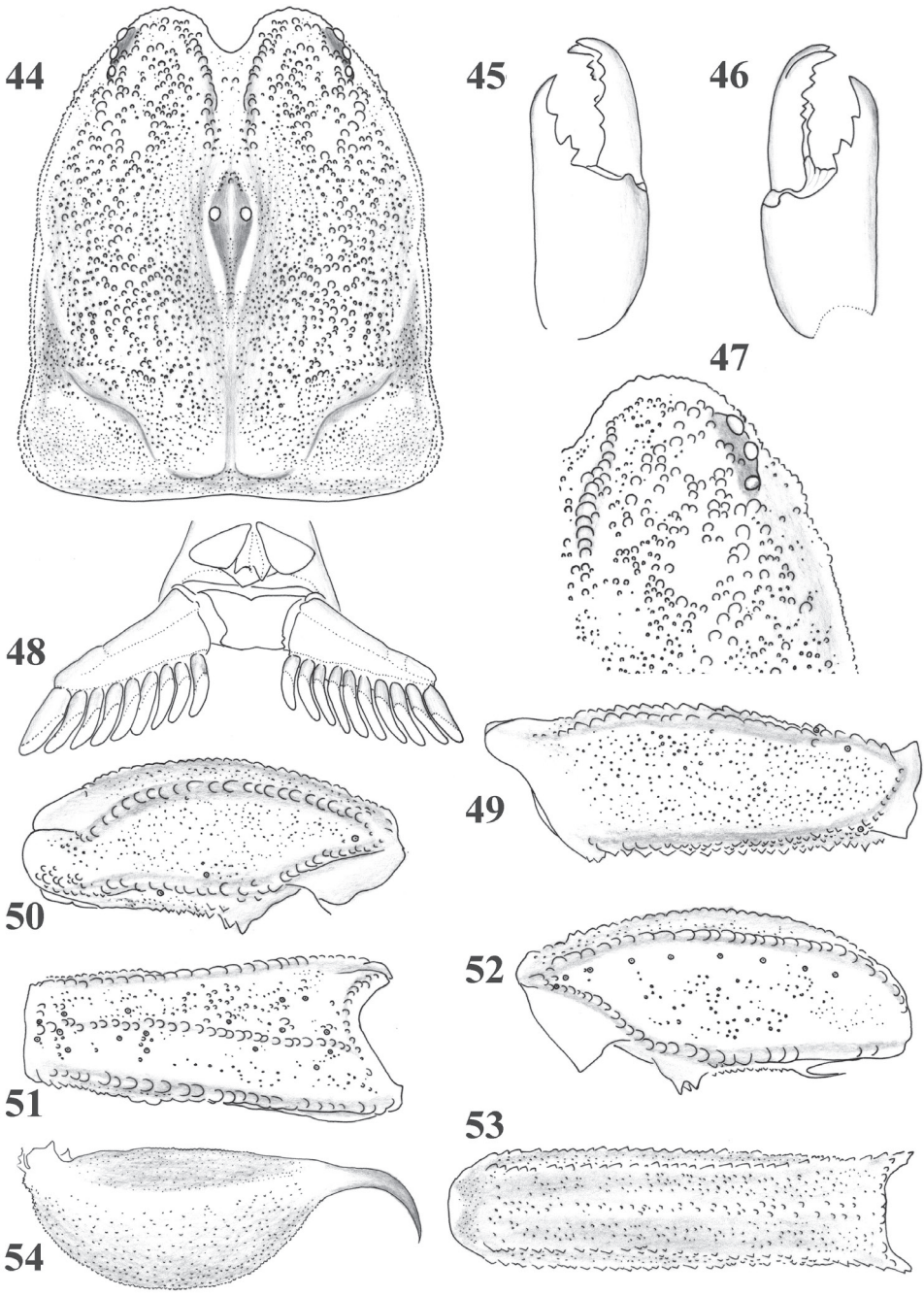
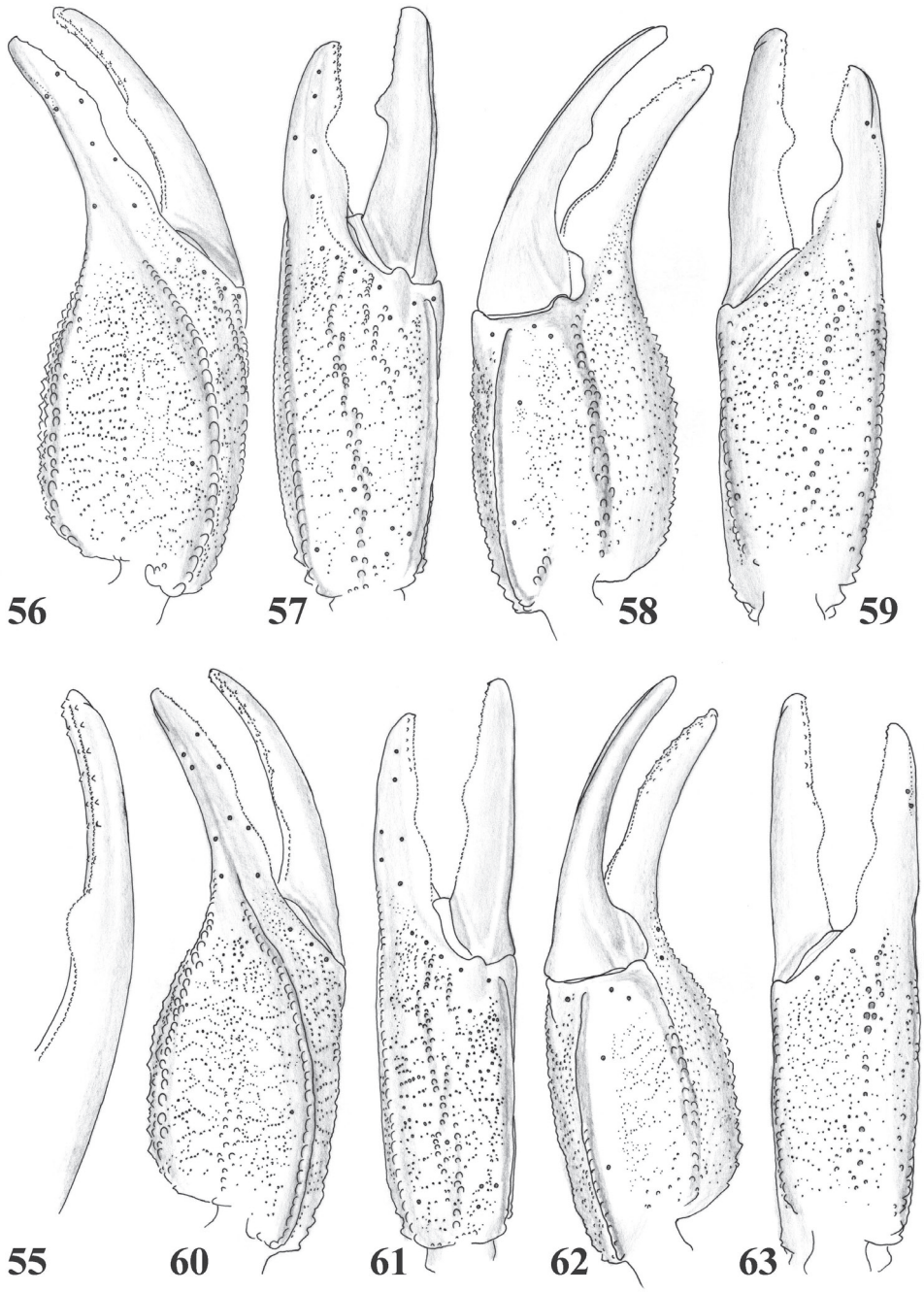



**Figure 43.** Habitus of *Scorpiops luridus*, male, holotype, dorsal view.

numer of pectinal teeth (12–13). Although the original description is poor, we can find another valuable information: *S. margerisonae* has a pair strong chelas with rectangular manus (with big granules in surface). Di & Zhu (2010) redescribed *S. margerisonae* and reported its female for the first time, and changed its pectinal teeth numer characters as a range 8–10 in females, 9–13 in males.




**Figures 44–54.** *Scorpiops luridus*, male, holotype. **44** Carapace **45–46** Chelicera, dorsal and ventral aspects **47** Lateral eyes **48** Genital operculum and pectines **49** Femur dorsal aspect **50–52** Patella dorsal, external and ventral aspects **53** Metasomal segment V, ventral aspect **54** Telson, lateral aspect.




**Figures 55–59.** *Scorpiops luridus*, male, holotype. **55** Dentate margin of movable finger, showing rows of granules **56–59** Chela dorsal, external, ventral and internal aspects **60–63** *Scorpiops luridus*, female, paratype. Chela dorsal, external, ventral and internal aspects.

***Scorpiops petersii* Pocock, 1893**
http://species-id.net/wiki/Scorpiops_petersii
Table 2

*Scorpiops petersii*: Kovařík, 2000b: 192–194, figs 35, 42, tabs 1–3; Fet, 2000d: 494.

**Distribution.** Xizang (China); Bhutan; (Assam, Himachal, Uttar, Kashmir, Meghalaya, Sikkim) India; Pakistan.

**Comments.** *S. petersii* Pocock, 1893 has a simple original description. Kishida (1939: 45) recorded this species distributed in Xizang and Xikang (western Sichuan and eastern Tibet of China). Kovařík (2000b) examined the lectotype and many specimens but thought it is necessary to re-evaluate the characters used in distinguishing this species from others in the genus scorpiops (Kovařík, 2000b: 193). We cannot distinguish *S. petersii* with *S. hardwickii* (Gervais, 1843) "complex" by the diagnostic characters provided by Kovařík (2000b: 193): total length is up to 75mm; male has finger of pedipalps strongly flexed; 17 external (5 *eb*, 2 *esb*, 2 *em*, 4 *est*, 4 *et*) and 7, or rarely 6 or 8 ventral trichobothria on the patella; pectinal teeth number 4–9. We checked *Scorpiops* sp (1 adult and 1 immature females and 1 immature male and 1 juvenile, Lhasa, 4/7/2008, Zhiyong DI leg, kept in MHBU), its adult female: body length 80.1mm (Figs 85–101; table 2), very strong; ventral trichobothria on patella number 7 (with other: rarely 6 or 8); pectinal teeth number 4-9; a swollen telson. Except the unusual body length can let us conjecture the specimens from Lhasa maybe *S. petersii*, all of other features shared by *S. hardwickii* and *S. petersii*. We noticed body length is an important character but it like the pectinal teeth number and patella ventral trichobothria number, all of them are some ranges and few exceptions are normal. We can't confirm any of these characters in one species if checked just few specimens. Here, we add it to *S. hardwickii* (Gervais, 1843) "complex" group. We checked an immature female (locality is Uttaranchal, India; identified as *S. petersii* by Kovařík). And confirm the diagnosis of *S. petersii* as follows: (1) male chela length to width ratio about 2.6, and about 2.5 in female (see Kovařík, 2000b: tab. 1); (2) male has finger of pedipalps strongly flexed; (3)17 external (5 *eb*, 2 *esb*, 2 *em*, 4 *est*, 4 *et*) and 7, or rarely 6 or 8 ventral trichobothria on the patella; (4) pectinal teeth number 4–9; (5) total length above 65mm. The first character is the key difference between *S. petersii* and *S. hardwickii* (Gervais, 1843) "complex" group.

***Scorpiops pococki* Qi, Zhu & Lourenço, 2005**
http://species-id.net/wiki/Scorpiops_pococki
Figures 64–84, Table 3

*Scorpiops pococki* Qi, Zhu & Lourenço, 2005: 14–18, figs 47–61.

**Type specimens.** Holotype, male, China, Xizang, Gyaca district (29°08'N, 92°43'E), 22/8/2002, Ming-Sheng Zhu leg. (MHBU); paratypes: 7 females and 4males, same data as holotype (1 female and 1 male in MNHN, the others in MHBU); 1 female, Chi-

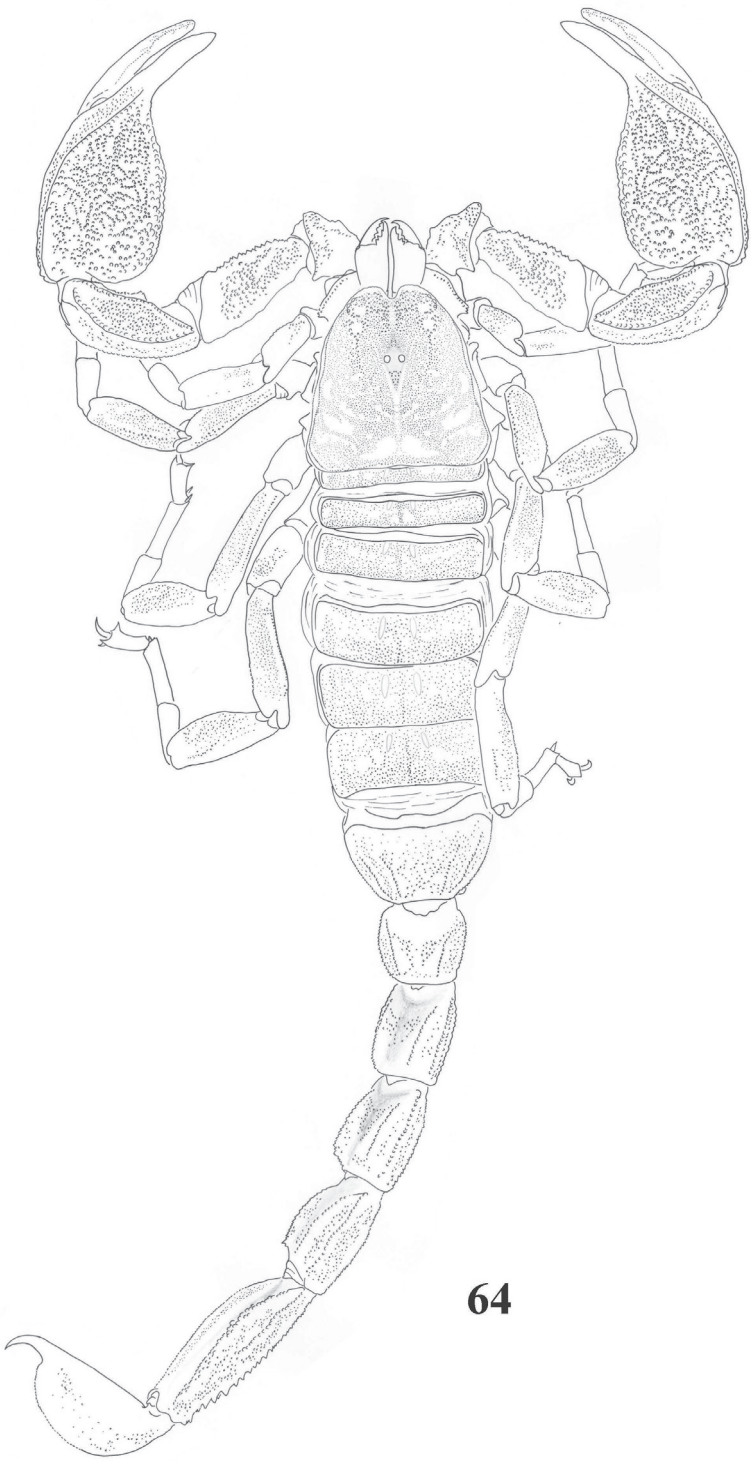



**Figure 64.** Habitus of *Scorpiops pococki*, male, holotype, dorsal view.

**Table 2.** Measurements (in mm) of *Scorpiops petersii*, *Scorpiops* sp (Lhasa) and *Scorpiops tibetanus*. * Data from Kovařík, 2000b.

| Species / Contents | *Scorpiops petersii** | | *Scorpiops* sp (Lhasa) | *Scorpiops tibetanus* | *Scorpiops tibetanus** | |
|---|---|---|---|---|---|---|
| **Sex** | **Male LT(BMNH)** | **Female AT(NHMB)** | **Female (XZLS0801)** | **Female (XZSH0601)** | **Male HT (BMNH)** | **Female (FKCP)** |
| Total length | 69.3 | 67..0 | 80.1 | 45.2 | 60.4 | 53.2 |
| Carapace: | | | | | | |
| -Length | 8.8 | 8.3 | 10.2 | 5.7 | 7.5 | 7.5 |
| - Anterior width | | | 5.5 | 3.5 | | |
| - Posterior width | 8.0 | 8.7 | 10.8 | 6.1 | 7.5 | 7.7 |
| Metasomal segment I: | | | | | | |
| - Length | 3.5 | 3.2 | 4.3 | 2.7 | 3.6 | 2.7 |
| - Width | 3.5 | 3.6 | 4.4 | 2.7 | 3.9 | 3.1 |
| - Depth | | | 3.6 | 2.3 | | |
| Metasomal segment II: | | | | | | |
| - Length | 4.1 | 3.6 | 5.6 | 3.2 | 4.3 | 3.2 |
| - Width | 3.0 | 3.4 | 4.0 | 2.4 | 3.5 | 2.7 |
| - Depth | | | 3.6 | 2.1 | | |
| Metasomal segment III: | | | | | | |
| - Length | 4.4 | 4.1 | 6.1 | 3.4 | 4.7 | 3.6 |
| - Width | 2.8 | 3.3 | 3.7 | 2.3 | 3.4 | 2.7 |
| - Depth | | | 3.6 | 2.1 | | |
| Metasomal segment IV | | | | | | |
| - Length | 5.0 | 4.4 | 6.5 | 3.8 | 5.2 | 4.2 |
| - Width | 2.6 | 3.0 | 3.5 | 2.1 | 3.2 | 2.5 |
| - Depth | | | 3.5 | 2.0 | | |
| Metasomal segment V | | | | | | |
| - Length | 8.2 | 7.1 | 10.3 | 6.0 | 8.1 | 6.7 |
| - Width | 2.3 | 2.8 | 3.2 | 2.0 | 2.9 | 2.4 |
| - Depth | | | 3.4 | 1.8 | | |
| Telson: | | | | | | |
| - Length | 8.7 | 7.5 | 10.2 | 5.6 | 7.6 | 6.7 |
| - Width | | | 4.1 | 2.2 | | |
| - Depth | | | 4.0 | 2.1 | | |
| Pedipalp femur: | | | | | | |
| - Length | 7.2 | 6.6 | 7.9 | 4.7 | 5.3 | 5.4 |
| - Width | 3.3 | 3.0 | 3.6 | 2.1 | 2.4 | 2.4 |
| - Depth | | | 3.3 | 1.9 | | |
| Pedipalp patella: | | | | | | |
| - Length | 7.2 | 7.0 | 8.2 | 4.5 | 5.8 | 5.8 |
| - Width | 3.4 | 3.1 | 3.5 | 2.7 | 2.5 | 2.5 |
| - Depth | | | 4.0 | 2.6 | | |
| Chela | | | | | | |
| - Length (chela) | 15.1 | 13.8 | 16.5 | 9.3 | 11.9 | 12.5 |
| - Length (manus) | | | 9.1 | 5.6 | | |

| Species / Contents | *Scorpiops petersii** | | *Scorpiops* sp (Lhasa) | *Scorpiops tibetanus* | *Scorpiops tibetanus** | |
|---|---|---|---|---|---|---|
| **Sex** | **Male LT(BMNH)** | **Female AT(NHMB)** | **Female (XZLS0801)** | **Female (XZSH0601)** | **Male HT (BMNH)** | **Female (FKCP)** |
| - Width | 5.8 | 5.5 | 7.5 | 4.3 | 5.9 | 5.1 |
| - Depth | | | 5.9 | 3.5 | | |
| Movable finger-Length | 7.5 | 8.1 | 9.9 | 5.5 | 6.8 | 7.0 |
| Pectinal teeth (left/right) | 5/5 | 7/7 | 5/5 | 7/7 | 8/7 | 8/7 |

na, Xizang, Zayü district, Xia Zayü town (28°30'N, 97°00'E), 7/8/2002, Ming-Sheng Zhu leg.; 1male, China, Xizang, Ny-ingchi district (29°34'N, 94°30'E), 2/8/2002, Ming- Sheng Zhu leg., 2 females, 3 males, 17/8/2002, other data same as above; 3 females, China, Xizang, Nêdong district (29°11'N, 91°48'E), 15/8/2002, Ming-Sheng Zhu leg.; 1 male, China, Xizang, Xigazê (29°16'N, 88°51'E), 7/9/2002, Ming-Sheng Zhu leg.; 3 females, China, Xizang, Lhasa (29°39'N, 91°08'E), 23/8/2003, Feng Zhang leg.(deposited in MHBU).

**Distribution.** Gyaca County, Nêdong County, Nyingchi County, Zayü County, Lhasa (China).

**Comments.** Kovařík & Ahmed (2009: 10) provided a list of *S. hardwickii* (Gervais, 1843) "complex", including *S. pococki*. *S. pococki*'s features accord with the summary of Di et al (2011a). We provided the figures of the type specimen of *S. pococki* and other members from Xizang.

***Scorpiops tibetanus* Hirst, 1911**
http://species-id.net/wiki/Scorpiops_tibetanus
Figures 102–118, Table 2

*Scorpiops tibetanus* Hirst, 1911: 472–473; Kovařík, 2000b: 197, figs 47, 68, 69, tab. 1–3; Fet, 2000d: 495.

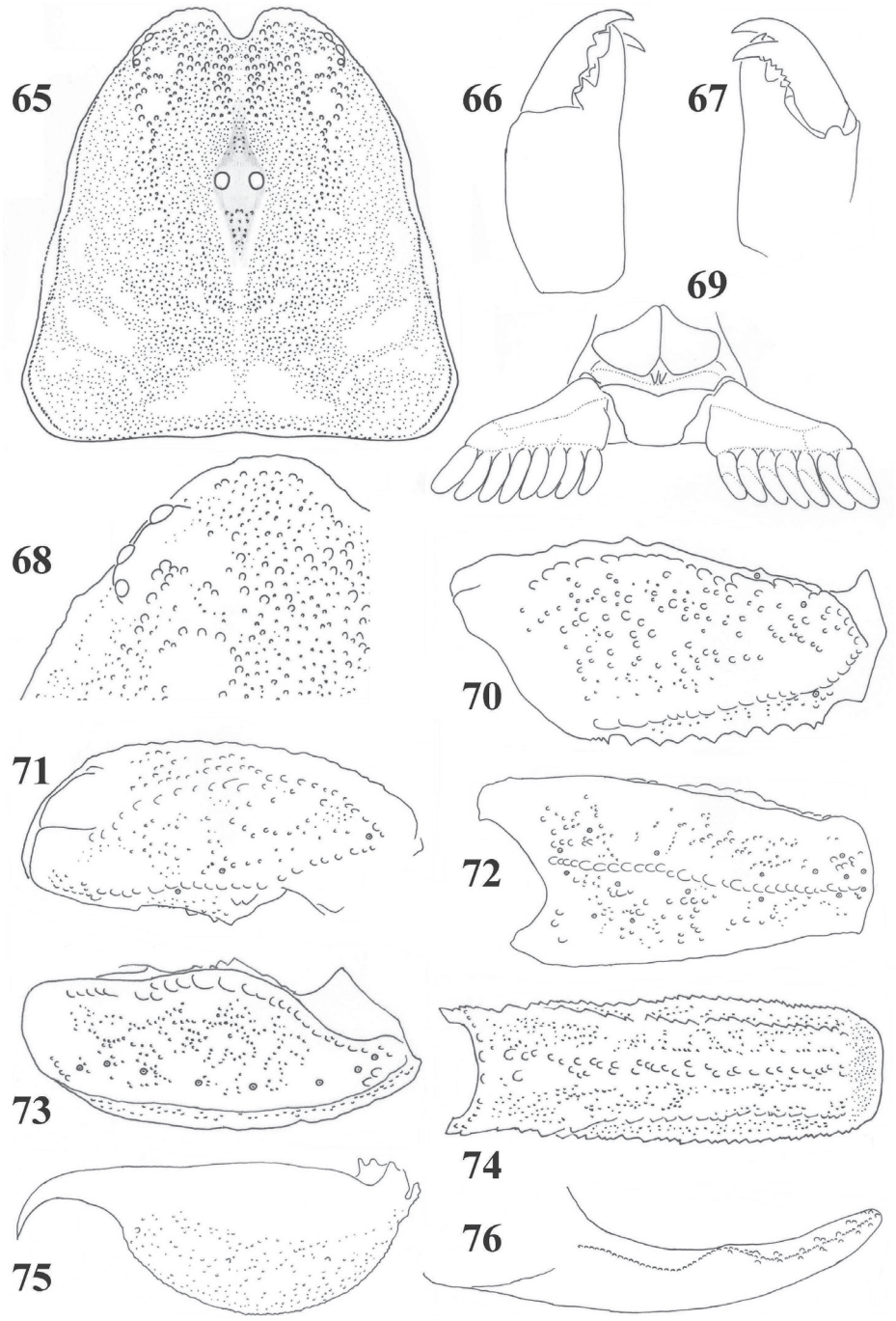
**Type locality.** China, Xizang, Tsangpo Valley, Chaksam Ferry..

**Type material.** Holotype, male. L. A. Wadell leg. BMNH, No. 1911. 8. 10. 1.

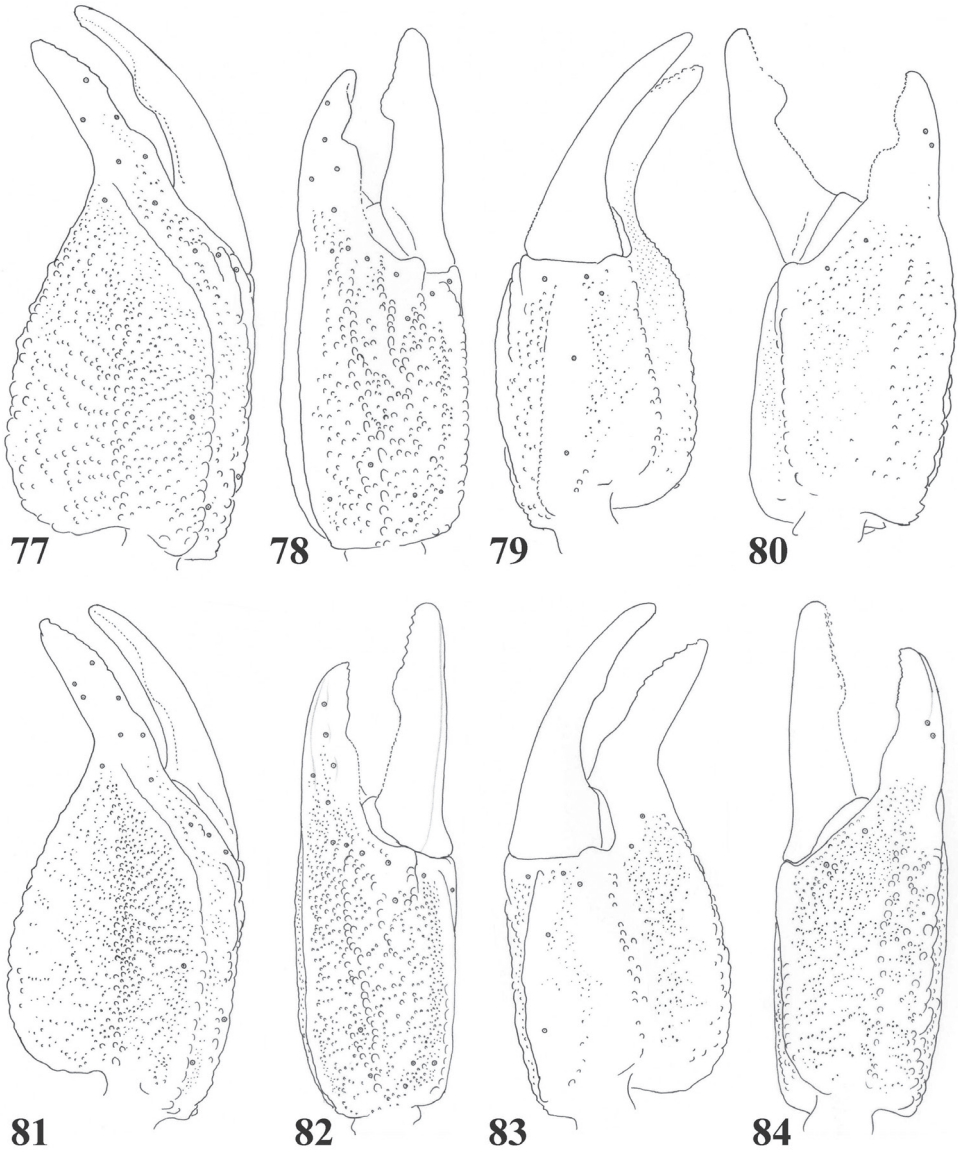
**Material examined.** 1 female and 5 juveniles, China, Xizang, Shigatse City, around the Zhabulun Temple, 13/8/2006, Xiao-Feng Yang leg, (MHBU, Ar.- MHBU - XZSH0601–6).

**Diagnosis.** Adult body length about 45–65 mm. Mainly color uniformly reddish-black. Male has finger of pedipalps more flexed and manus shorter and broader than the female. 17 external trichobothria (5 *eb*, 2 *esb*, 2 *em*, 4 *est*, 4 *et*) and 7–10 ventral trichobothria (usually 9) on the patella. Pectinal teeth number 5–11.

Comments. In Kovařík & Ahmed's list of *S. hardwickii* (Gervais, 1843) "complex"(2009: 10) : containing *S. tibetanus* Hirst, 1911. Hirst (1911) did not provide a detailed description except the brief comparison with *S. austerus* Hirst, 1911 (syn-




**Figures 65–76.** *Scorpiops pococki*, male, holotype. **65** Carapace **66–67** Chelicera, dorsal and ventral aspects **68** Lateral eyes **69** Genital operculum and pectines **70** Femur dorsal aspect **71–73** Patella dorsal, external and ventral aspects **74** Metasomal segment V, ventral aspect **75** Telson, lateral aspect **76** Dentate margin of movable finger, showing rows of granules.




**Figures 77–84.** *Scorpiops pococki.* **77–80** male, holotype. Chela dorsal, external, ventral and internal aspects **81–84** female, paratype. Chela dorsal, external, ventral and internal aspects.

onymized with *S. hardwickii* by Tikader & Bastawade, 1983: 418) and *S. crassimanus* Pocock, 1899 (synonymized with *S. hardwickii* by Kovařík, 2000b: 175). Kovařík (2000b) examined the holotype (male) of *S. tibetanus* and recorded some important information: (1) total length is 50–65mm; (2) male has finger of pedipalps more flexed and manus shorter and broader than the female; (3) 17 external trichobothria (5 *eb*, 2 *esb*, 2 *em*, 4 *est*, 4 *et*) and 7–10 ventral trichobothria (usually 9) on the patella; (4)

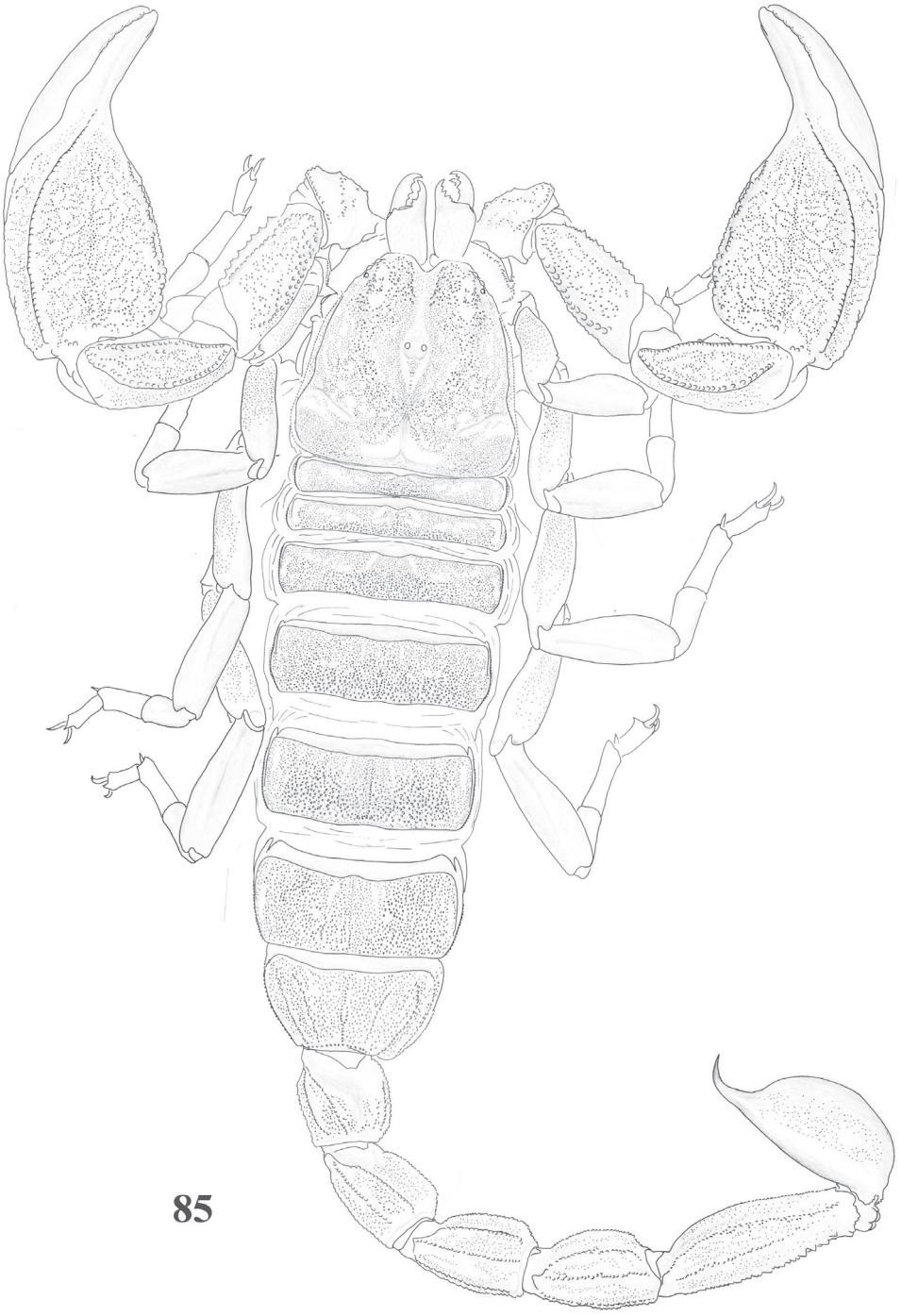
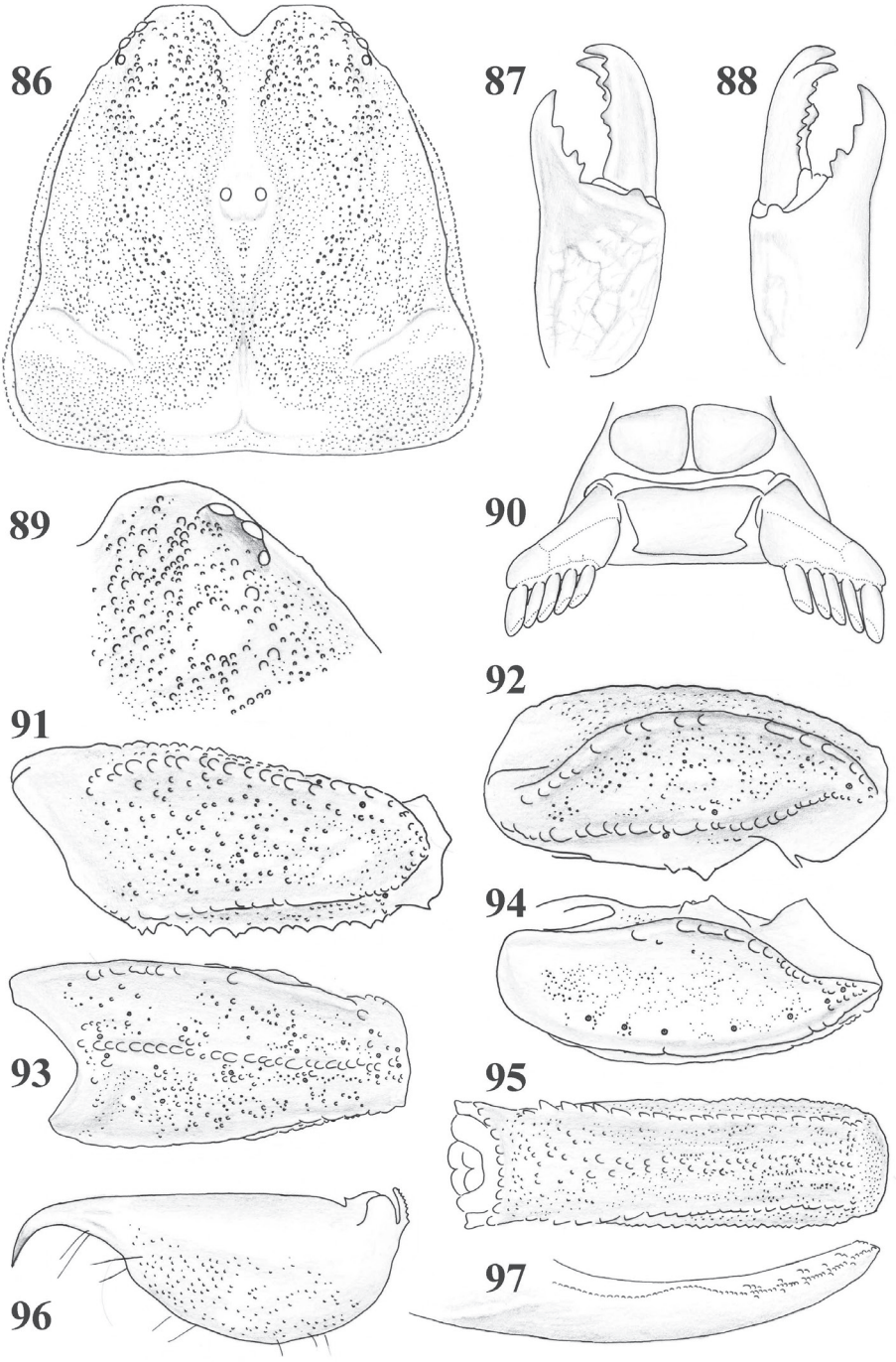
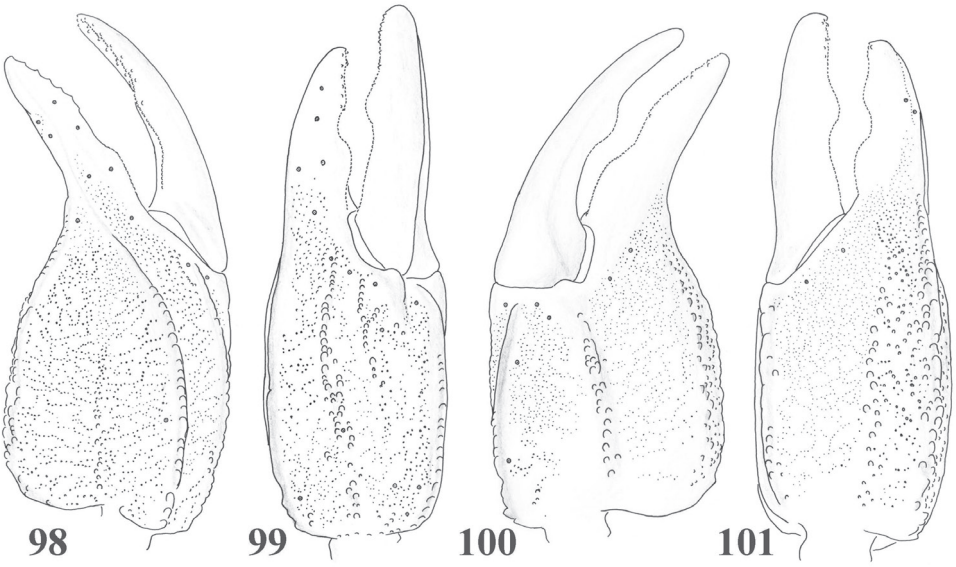



**Figure 85.** Habitus of *Scorpiops* sp. (*hardwickii* "complex") from Lhasa, female, dorsal view.




**Figures 86–97.** *Scorpiops* sp. (*hardwickii* "complex") from Lhasa, female. **86** Carapace **87–88** Chelicera, dorsal and ventral aspects **89** Lateral eyes **90** Genital operculum and pectines **91** Femur dorsal aspect **92–94** Patella dorsal, external and ventral aspects **95** Metasomal segment V, ventral aspect **96** Telson, lateral aspect **97** Dentate margin of movable finger, showing rows of granules.




**Figures 98–101.** *Scorpiops* sp. (*hardwickii* "complex") from Lhasa, female. Chela dorsal, external, ventral and internal aspects.

pectinal teeth number 5–11. Di et al. (2011a) excluded *S. tibetanus* from Kovařík's *S. hardwickii* "complex" as followed reasons: (1) ventral trichobothria on patella in S. *tibetanus* number 7–10 (usually 9, in one young out of 37 specimens, 7 on one side; Kovařík, 2000b: 196), 6–8 in *S. hardwickii* "complex"; (2) pectinal teeth number is 5–11 (usually 7–11) in *S. tibetanus*, 4–9 in *S. hardwickii* (usually 5–7).

**Description.** (based on female specimens: Ar.- MHBU - XZSH0601).

*Coloration*: red brown mainly.

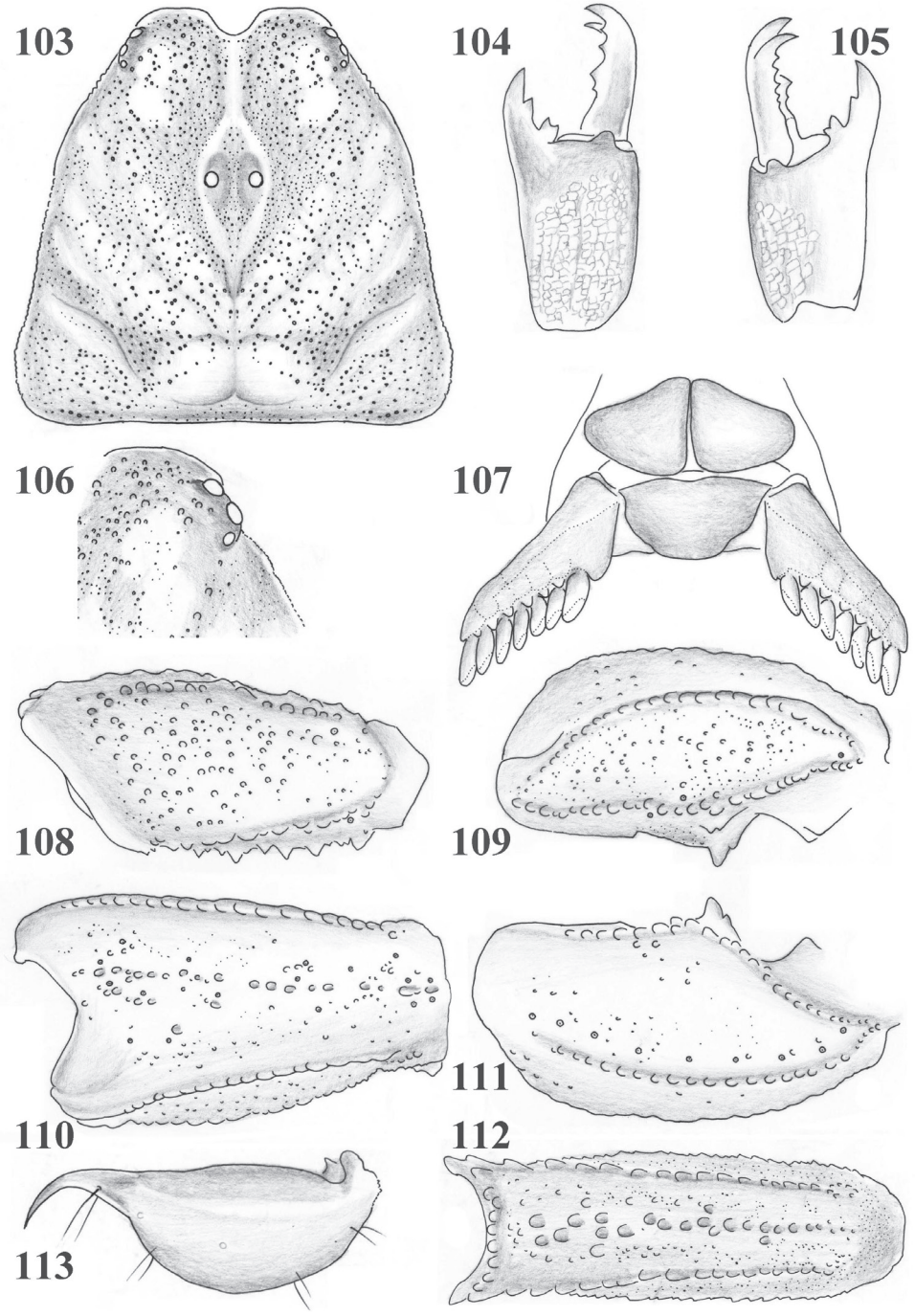
Carapace dark red brown. Median and lateral ocular tubercles black. Tergites mostly red brown to dark brown. Metasoma segments dark red brown to dark brown. Vesicle red brown with a reddish aculeus. Chelicerae yellow brown with fingers dark red brown gradually lighter toward the tip. Pedipalp femur and patella dark red brown, chela manus and fingers red brown. Legs red brown with yellow brown tarsi. Tarsal ungues yellowish brown. Sternum, genital operculum and sternites pale brown. Pectines yellowish.

*Morphology*. *Prosoma*: Carapace with sparse, coarse granules (Fig. 103); lateral furrow broad; anterior median furrow broad and moderately deep; posterior median furrow deep; margin behind lateral eyes with granules, other margins smooth. Median eyes situated anteriorly compared to center of carapace; three pairs of lateral ocelli, posterior smallest (Figs 103, 106). Median ocular tubercle with granules and a pair of big median eyes and a median furrow. Lateral ocular tubercle with some granules.

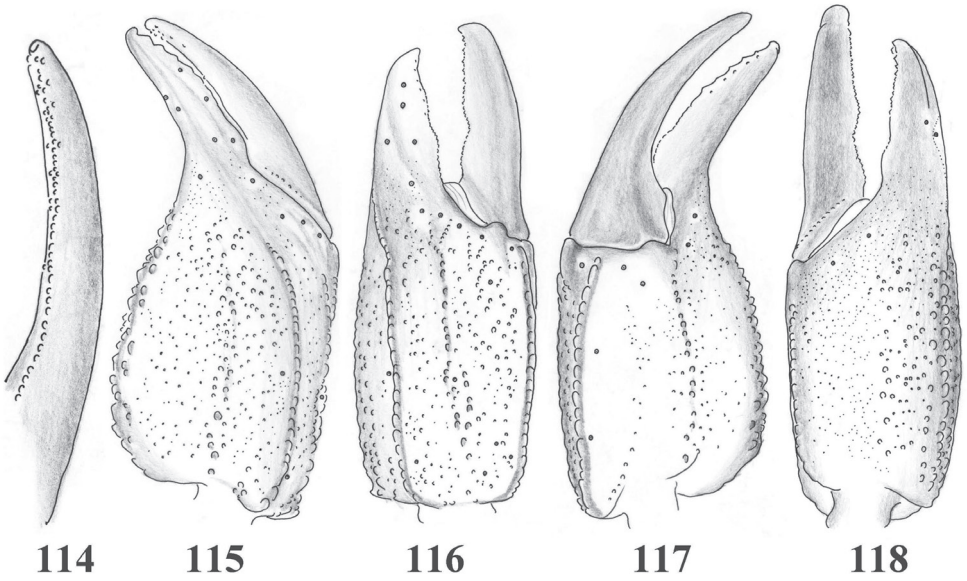
*Mesosoma*: Tergites sparsely covered with coarse and big granules, posterior part of tergites with bigger granules; tergites III–VI with a median carina; tergite VII with two pairs of lateral carinae (shaped by bigger granules); tergites margin smooth. Pectinal


**Figure 102.** Habitus of *Scorpiops tibetanus* from Shigatse, female, dorsal view.

teeth count 7/7, fulcra present (Fig. 107). Sternum quinquangular. Genital operculum subtriangular. Sternites smooth and shiny; segment VII with 4 smooth ventral carinae and few granules.




**Figures 103–113.** *Scorpiops tibetanus* from Shigatse, female. **103** Carapace **104–105** Chelicera, dorsal and ventral aspects **106** Lateral eyes **107** Genital operculum and pectines **108** Femur dorsal aspect **109–111** Patella dorsal, external and ventral aspects **112** Metasomal segment V, ventral aspect **113** Telson, lateral aspect.




**Figures 114–118.** *Scorpiops tibetanus* from Shigatse, female. **114** Dentate margin of movable finger, showing rows of granules **115–118** Chela dorsal, external, ventral and internal aspects.

*Metasoma*: Tegument coarse. Segments II to V longer than wide; segments I to V with respectively 10-8-8-8-7 carinae, segments II–IV with a pair of vestigial lateral carinae; all dorsal carinae crenulate, slightly stronger distally; segment V carinae with smaller granules dorsally and larger serration ventrally. Vesicle with few setae and granules. *Pedipalps*: Tegument coarse. Femur with external, dorsointernal, dorsoexternal, ventrointernal, ventroexternal and internal carinae granulated; tegument with scattered granules dorsally (Fig. 108) and smooth ventrally. Patella with dorsointernal, dorsoexternal, ventrointernal, ventroexternal and external carinae with big granules; two large spinoid granules present on the internal aspect; tegument with some granules. Trichobothrial pattern C, neobothriotaxic (Vachon 1974); patella with 17 external trichobothria (5 *eb*, 2 *esb*, 2 *em*, 4 *est*, 4 *et*), 9 ventral trichobothria (Figs 109–111). Chela with length/width ratio: 2.2–2.5 in adult females and 2.0 in male (holotype, Kovařík, 2000b: 161. tab. 1). Chela with dorsal marginal, external secondary, and ventrointernal carinae granulated (Figs 115–118); ventrointernal carina with some big granules; tegument with granules; female fingers scalloped with a pronounced lobe in the movable finger and a corresponding notch in fixed finger, lobe and corresponding notch reduced to absent in females. The male has fingers of pedipalps more flexed and manus shorter and broader than the female (Kovařík, 2000b: 196).

*Chelicerae*: Tegument smooth. Tibia smooth. Movable finger with 4 teeth on dorsal edge, 5teeth on ventral edge. Fixed finger with 3 teeth on dorsal edge (Figs 104, 105).

**Table 3.** Measurements (in mm) of *Scorpiops pococki*, and *Scorpiops jendeki*. * Data from Kovařík, 2000b.

| Species / Contents | *Scorpiops pococki* | | **Scorpiops jendeki* | | *Scorpiops jendeki* | |
|---|---|---|---|---|---|---|
| **Sex** | **Male HT(MHBU)** | **Female PT(MHBU)** | **Male (FKCP)** | **Female HT(FKCP)** | **Female (YNLL0801)** | **Female (YNLL0802)** |
| Total length | 40.0 | 45.7 | 32.2 | 42.1 | 22.8 | 20.8 |
| Carapace: | | | | | | |
| -Length | 6.2 | 7.1 | 4.5 | 5.1 | 3.1 | 2.9 |
| - Anterior width | 3.6 | 4.1 | | | 1.6 | 16. |
| - Posterior width | 6.3 | 7.2 | 4.8 | 5.9 | 3.3 | 3.2 |
| Metasomal segment I: | | | | | | |
| - Length | 2.2 | 2.5 | 1.9 | 2.1 | 1.3 | 1.1 |
| - Width | 2.4 | 2.2 | | | 1.6 | 1.5 |
| - Depth | 2.0 | 2.2 | 2.4 | 2.6 | 1.3 | 1.3 |
| Metasomal segment II: | | | | | | |
| - Length | 2.8 | 2.8 | 2.1 | 2.5 | 1.5 | 1.4 |
| - Width | 2.1 | 2.3 | 2.1 | 2.3 | 1.4 | 1.3 |
| - Depth | 1.9 | 2.0 | | | 1.2 | 1.1 |
| Metasomal segment III: | | | | | | |
| - Length | 3.0 | 3.1 | 2.3 | 2.6 | 1.5 | 1.6 |
| - Width | 2.0 | 2.2 | 2.0 | 2.1 | 1.3 | 1.2 |
| - Depth | 2.0 | 2.1 | | | 1.1 | 1.1 |
| Metasomal segment IV | | | | | | |
| - Length | 3.5 | 3.4 | 2.8 | 3.1 | 1.8 | 2.8 |
| - Width | 1.9 | 2.0 | 1.9 | 2.1 | 1.2 | 1.1 |
| - Depth | 2.0 | 2.2 | | | 1.1 | 1.0 |
| Metasomal segment V | | | | | | |
| - Length | 5.4 | 5.8 | 4.5 | 5.4 | 2.8 | 2.7 |
| - Width | 1.9 | 2.0 | 1.9 | 2.0 | 1.2 | 1.1 |
| - Depth | 1.8 | 1.8 | | | 1.0 | 0.8 |
| Telson: | | | | | | |
| - Length | 5.8 | 6.2 | 4.9 | 4.8 | 3.0 | 3.0 |
| - Width | 2.3 | 2.4 | | | 1.1 | 1.1 |
| - Depth | 2.1 | 2.2 | | | 1.0 | 0.9 |
| Pedipalp femur: | | | | | | |
| - Length | 5.5 | 4.3 | 3.5 | 4.2 | 2.2 | 2.1 |
| - Width | 2.4 | 2.8 | 1.5 | 1.6 | 1.1 | 1.0 |
| - Depth | 1.9 | 2.0 | | | 1.0 | 0.9 |
| Pedipalp patella: | | | | | | |
| - Length | 5.1 | 5.6 | 3.7 | 4.4 | 2.3 | 2.4 |

| Species / Contents | *Scorpiops pococki* | | **Scorpiops jendeki* | | *Scorpiops jendeki* | |
|---|---|---|---|---|---|---|
| **Sex** | **Male HT(MHBU)** | **Female PT(MHBU)** | **Male (FKCP)** | **Female HT(FKCP)** | **Female (YNLL0801)** | **Female (YNLL0802)** |
| - Width | 2.8 | 3.1 | 1.7 | 1.8 | 1.1 | 1.1 |
| - Depth | 2.6 | 2.8 | | | 1.1 | 1.0 |
| Chela | | | | | | |
| - Length (chela) | 10.0 | 10.8 | 7.5 | 8.3 | 4.4 | 4.1 |
| - Length (manus) | 6.2 | 6.6 | | | 2.6 | 2.6 |
| - Width | 4.7 | 4.9 | 3.4 | 3..8 | 1.8 | 1.8 |
| - Depth | 3.3 | 3.5 | | | 1.4 | 1.2 |
| Movable finger-Length | 6.1 | 6.6 | 4.0 | 4.6 | 2.7 | 2.8 |
| Pectinal teeth (left/right) | 11/10 | 9/10 | 5/5 | 4/4 | 4/4 | 4/4 |

*Legs*: Tegument coarsely granular dorsally, except basitarsi and telotarsi, smooth ventrally. Trochanters with few setae. Femur dorsal surface with few small granules, external surface with a granular carina, internal surface with two granular carinae. Patella internally with a dentate carina. Tibia with few setae and small granules, without spurs. Basitarsi with some spinules, few setae and 2 lateral pedal spurs. Tarsi ventrally with one row of short spinules and few setae. Tarsal ungues curved and hook-like.

**Variation.** Both sexes with coloration and morphology very similar to holotype. Sexual dimorphism: adult males, with more pronounced lobes on the movable fingers of the chela, and a more pronounced notch in the fixed finger and bigger pectinal teeth than females. Measurements in Table 2.

**Ecology.** This species was collected from barren mountain. They were found under stones.

**Distribution.** Tsangpo Valley and Xigazê (standard notation of Shigatse) (China).

## Family Hemiscorpiidae Pocock, 1893

Ischnuridae: Fet, 2000b: 383.
Liochelidae: Fet & Bechly, 2001: 1–2.
Liochelidae: Soleglad & Fet, 2003: 112–113.
Hemiscorpiidae: Soleglad, Fet & Kovařík, 2005: 1.

## Genu *Tibetiomachus* Lourenço & Qi, 2006

*Tibetiomachus* Lourenço & Qi, 2006: 291.

***Tibetiomachus himalayensis* Lourenço & Qi, 2006**
http://species-id.net/wiki/Tibetiomachus_himalayensis

*Tibetiomachus himalayensis* Lourenço & Qi, 2006: 291–294, figs 1, 2, 5–26.

**Type specimens.** Holotype, female, China, Xizang, Guerla Mandhata, ≈4600 m, 7/1939 (Italian expedition leg) (deposited in MNHN).

**Habitat.** In soil under rocks.

**Distribution.** Guerla Mandhata (China).

**Family Scorpionidae Latreille, 1802**

Scorpionidae: Fet, 2000c: 427–428. Soleglad & Fet, 2003: 113–114.

**Genus *Heterometrus* Hemprich & Ehrenberg, 1828**

*Heterometrus*: Fet, 2000c: 431; Lourenço, Qi & Zhu, 2005: 9.

***Heterometrus tibetanus* Lourenço, Qi & Zhu, 2005**
http://species-id.net/wiki/Heterometrus_tibetanus

*Heterometrus tibetanus* Lourenço, Qi & Zhu, 2005: 10–14, figs 18–34, tab. 1.

**Type specimens.** Holotype, male; Paratypes, 2 males, China, Xizang, south region of Pulan, low valley of the river Kongque He, near to the border with Nepal, 7/1931. Holotype and 1 paratype deposited in the MNHN. One paratype deposited in MHBU.

**Distribution.** Burang County (China).

**Key to genera of Scorpiones from Xizang**

1 Orthobothriotaxic pattern type A; ventral aspect of leg tarsus with multiple irregular rows of setae, no trace of spinules; dorsal edge of cheliceral movable finger with *two* basal denticles; hemispermatophore is *flagelliform* (Buthidae).....**2**

– Orthobothriotaxic pattern type B or C; ventral aspect of leg tarsus with or without irregular setal rows, spinules present medially; dorsal edge of cheliceral movable finger with a *single* basal denticle; hemispermatophore is either *fusiform* or *lamelliform* .....**3**

2 Telson without subaculear tooth..... ***Hottentotta* Birula, 1908**

– Telson with subaculear tooth pointed or rounded (*Isometrus* Ehrenberg, 1828), Trichobothrium *db* on chela of pedipalp situated between trichobothria *et* and *est*. Males of most species have longer segments of metasoma and often also wider manus than females; segments of pedipals are of equal length in both sexes ..... **Subgenus *Reddyanus* Vachon, 1972**

3 Orthobothriotaxic pattern type B; sternum is *type 1*; hemispermatophore is *fusiform*..... ***Chaerilus* Simon, 1877**

– Orthobothriotaxic pattern type C; sternum is *type 2*; hemispermatophore is *lamelliform*..... **4**

4 Legs with two pedal spurs (though one or more pedal spurs are lost in many troglobitic species); ventral aspect of leg tarsus equipped with moderately developed setal pairs and/or median row of spinules (configuration 5, see Soleglad & Fet, 2003); paraxial organ without reflection of internobasal sperm duct (Chactoidea, see Soleglad & Fet, 2003, p. 92–93: Key to the superfamilies of parvorder Iurida); chelal fingers equipped with inner accessory denticles (IAD), outer denticles (OD) situated outside of median denticle (MD) row; major variable neobothriotaxy present, types Eu1 and Eu2; chelal palm is flat in appearance, carinae D3 and V2 essentially obsolete, angle formed by carinae D3: D4: D5 greater than 90° (Euscorpiidae, see Soleglad & Fet, 2003, p. 94: Key to the families of superfamily Chactoidea) ..... **5**

– Legs with one pedal spur (retrolateral spur absent, though this character is reversed in some bothriurid genera); ventral aspect of leg tarsus equipped with pairs of large limbated socketed setae, median spinule row optional (configuration 4, see Soleglad & Fet, 2003); paraxial organ with reflection of internobasal sperm duct(Scorpionoidea, see Soleglad & Fet, 2003, p. 92–93: Key to the superfamilies of parvorder Iurida) ..... **6**

5 Tricho-bothrium $Eb_3$ on external surface of chela is located between trichobothria *Dt* and *Est*. Telson vesicle/aculeus juncture with annular ring..... ..... ***Euscorpiops* Vachon, 1980**

– Trichobothrium $Eb_3$ on the external aspect of pedipalp chela located basally from trichobothrium Dt. Annular ring at vesicle/aculeus juncture absent ..... ..... ***Scorpiops* Peters, 1861**

6 Median ocular tubercle of carapace shallow, not raised above carapace surface; 2 pairs of lateral eyes; telotarsus with lateral lobes truncated; *Est* located in middle of hand (Hemiscorpiidae, see Stockmann & Ythier, 2010: 201) .7

– Median ocular tubercle raised up; 3 pairs of lateral eyes; telotarsus with lateral margins ending in rounded lobes; *Est* located in distal of hand (Scorpionidae, see Stockmann & Ythier, 2010, p. 201); pedipalp femur with three trichobothria; patella of pedipalp with 19 trichobothria, three on ventral and 13 on external surface; chela of pedipalp with 26 trichobothria; retrolateral pedal spurs absent; lateroapical margins of tarsi produced into rounded lobes; metasomal segments I to IV with paired ventral submedian carinae; stridula-

tory organ located on opposing surfaces of pedipalp coxa and first leg; total length 60 to 180 mm ..... ***Heterometrus*** **Ehrenberg, 1828**

7 Chela trichobothrium *dt* present ..... ***Liocheles*** **Sundevall, 1833**

– Chela trichobothrium *dt* absent ..... ***Tibetiomachus*** **Lourenço & Qi, 2006**

**Key to species of Family Chaerilidae from Xizang (China)**

1 Movable finger of pedipalp with 7–8 rows of granules ..... **2**

– Movable finger of pedipalp with 10–14 rows of granules ..... **6**

2 Chela length to width ratio in adults 1.6–1.8..... ..... ***C. conchiformus*** **Zhu, Han & Lourenço, 2008**

2 Chela length to width ratio in adults higher than 2.0..... **3**

– Ventral side of seventh mesosomal segment with 2 pair of granular carina, anterior margin straight with a median notch ..... **4**

– Ventral side of seventh mesosomal segment with many granules but without carina, anterior margin straight without median notch ..... **5**

4 Pedipalp femur shorter than carapace; 8–9 minute teeth on inner ventral margins of movable and immovable fingers respectively..... ..... ***C. dibangvalleycus*** **Bastawade, 2006**

– Pedipalp femur longer than carapace, 7–8 minute teeth on inner ventral margins of movable and immovable fingers respectively..... ..... ***C. mainlingensis*** **Di & Zhu, 2009**

5 Manus of pedipalp in male narrow and long. Chela length/width ratio in male higher than 3 ..... ***C. tryznai*** **Kovařík, 2000**

– Manus of pedipalp in male robust. Chela length/width ratio in adults lower than 2.6 ..... ***C. wrzecionkoi*** **Kovařík 2012**

6 Movable finger of pedipalp with 13–14 rows of granules; telson of male rather long and about 4.7 times longer than wide, with a obvious sexual dimorphism ..... ***C. pictus*** **(Pocock, 1890)**

– Movable finger of pedipalp with 11–12 rows of granules, telson of male and female without sexual dimorphism, manus lacks 1 dorsal carina ..... **7**

7 Carapace, tergites nearly smooth in adults, chelicerae dorsal aspect without granules (Zhu, Han & Lourenço, 2008) ..... ..... ***C. tessellatus*** **Qi, Zhu & Lourenço, 2005**

– Carapace, tergites with many big granules in adults, chelicerae dorsal aspect with granules ..... ***C. tricostatus*** **Pocock, 1899**

**Key to species of family Euscorpiidae from Xizang (China)**

1 Trichobothrium $Eb_3$ on external surface of chela is located between trichobothria *Dt* and *Est*. Telson vesicle/aculeus juncture with annular ring (*Euscorpiops*) ..... **2**

– Trichobothrium $Eb_3$ on the external aspect of pedipalp chela located basally from trichobothrium *Dt*. Annular ring at vesicle/aculeus juncture absent (*Scorpiops*) ..... **5**

2 Number of trichobothria on external surface of pedipalp patella: 19 (5 *eb*, 2 *esb*, 2 *em*, 5 *est*, 5 *et*) ..... **3**

– Number of trichobothria on external surface of pedipalp patella: 17–18 (5 *eb*, 1–2 *esb*, 2 *em*, 4*est*, 5*et*) ..... **4**

3 Number of trichobothria on ventral surface of patella: 7; number of pectinal teeth: 4–5; movable finger longer than carapace and as long as pedipalp femur ..... ***E. kamengensis* Bastawade, 2006**

– Number of trichobothria on ventral surface of patella: 9; pectinal teeth number 8; movable finger as long as carapace and shorter than pedipalp femur ... ..... ***E. novaki* Kovaník, 2005**

4 Female pedipalp fingers nearly straight ..... ***E. asthenurus* (Pocock, 1900)**

– Female pedipalp fingers obviously scalloped..... ..... ***E. karschi* Qi, Zhu & Lourenço, 2005**

5 Fingers of pedipalps are straight or only slightly flexed in both sexes..... **6**

– Fingers of pedipalps are flexed (curved) in both sexes..... **7**

6 Ventral trichobothria on patella number 6 (7 rarely), total length 30–42.1mm, pectinal teeth number 4–5, chela length to width ratio about 2.2 ..... ..... ***S. jendeki* Kovařík, 2000 (Yunnan)**

– Ventral trichobothria on patella number 7, total length 40–58 mm, pectinal teeth number 7–9, chela length to width ratio about 3.3–3.5 ..... ..... ***S. leptochirus* Pocock, 1893**

7 Male chela length to width ratio about 1.8–2.2; the manus with same or very similar length and width, fingers of pedipalps are very strongly flexed in the male; ventral trichobothria on patella number 6–8 ..... ..... ***S. hardwickii* (Gervais, 1843) "complex"**

– Male chela length to width ratio above 2.2; or the manus with length longer than width, or ventral trichobothria on patella number more than 8 ..... **8**

8 Total length more than 65 mm..... **9**

– Total length less than 65 mm ..... **10**

9 Mostly yellowish to yellow in adults, ventral patella of pedipalps with 9 trichobothria..... ***S. luridus* Qi, Zhu & Lourenço, 2005**

– Mostly red brown in adults, ventral patella of pedipalps with 7 (rarely 6 or 8) trichobothria..... ***S. petersii* Pocock, 1893**

10 Dorsally flat manus of pedipalps and chela of both sexes with length/width ratio: 2.1–2.2 (mean about 2.1 in males and 2.2 in females), total length 40.0–50.0 mm in adults ..... ***S. margerisonae* Kovařík, 2000**

– Dorsally round manus of pedipalps or at least the chela of one sex with length to width ratio higher than 2.2 or total length higher than 50 mm..... **11**

11 Total length more than 50 mm, chela strong, with length/width ratio: 2.0 in male and 2.5 in female..... ***S. tibetanus* Hirst, 1911**

– Total length less than 40 mm ..... **12**
12 Chela of pedipalp length to width ratio about 2.6–3.0, dorsal surface of chela of pedipalp coarse ..... ***S. lhasa*** **Di & Zhu, 2009**
– Chela of pedipalp length to width ratio lower than 2.5, dorsal surface of chela of pedipalp smooth with luster .... ***S. atomatus*** **Qi, Zhu & Lourenço, 2005**

***Scorpiops jendeki*** **Kovařík, 2000**
http://species-id.net/wiki/Scorpiops_jendeki
Figures 119–135, Table 3

*Scorpiops jendeki* Kovařík, 2000: 180, 182, figs 59–60, tabs 1–3.
*Scorpiops hardwickii jendeki*: Kovařík, 1994: 62, figs 7–13, tab. 1; Fet, 2000b: 492.
*Scorpiops jendeki*: Di et al., 2011b: 29–30, figs 118–122.

**Type locality.** China, Yunnan, Gaoligongshan Nature Reserve 100 km west of Baoshan.

**Type material.** Holotype, female, China, Yunnan, Gaoligongshan Nature Reserve 100 km west of Baoshan; 1 female paratype (NMPC), 4 females paratypes (FKCP),14–21/6/1993, E. Jendek and O. Sausa leg.

**Material examined.** 3 females and 1 immature male (MHBU, Ar.- MHBU-YNLL0801–4, 0804 is male), China, Yunnan Province, Baoshan City, Longling County, 7/2008, Ji-Shan Xu and Zhen-Hua Gao leg.

**Diagnosis.** Total length is 30–42.1 mm. Patella with 17 external trichobothria (5*eb*, 2 *esb*, 2 *em*, 4 *est*, 4 *et*) (Fig. 127) and 6–7 ventral trichobothria (6 specimens, Fig. 128). Pectinal teeth count 4–5. Both males and females have fingers of pedipalps straight, without any flexure. The carapace bears very sparse large granules.

*S. jendeki* appears to be closely related to *S. hardwickei* (Gervais, 1843), both species have the same number of external and ventral trichobothria on the patella, and a similar length/width ratio of chela; however, in the latter the fingers of pedipalps are strongly flexed.

**Description.** (based on female specimen: Ar.- MHBU -YNMH0801).

*Coloration*: mainly yellow. Carapace red brown with yellow stripe. Median and lateral ocular tubercles black. Tergites mostly dark red brown to dark brown with yellow stripe. Metasoma segments dark red brown to dark brown. Vesicle red yellow brown with brown stripe and a red brown aculeus. Chelicerae yellow brown with fingers dark red brown gradually lighter toward the tip. Pedipalp femur and patella dark red brown, chela manus and fingers red brown. Legs red brown with yellow stripe, tarsi yellow brown. Tarsal ungues yellowish brown. Sternum, genital operculum and sternites pale brown. Pectines yellowish.

*Morphology*. *Prosoma*: Carapace with sparse, big granules (Fig. 120); anterior edge with big granules, lateral and posterior edges smooth; lateral furrow broad, anterior median furrow broad and moderately deep, posterior median furrow deep; margin behind lateral eyes with granules, other margins smooth. Median eyes situated ante-

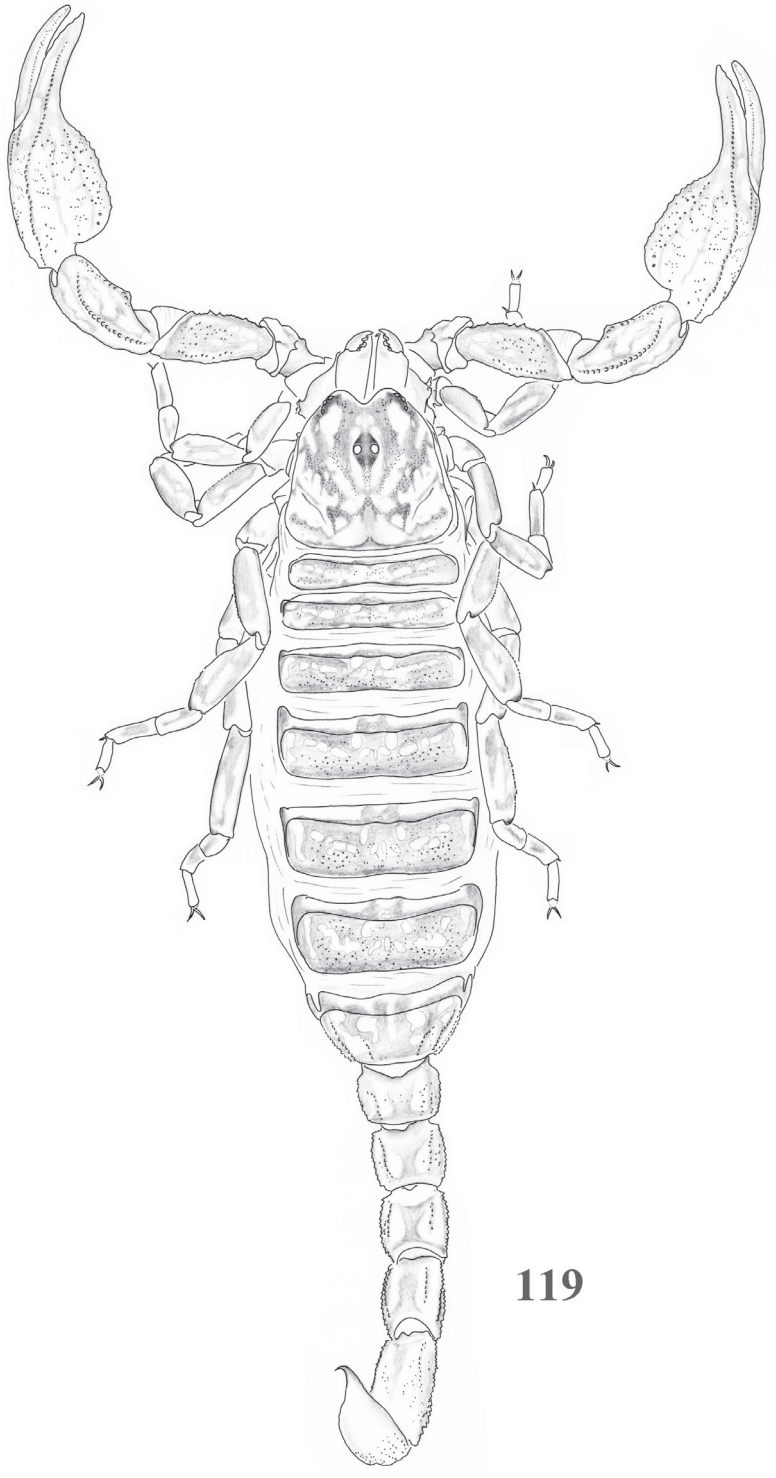
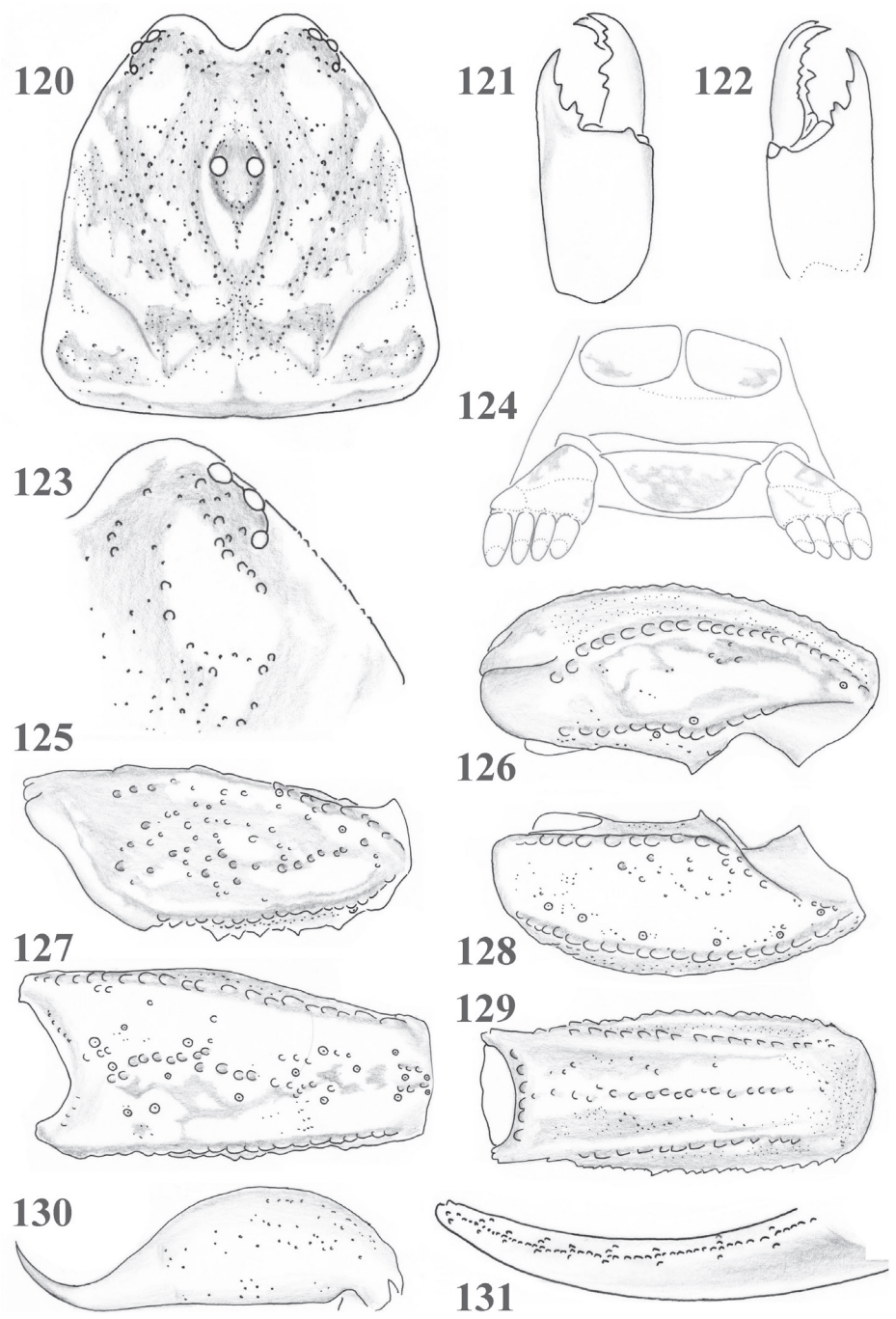
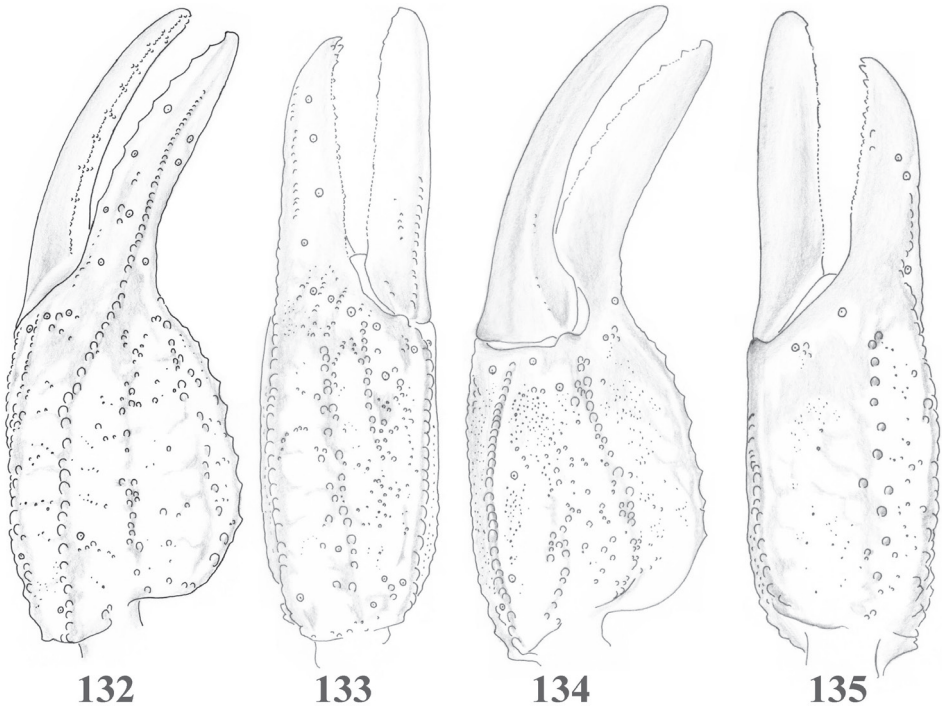



**Figure 119.** Habitus of *Scorpiops jendeki* from Longling County, female, dorsal view.




**Figures 120–131.** *Scorpiops jendeki* from Longling County, female. **120** Carapace **121–122** Chelicera, dorsal and ventral aspects **123** Lateral eyes **124** Genital operculum and pectines **125** Femur dorsal aspect **126–128** Patella dorsal, external and ventral aspects **129** Metasomal segment V, ventral aspect **130** Telson, lateral aspect **131** Dentate margin of movable finger, showing rows of granules.




**Figures 132–135.** *Scorpiops jendeki* from Longling County, female. Chela dorsal, external, ventral and internal aspects.

riorly compared to center of carapace; three pairs of lateral ocelli, posterior smallest (Fig. 123). Median ocular tubercle smooth with a pair of median eyes which are much larger than lateral eyes, and a median furrow. Lateral ocular tubercle with some granules around eyes.

*Mesosoma*: Tergites sparsely covered with coarse granules, posterior part of tergites with bigger granules; tergites III−VI with a median swell and two pairs of lateral carinae (shaped by bigger granules). Pectinal teeth count 4/4, fulcra absent (Fig. 124). Genital operculum subtriangular. Sternites smooth and shiny; segment VII with 4 smooth ventral carinae.

*Metasoma*: Tegument coarse. Segments II to V longer than wide; segments I to V with respectively 10-8-8-8-7 carinae; ventromedian, ventrolateral carinae stronger distally, dorsal carinae with small granules, lateral carinae weaker distally; segment V carinae with smaller granules dorsally and larger serration ventrally (Fig. 129). Vesicle with few setae and granules. Aculeus short and slightly curved (Fig. 130). The boundary between vesicle and aculeus not sharp.

*Pedipalps*: Tegument coarse. Femur with external, dorsointernal, dorsoexternal, ventrointernal, ventroexternal and internal carinae with round granules; tegument with few small granules dorsally (Fig. 125) and smooth ventrally. Patella (Figs 126–128) with dorsointernal, dorsoexternal, ventrointernal, ventroexternal and external

carinae with round granules; two large spinoid granules present on the internal aspect; tegument with few granules dorsally and ventrally nearly smooth. Trichobothrial pattern C, neobothriotaxic (Vachon 1974); patella with 17 external trichobothria (5 *eb*, 2 *esb*, 2 *em*, 4 *est*, 4 *et*), 6 ventral trichobothria. Chela with length/width ratio: 2.2 in adult males and 2.2–2.4 in adult females (2.2 on female holotype and a male specimen in Kovařík 2000b: 160, tab. 1) (Figs 131–135). Chela with dorsal marginal, external secondary, and ventrointernal carinae granulated. For position and distribution of trichobothria on the tibia of pedipalp see (Figs 132–135).

*Chelicerae*: Tegument smooth. Movable finger with 4 teeth on dorsal edge, 4 teeth on ventral edge. Fixed finger with 3 teeth on dorsal edge (Figs 121, 122).

*Legs*: Tegument coarsely granular dorsally, except basitarsi and telotarsi, smooth ventrally. Femur dorsal surface with few small granules, external surface with a granular carina, internal surface with two granular carinae. Patella internally with a dentate carina. Tibia with few setae and small granules, without spurs. Basitarsi with some spinules, few setae and 2 lateral pedal spurs. Tarsi ventrally with one row of short spinules and few setae. Tarsal ungues curved and hook-like.

**Variation.** Female and male materials: coloration and morphology are very similar to holotype. Sexual dimorphism is not distinct. Total length is 30–42.1mm. 6–7 ventral trichobothria on the patella of pedipalps. Pectinal teeth count 4–5. Measurements in Table 3.

**Ecology.** This species is uncommon, collected from moist mixed forest and in the bark or leavers and moss.

**Distribution.** Yunnan (China).

## Discussion

Twenty-six scorpion species of 7 genera and 5 families (Buthidae: *Hottentotta* (1 species), *Isometrus*(1); Chaerilidae: *Chaerilus* (8); Euscorpiidae: *Euscorpiops* (4), *Scorpiops* (10); Hemiscorpiidae: *Tibetiomachus* (1); Scorpionidae: *Heterometrus* (1)) were recorded in Xizang, all of them distribute in south and the north shores of Yarlung Zangbo Jiang: south of 31°N, bound on the north by the Burang - Lhasa- Maizhokunggar - Gongbo'gvamda - Bomê line (Figs 136–139). In them, 20 of 26 recorded species are endemic (76.9%).

In China, the closest area of scorpion fauna with Xizang is Yunan. Except one *Scorpiops* sp. was found in Hubei, all of euscorpiids were found in Xizang and Yunnan. Species of the genera *Scorpiops* and *Euscorpiops* are dominant, with confined distribution and not overlapped in Xizang and Yunnan. All of the species of family Chaerilidae found in China are living in Xizang. Qinghai, Sichuan and Xinjiang, are also with border on of Xizang. In Qinghai, just *Mesobuthus martensii martensii* (Karsch, 1879) reported in its northeast (Zhu et al., 2004; Zhang & Zhu, 2009). There is no scorpion species reported in Sichuan (Zhu et al., 2004). In Xinjiang, species genera of the family Buthidae recorded (*Mesobuthus* (7 species and subspecies), *Razianus* (1)) (Zhu et al., 2004; Lourenço et al., 2010; Sun and Sun, 2011). *Mesobuthus martensii martensii* (Karsch, 1879) and *M. eupeus mongolicus* (Birula 1911) found in South of Gansu

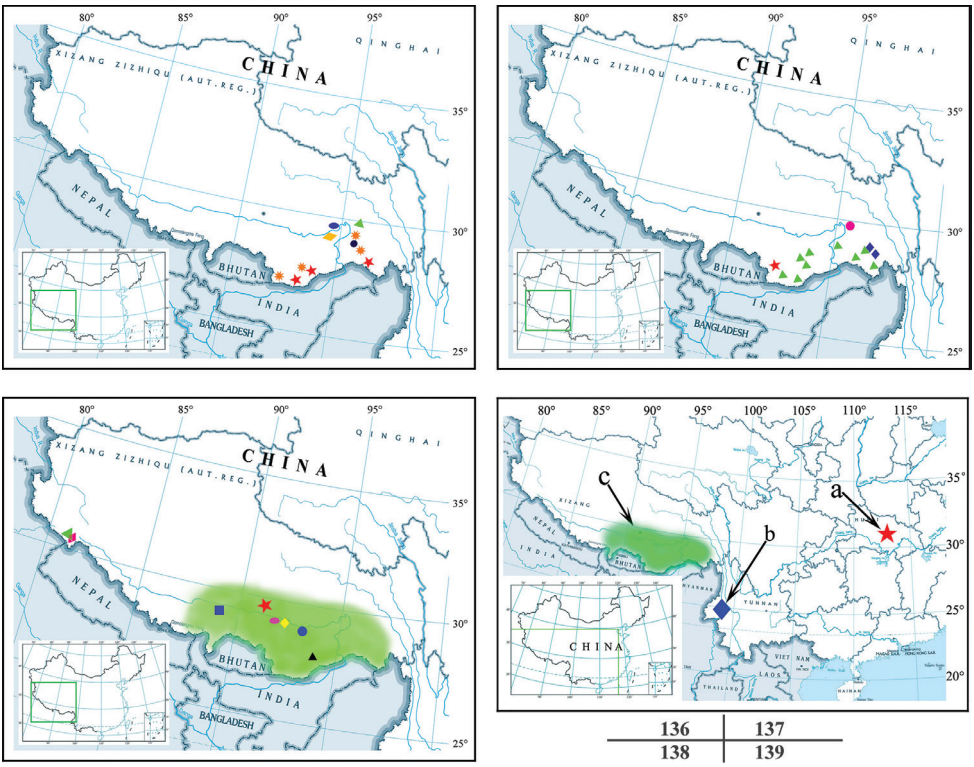



**Figure 136–139. 136** Map of Xizang (China), showing the localities of the *Chaerilus* species. Map abbreviations: **a** (ellipse and rhombus) *C. conchiformus* **b** (round) *C. dibangvalleycus* **c** (rhombus) *C. mainlingensis* **d** (triangle and round) *C. tryznai* (macula) **e** (star) *C. tricostatus* **f** (pentagram) *C. pictus* **g** (triangle) *C. wrzecionkoi* **h** (ellipse, triangle and macula) *C. tessellatus*. The red line showing the scorpions appears to be restricted to latitude north of 31°N, bordered by Burang - Lhasa- Maizhokunggar - Gongbo'gvamda – Bomê line **137** Map of Xizang (China), showing the localities of Euscorpiops species. Map abbreviations: **a** (triangle) *E. asthenurus* **b** (pentagram) *E. kamengensis* **c** (rhombus) *E. karschi* **d** (round) *E. novaki* **138** Map of Xizang (China), showing the localities of Scorpiops species, Heterometrus tibetanus and Hottentotta songi. Map abbreviations: **a** (round) *S. atomatus, S. langxian* and *S. luroris* **b** (black triangle) *S. leptochirus* **c** (pentagram) *S. lhasa* **d** (ellipse) *S. margerisonae* **e** (square) *S. tibetanus* **f** (yellow rhombus) *Scorpiops pococki* **g** (purple rhombus) *Heterometrus tibetanus* **h** (green triangle), *Hottentotta songi* **139** Map of China, showing the localities of Scorpios species. Map abbreviations: **a** (pentagon), *Scorpiops* sp. from Hubei (Huzhaoshan Mountains) **b** (rhombus), *S. jendeki* from Yunnan (Gaoligongshan Mountains) **c** (green part), the area rich in *Scorpiops* (Xizang).

which also belong to Qinghai-Tibetan Plateau (Sun and Sun, 2011). We conjecture the vast area of gap of scorpion distribution in the north of Xizang and the south of Qinghai is caused by the cold and clammy climate. So the scorpion fauna of Xizang isn't related to Qinghai and Xinjiang.

In the world, the 7 genera found in Xizang were recorded distributing to the south of Xizang. Modern species of genera *Chaerilus*, *Euscorpiops* and *Scorpiops* are limited to tropical areas of South Asia and Southeast Asia, although they reached considerable altitudes

in Kashmir, Nepal, and Tibet (Kovařík, 2000a, 2000b). The distribution of the species of genera *Hottentotta*, *Isometrus*, *Heterometrus* and the close related genera of *Tibetiomachus* also suggest the scorpion fauna of Xizang is close to South Asia and Southeast Asia.

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## References

Bai M (2004) Chapter 1: Natural environment and resources assessment. In: Bai M (Eds) Xizang Geography. The Peoples Press of Xizang, Lhasa, China, 6–92.

Bastawade DB (2006) Arachnida: Scorpionida, Uropygi, Schizomida and Oncopodid Opiliones (Chelicerata). Zool. Surv, India. Fauna of Arunachal Pradesh, State Fauna Series 13 (2): 449–465.

Di ZY, He YW, Cao ZJ, Wu YL, Li WX (2011a) The first record of the family Euscorpiidae (Arachnida: Scorpiones) from Central China, with a key of Chinese species of the genus *Scorpiops*. Euscorpius 116:1–11.

Di ZY, He YW, Wu YL, Cao ZJ, Liu H, Jiang DH, Li WX (2011b) The scorpions of Yunnan (China): updated identification key, new record and redescriptions of *Euscorpiops kubani* and *E. shidian* (Arachnida, Scorpiones). ZooKeys 82: 1–33. doi: 10.3897/zookeys.82.715

Di ZY, Cao ZJ, Wu YL, Zhu L, Liu L, Li WX (2013) The scorpions of Hainan Island, China (Arachnida: Scorpiones) Euscorpius (In press).

Di ZY, Wu YL, Cao ZJ, Fan LQ, Li WX (2009) The genus *Chaerilus* Simon, 1877 (Scorpiones: Chaerilidae) in China, with a description of the female *C. tricostatus* Pocock, 1899. Arthropoda Selecta 18 (3/4): 131–138.

Di ZY, Wu YL, Cao ZJ, Xiao H, Li WX (2010) A catalogue of the genus *Euscorpiops* Vachon, 1980 (Scorpiones: Euscorpiidae, Scorpiopinae) from China, with description of a new species. Zootaxa 2477: 49–61.

Di ZY, Zhu MS (2009a) One new species of the Genus *Scorpiops* Peters, 1861 (Scorpiones: Euscorpiidae, Scorpiopinae) from Xizang, China. Zootaxa 2030: 39–48.

Di ZY, Zhu MS (2009b) A new species of *Chaerilus* Simon, 1877 (Scorpiones, Chaerilidae) from China. Acta Arachnologica 58 (2): 97–102. doi: 10.2476/asjaa.58.97

Di ZY, Zhu MS (2009c) The male of *Euscorpiops karschi* (Scorpiones: Euscorpiidae, Scorpiopinae) from China (Xizang). Arthropoda Selecta 18 (1/2): 9–16.

Di ZY, Zhu MS (2010) Redescription of *Scorpiops margerisonae* Kovařík, 2000, with the first record of its female, from China (Scorpiones: Euscorpiidae: Scorpiopinae). Euscorpius 104: 1–9.

Fet V (2000a) Family Chaerilidae Pocock, 1893. In: Fet, V., Sissom, W. D., Lowe, G. & Braunwalder, M. E., Catalog of the Scorpions of the World (1758–1998). The New York Entomological Society, New York, 323–328.

Fet V (2000b) Family Ischnuridae Simon, 1879. In: Fet V, Sissom WD, Lowe G, Braunwalder ME (Eds) Catalog of the Scorpions of the world (1758–1998). The New York Entomological Society, New York, 383–408.

Fet V (2000c) Family Scorpionidae Latreille, 1802. In: Fet V, Sissom WD, Lowe G, Braunwalder ME (Eds) Catalog of the Scorpions of the world (1758–1998). The New York Entomological Society, New York, 427–486.

Fet V (2000d) Family Scorpiopidae Kraepelin, 1905. In: Fet V, Sissom WD, Lowe G, Braunwalder ME (Eds) Catalog of the Scorpions of the World (1758–1998). The New York Entomological Society, New York, 487–495.

Fet V, Lowe G (2000) Family Buthidae C. L. Koch, 1837. In: Fet V, Sissom WD, Lowe G, Braunwalder ME (Eds) Catalog of the Scorpions of the world (1758–1998). The New York Entomological Society, New York, 54–286.

Fet V, Bechly G (2001) Case 3120a. Liochelidae, fam. nov. (Scorpiones): proposed introduction as a sustitute name for Ischnuridae Simon, 1879, as an alternative to the suggested emendment of Ischnurinae Fraser, 1957 (Insecta, Odonata) to Ischnurainae in order to remove homonymy. Bull. Zool. Nomen. 58 (4): 280–281.

Fet V, Sissom WD (2000) Family Euscorpiidae Laurie, 1896. In: Fet V, Sissom WD, Lowe G, Braunwalder ME (Eds) Catalog of the Scorpions of the world (1758–1998). The New York Entomological Society, New York, 355–380.

Hirst S (1911) Descriptions of new scorpions. Annals and Magazine of Natural History, 8 (8): 462–473. doi: 10.1080/00222931108693056

Hjelle JT (1990) Anatomy and morphology, in: G.A. Polis (Ed.), The Biology of Scorpions. Stanford Univ. Press, pp. 9–63.

Kishida K (1939) "Arachnida of Jehol. Scorpiones". Report of the first scientific expedition to Mandchoukuo under the leadership of Shigeyasu Tokunage. June–October 1933, 5, 1, 4(10): 1–66.

Kishida K (1939) Arachnida of Jehol. Order Scorpiones. Report of the First Scientific Expedition to Manchoukuo Under the Leadership of Shigeyasu Tokunaga, June–October 1933, 5, 1(4), 10: 49–67.

Kovařík F (2000a) Revision of family Chaerilidae (Scorpiones), with descriptions of three new species. Serket 7(2): 38–77.

Kovařík F (2000b) Revision of family Scorpiopidae (Scorpiones), with descriptions of six new species. Acta Soc. Zool. Bohem 64: 153–201.

Kovařík F (2003) A review of the genus *Isometrus* Ehrenberg, 1828 (Scorpiones: Buthidae) with descriptions of four new species from Asia and Australia. Euscorpius 10: 1–19.

Kovařík F (2004) A review of the genus *Heterometrus* Ehrenberg, 1828, with descriptions of seven new species (Scorpiones, Scorpionidae). Euscorpius 15: 1–60.

Kovařík F (2005) Three new species of the genera *Euscorpiops* Vachon, 1980 and *Scorpiops* Peters, 1861 from Asia (Scorpiones: Euscorpiidae, Scorpiopinae). Euscorpius 27: 1–10.

Kovařík F (2007) A revision of the genus *Hottentotta* Birula, 1908, with descriptions of four new species (Scorpiones: Buthidae). Euscorpius 58: 1–107.

Kovařík F, Ahmed Z (2009) Three new species of *Scorpiops* Peters, 1861 (Scorpiones: Euscorpiidae: Scorpiopinae) from Pakistan. Euscorpius 88: 1–11.

Kovařík F (2012a) *Euscorpiops thaomischi* sp. n. from Vietnam and a key to species of the genus (Scorpiones: Euscorpiidae: Scorpiopinae). Euscorpius 142: 1–8.

Kovařík F (2012b) Five new species of *Chaerilus* Simon, 1877 from China, Indonesia, Malaysia, Philippines, Thailand, and Vietnam (Scorpiones: Chaerilidae). Euscorpius 149: 1–14.

Lamoral BH (1980) A reappraisal of supragenic classification of recent scorpions and their zoogeography. Proc. 8th Int. Congr. Arachnol. Vienna 1980: 439–444.

Lourenço WR, Duhem B (2010) The genus *Chaerilus* Simon, 1877 (Scorpiones, Chaerilidae) in the Himalayas and description of a new species. Zookeys 37: 13–25. doi: 10.3897/zookeys.37.369

Lourenço WR, Duhem B, Leguin EA (2011) The genus *Chaerilus* Simon, 1877 (Scorpiones, Chaerilidae) in the Indian Ocean Islands and description of a new species. Euscorpius 110: 1–8.

Lourenço WR, Qi JX (2006) Mountain scorpions: a new genus and species from Tibet (China). C R Biol Apr; 329(4): 289–295.

Lourenço WR, Qi JX, Zhu MS (2005) Description of two new species of scorpions from China (Tibet) belonging to the genera *Mesobuthus* Vachon (Buthidae) and *Heterometrus* Ehrenberg (Scorpionidae). Zootaxa 985: 1–16.

Lourenço WR, Sun D, Zhu MS (2010) *Razianus xinjianganus* sp. nov.: A new record Genus and new species of (Scorpiones, Buthidae) from China. Journal of Hebei University (Natural Science Edition) 30 (3): 307–312.

Lourenço WR, Zhu MS (2008) A new species of the genus *Isometrus* Ehrenberg, 1828 (Scorpiones, Buthidae) from China. Acta Zootaxonomica Sinica, 33 ( 2) : 264–271.

Monod L,Volschenk ES (2004) *Liocheles litodactylus* (Scorpiones: Liochelidae): An unusual new *Licheles* species from the Australian wet tropics (Queensland). Memoirs of the Queensland Museum, 49 (2): 675–687.

Prendini L (2000) Phylogeny and classification of the superfamily Scorpionoidea Latreille, 1802 (Chelicerata, Scorpiones): An exemplar approach. Cladistics 16: 1–78. doi: 10.1111/j.1096-0031.2000.tb00348.x

Qi J X, Zhu MS, Lourenço WR (2005) Eight new species of the genera *Scorpiops* Peters, *Euscorpiops* Vachon, and *Chaerilus* Simon (Scorpiones: Euscorpiidae, Chaerilidae) from Tibet and Yunnan, China. Euscorpius 32: 1–40.

Shi CM, Huang ZS, Wang L, He LJ, Hua YP, Leng L, Zhang DX (2007) Geographical distribution of two species of *Mesobuthus* (Scorpiones, Buthidae) in China: insights from systematic field surveys and predictive models. The Journal of Arachnology 35: 215–226. doi: 10.1636/T06-20.1

Sissom WD (1990) Systematics, biogeography and paleontology. In: Polis, G.A. (ed.). The Biology of Scorpions. Stanford University Press, Stanford, California. pp.64–160.

Soleglad ME, Fet V (2003) High–level systematics and phylogeny of the extant scorpions (Scorpiones: Orthosterni). Euscorpius 11: 1–175.

Soleglad ME, Fet V, Kovařík F (2005) The systematic position of the scorpion genera *Heteroscorpion* Birula, 1903 and *Urodacus* Peters, 1861 (Scorpiones: Scorpionoidea). Euscorpius 20: 1–38.

Soleglad ME, Sissom WD (2001) Phylogeny of the family Euscorpiidae Laurie, 1896: a major revision. In: Fet V, Selden PA (Eds) Scorpions 2001. In Memorium Gary A. Polis. Brit. Arachnol. Soc. pp 25–111.

Sun D, Sun, ZN (2011) Notes on the genus *Mesobuthus* (Scorpiones: Buthidae) in China, with description of a new species. The Journal of Arachnology 39:59–75. doi: 10.1636/Ha10-36.1

Sun D, Zhu MS, Lourenço WR (2010) A new species of *Mesobuthus* (Scorpiones: Buthidae) from Xinjiang, China, with notes on *Mesobuthus songi*. The Journal of Arachnology 38:35–43. doi: 10.1636/Ha09-39.1

Teruel R, Rein JO (2010) A new species of *Hottentotta* Birula, 1908 from Afghanistan, with a note on the generic position of *Mesobuthus songi* Lourenço, Qi et Zhu, 2005 (Scorpiones: Buthidae). Euscorpius 94: 1–8.

Vachon M (1952) *Etudes sur les scorpions*. Publications de l'Institut Pasteur d'Algérie, Alger, 482 pp.

Vachon M (1973) [1974] Etude des caractères utilisés pour classer les familles et les genres de Scorpions (Arachnides). 1. La trichobothriotaxie en arachnologie. Sigles trichobothriaux et types de trichobothriotaxie chez les Scorpions. Bulletin du Muséum national d'Histoire naturelle, Paris, 3e sér., 140: 857–958.

Zhang L, Zhu MS (2009) Morphological variation of *Mesobuthus martensii* (Karsch, 1879) (Scorpiones: Buthidae) in Northern China. Euscorpius 81: 1–17.

Zhu MS, Han GX, Lourenço WR (2008) The chaerilid scorpions of China (Scorpiones: Chaerilidae). Zootaxa 1943: 37–52.

Zhu MS, Qi JX, Song DX (2004) A Checklist of Scorpions from China (Arachnida: Scorpiones). Acta Arachnologica Sinica 13 (2): 111–118.

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# First record of *Tyrodes* Raffray (Coleoptera, Staphylinidae, Pselaphinae) in China, with description of *T. jenisi* sp. n. from Yunnan Province

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## Abstract

*Tyrodes jenisi* Yin & Li, **sp. n.**, of the pselaphine tribe Tyrini, from Yunnan, Southwest China is described, illustrated and distinguished from allied species mainly using aedeagal characters. This represents the first record of *Tyrodes* in China.

## Keywords

Staphylinidae, Pselaphinae, taxonomy, *Tyrodes*, new species, China

## Introduction

The small genus *Tyrodes* Raffray currently contains six valid species scattered in the Oriental (5 spp.) and Northeast Palaearctic (1 sp.) regions: *T. histrio* (Schaufuss, 1887) (Sri Lanka, type species), *T. championi* (Jeannel, 1960) (India), *T. clavatus* (Raffray, 1895) (Singapore), *T. janetscheki* Besuchet, 1970 (Nepal), *T. setosus* Jeannel, 1957 (Vietnam),

and *T. segrex* Kurbatov, 1990 (Russian Far East) (Raffray 1895, 1908; Newton and Chandler 1989; Hlaváč and Chandler 2005). *Tyrodes* is allied to the Holarctic and Oriental *Tyrus* Aubé by sharing a similar general habitus, and similar forms of the maxillary palpi and pronotum. The two genera can be separated by the presence of an indistinct frontal fovea, the abdominal tergite IV (first visible tergite) being longer than tergite V, and the aedeagus being stouter and has a short median lobe in *Tyrodes*, while *Tyrus* has a distinct frontal fovea, the tergite IV is subequal to tergite V, and the aedeagus is more slender and bears a longer median lobe.

In this paper, we report a new species of *Tyrodes* from Yunnan, Southwest China. A diagnosis, a description, and illustrations of male diagnostic features are provided. This also represents the first record of the genus in China.

## Material and methods

The holotype is housed in the private collection of Peter Hlaváč (pcPH), and will eventually be deposited in the National Museum of Natural History, Prague (NMPC)

The collection data of the referred material are quoted verbatim. A slash (/) is used to separate lines on the same label, and a double slash (//) is used to separate different labels.

All measurements are in millimeters. The following acronyms are applied: **AL**–length of the abdomen along the midline; **AW**–maximum width of the abdomen; **BL**–length of the body (= HL + PL + EL + AL); **EL**–length of the elytra along the sutural line; **EW**–maximum width of the elytra; **HL**–length of the head from the anterior clypeal margin to the occipital constriction; **HW**–width of the head across eyes; **PL**–length of the pronotum along the midline; **PW**–maximum width of the pronotum.

## Description of new species

***Tyrodes jenisi* Yin & Li, sp. n.**
urn:lsid:zoobank.org:act:01240E37-DF20-4B5F-99F9-BF8C7DA6A42E
http://species-id.net/wiki/Tyrodes_jenisi
Fig. 1

**Type material** (1 ♂)**.** Holotype: ♂, labeled 'CHINA: Yunnan / Pass SW from Baoshan / Gaoligong Shan / 4–8.VI.2006, Jeniš lgt. // HOLOTYPE [red] / *Tyrodes jenisi* / sp. n., Yin & Li / det. 2013.' (pvPH).

**Description.** Male (Fig. 1A). Length 1.84 mm. Head about as long as wide, HL 0.37 mm, HW 0.36 mm; eyes each composed of about 35 facets; maxillary palpi as in Fig. 1E; antennae (Fig. 1B) elongate, scapes (Fig. 1D) triangularly projecting basolaterally, antennomeres II–VIII successively shorter; terminal three antennomeres enlarged (Fig. 1C). Pronotum about as long as wide, PL 0.39 mm, PW 0.38 mm, with rounded lateral margins, evenly narrowed apically at middle. Elytra wider

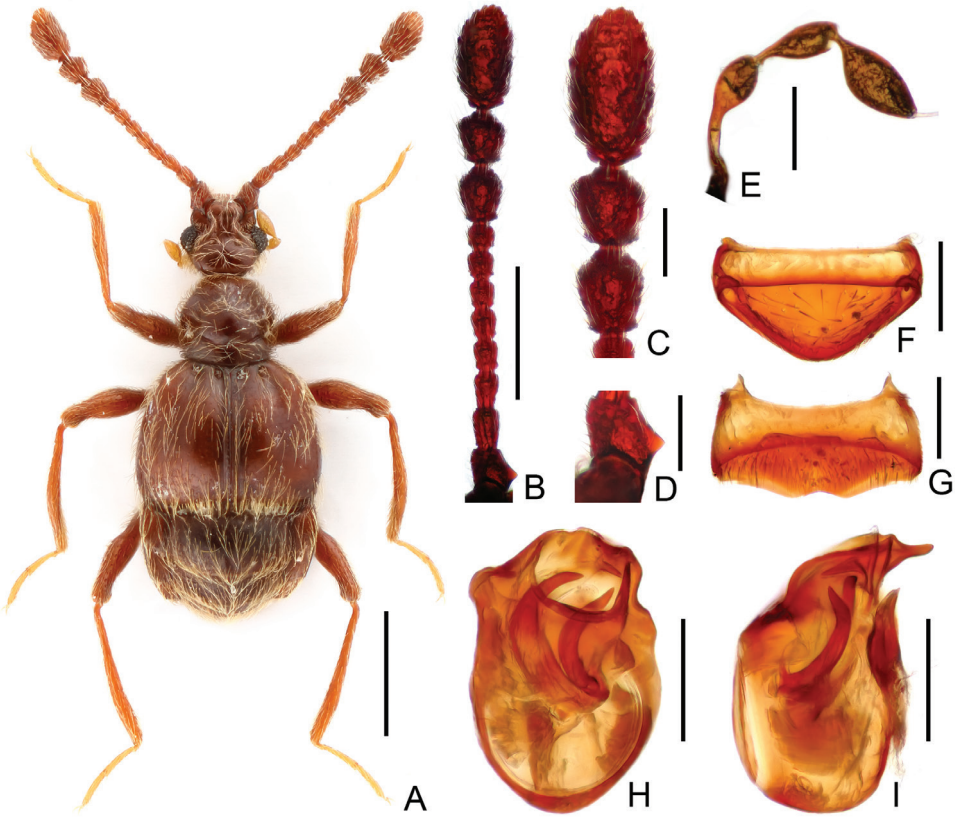


**Figure 1.** *Tyrodes jenisi*, male. **A** dorsal habitus **B** antenna **C** antennal club, enlarged **D** scape, enlarged **E** maxillary palpus **F** tergite VIII **G** sternite VIII **H** aedeagus, in dorsal view **I** same, in lateral view. Scales (mm): **A** = 0.5; **B** = 0.2; **C–I** = 0.1.

than long, EL 0.55 mm, EW 0.77 mm. Legs lacking spines or projections. Abdomen broad at base and narrowed apically, AL 0.53 mm, AW 0.73 mm. Tergite VIII (Fig. 1F) and sternite VIII (Fig. 1G) transverse. Aedeagal length 0.24 mm, stout; with short, asymmetric median lobe (Figs 1H, I); endophallus composed of two sclerites curved to left.

Female. Unknown.

**Comparative notes.** *Tyrodes jenisi* can be separated from all congeners, except for *T. clavatus*, by the distinct form of the aedeagus, as well as the consideration of distributional patterns.

*Tyrodes championi* is subequal in size (1.8 mm), but its aedeagal median lobe forms a distinct process at apex; *T. histrio* is smaller (1.5 mm), with the aedeagus being split at apex, and the endophallus with a long sclerite on the left side; *T. janetscheki* is greater in size (1.9 mm), its aedeagus has much more complicated structure of endophallus; *T. segrex* has a greater size as well (1.9–2.0 mm), and has clear different structure of

aedeagal endophallus; *T. setosus* is subequal in size (1.8 mm), but the apical portion of aedeagal median lobe is curving to right, and has a strong apophysis on the right side. Aedeagus of *Tyrodes clavatus* has not been illustrated in any reference, but it is much smaller (1.4 mm), and is found in Singapore.

**Comments.** In his world catalog of the genera of Pselaphidae, Raffray (1908) moved *Pselaphodes clavatus* Raffray, 1895 to *Tyrodes*, followed in the later Coleopterorum Catalogus (Raffray 1911). Jeannel (1957: 32) compared the new species *Tyrodes setosus* Jeannel with *T. clavatus* when treating the pselaphines collected from Tonkin, Vietnam by Albert de Cooman. Besuchet (1970: 316), Newton & Chandler (1989: 60) and Kurbatov (1990: 145) also suggested or mentioned the placement of *clavatus* in *Tyrodes*. In the recent catalog of Tyrini (Hlaváč and Chandler 2005), this placement was probably overlooked, the species was remained in the genus *Pselaphodes*. According to the original description, it is clear that *clavatus* belongs to *Tyrodes*.

**Distribution.** Southwest China: Yunnan.

**Etymology.** The new species is named after Ivo Jeniš (Náklo, Czech Republic), collector of the holotype.

## Acknowledgments

We thank Peter Hlaváč (Prague, Czech Republic) for providing the material used in this study. Alfred F. Newton kindly provided discussion on *Tyrodes clavatus*. Two anonymous reviewers are thanked for the critical comments on a previous draft. This study is supported by the National Science Foundation of China (No. 31172134), and Shanghai Normal University (Sk201242, DZL125).

## References

Besuchet C (1971) Psélaphides récoltés au Népal par le Prof. H. Janetschek (Coleoptera). Berichte des Naturwissenschafilich-medizinischen Vereins in Innsbruck 58 (1970): 313–318.

Hlaváč P, Chandler DS (2005) World Catalogue of the species of Tyrini with a key to the genera (Coleoptera: Staphylinidae: Pselaphinae). Folia Heyrovskyana 13: 81–143.

Jeannel R (1957) Sur quelques Psélaphides du Tonkin recueillis par le Père A. de Cooman. Revue Française d'Entomologie 24: 5–32.

Jeannel R (1960) Sur les Psélaphides (Coleoptera) de l'Inde septentrionale. Bulletin of the British Museum of Natural History, Entomology 9: 403–456.

Kurbatov SA (1990) New beetles (Coleoptera, Pselaphidae) from southern Primorye. Zoologicheskii Zhurnal 69: 141–145 [in Russian with English abstract].

Newton AF, Chandler DS (1989) World Catalog of the Genera of Pselaphidae (Coleoptera). Fieldiana: Zoology, (N.S.) 53: iv + 93 pp.

Raffray A (1895) Révision des Psélaphides des îles de Singapore et de Penang (Suite et fin). Revue d'Entomologie 14: 21–82, pl. 2.

Raffray A (1908) Coleoptera. Fam. Pselaphidae. Genera Insectorum 64: 1–487, pls 1–9.
Raffray A (1911) Pselaphidae. In: Schenkling S (Ed.) Coleopterorum Catalogus, Pars 27. Berlin, W. Junk, 222 pp.
Schaufuss LW (1888) Ueber Pselaphiden und Scydmaeniden des Königl. zoologischen Museums zu Berlin und verwandte Arten. Berliner Entomologische Zeitschrift 31 (1887): 287–320.

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# Notes on Michael Schülke's pselaphine collections from China. – Tyrini. II. Genus *Megatyrus* Hlaváč & Nomura (Coleoptera, Staphylinidae, Pselaphinae)

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## Abstract

Two new species of the tyrine genus *Megatyrus* Hlaváč & Nomura, *M. schuelkei* Yin & Li, **sp. n.** (based on two males) and *M. tengchongensis* Yin & Li, **sp. n.** (based on one female), from Yunnan, Southwest China are described, illustrated and distinguished from allied species. The body size, form of maxillary palpi, male and female genital structures, and distributional patterns are used to separate the new species.

## Keywords

Staphylinidae, Pselaphinae, taxonomy, *Megatyrus*, new species, China

## Introduction

Members of *Megatyrus* Hlaváč & Nomura (type species: *M. menglianensis* Hlaváč & Nomura) are large (3.30–4.12 mm), rare pselaphine rove beetles inhabiting leaf litter of the forest floor. Six species have been described from South Asia: one from China, two from Vietnam (Hlaváč and Nomura 2003), and three recently described (Nomura et al. 2011) from Thailand. *Megatyrus* is morphologically similar to the genera *Tyrus*

Aubé and *Tyrodes* Raffray in sharing a similar general habitus and pronotal structure. It can be readily separated from both by the much larger body size, the more pedunculate maxillary palpi, the absence of a palpal cone, and the abdominal tergite IV (first visible tergite) being clearly longer than tergite V. A recent study on the pselaphine collections of Michael Schülke, all collected during several expeditions to China, produced numerous undescribed species. After a comparative study on the types of all known species of *Megatyrus* (all in National Museum of Nature and Science, Tokyo, Japan [NSMT]), the present study reports two new species, as the second of a series dealing with Schülke's material. Diagnoses, descriptions, and illustrations of major diagnostic features of the new species are provided.

## Material and methods

The material treated in this study is housed in the following public institution and private collection:

**SNUC** Insect Collection of Shanghai Normal University, Shanghai, China (Zi-Wei Yin)
**pcMS** private collection of Michael Schülke, Berlin, German

The collection data of the referred material are quoted verbatim. A slash (/) is used to separate lines on the same label, and a double slash (//) is used to separate different labels. Authors' notes are included in a '[]'. All type material bears the following label: 'HOLOTYPE [red] or PARATYPE [yellow] / [genus name, species name] / sp. n., [authors of the species] / det. 2013. The depository is indicated after the collection data of the respective species.

All measurements are in millimeters. The following acronyms are applied: **AL**–length of the abdomen along the midline; **AW**–maximum width of the abdomen; **BL**–length of the body (= HL + PL + EL + AL); **EL**–length of the elytra along the sutural line; **EW**–maximum width of the elytra; **HL**–length of the head from the anterior clypeal margin to the occipital constriction; **HW**–width of the head across eyes; **PL**–length of the pronotum along the midline; **PW**–maximum width of the pronotum.

## Descriptions of new species

***Megatyrus schuelkei* Yin & Li, sp. n.**
urn:lsid:zoobank.org:act:FCA38920-031F-4F09-8060-A455CB8927B1
http://species-id.net/wiki/Megatyrus_schuelkei
Figs 1A, 2

**Type material** (2 ♂♂)**.** Holotype: ♂, labeled 'CHINA: Yunnan, Lincang Pref., / Xue Shan, 48 km N Lincang, / 2070 m, 24°19'03"N, 100°07'13"E, / forest remnant, N-

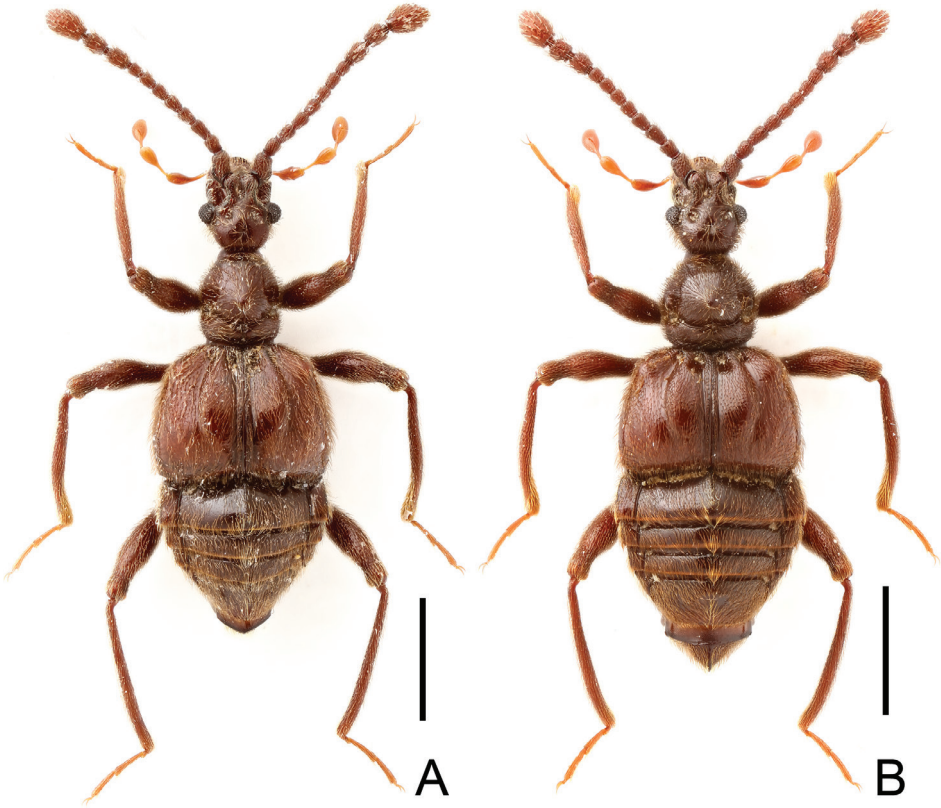


**Figure 1.** Habitus of *Megatyrus*. **A** *M. schuelkei*, male **B** *M. tengchongensis*, female. Scales (mm): 1.0.

slope, litter & / mushrooms sifted, 12.IX.2009, / leg. M. Schülke [CH09-45]' (pcMS). Paratype: 1 ♂, same label data as holotype (SNUC).

**Description.** Male (Fig. 1A). Length 3.52–3.70 mm. Head longer than wide, HL 0.81–0.84 mm, HW 0.68–0.69 mm; eyes each composed of about 50 facets; maxillary palpi as in Fig. 2B; antennae (Fig. 2A) with scapes roundly projecting basolaterally; terminal three antennomeres enlarged. Pronotum longer than wide, PL 0.71–0.73 mm, PW 0.64–0.65 mm, lateral margins nearly parallel, evenly narrowed apically at basal 2/3. Elytra wider than long, EL 0.97–0.99 mm, EW 1.43–1.48 mm. Mesotrochanters, metatrochanters and metafemora lacking spine or projection at ventral margins. Abdomen broad at base and narrowed apically, AL 1.03–1.14 mm, AW 1.38–1.40 mm. Tergite VIII as in Fig. 2C; sternite VIII as in Fig. 2D; sternite IX as in 2E. Aedeagus length 0.83 mm, with elongate median lobe asymmetric (Figs 2F, G).

Female. Unknown.

**Comparative notes.** *Megatyrus schuelkei* is most similar to *M. laqueus* Hlaváč & Nomura from Vietnam in sharing similar body size and aedeagal structure. The two species can be clearly separated by the more elongate maxillary palpi, and the antennomeres VI–VIII are slightly more elongate in the new species. *Megatyrus laqueus* has shorter maxil-

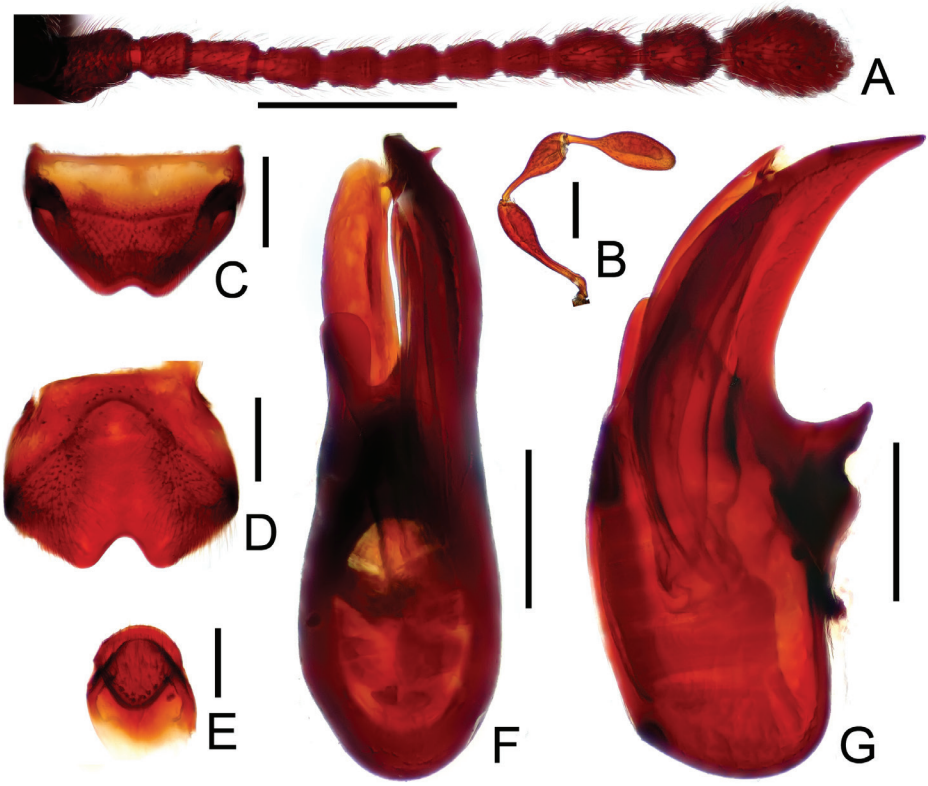


**Figure 2.** Diagnostic features of male *M. schuelkei*. **A** antenna **B** maxillary palpus **C** tergite VIII **D** sternite VIII **E** sternite IX **F** aedeagus, in dorsal view **G** same, in lateral view. Scales (mm): **A** = 0.5; **B, C, D, F, G** = 0.2; **E** = 0.1.

lary palpi and quadrate antennomeres VI–VIII. *Megatyrus schuelkei* can be separated from *M. menglianensis* by the more elongate pronotum, and different aedeagal structure.

**Distribution.** Southwest China: Yunnan.

**Biology.** Individuals were collected from sifted leaf litter with mushrooms in a forest remnant.

**Etymology.** The new species is named after Michael Schülke, collector of the type series.

***Megatyrus tengchongensis* Yin & Li, sp. n.**
urn:lsid:zoobank.org:act:989B0696-4F01-47B8-9279-DAE226D8D119
http://species-id.net/wiki/Megatyrus_tengchongensis
Figs 1B, 3

**Type material** (1 ♀)**.** Holotype: ♀, labeled 'CHINA: Yunnan [CH07-17] / Baoshan Pref., mountain range 25 km S / Tengchong, 1900 m, 24°48'28"N, 98°32'03"E, dev. primary decid. forest, / litter, fungi sifted, 2.V.2007, M. Schülke' (pcMS).

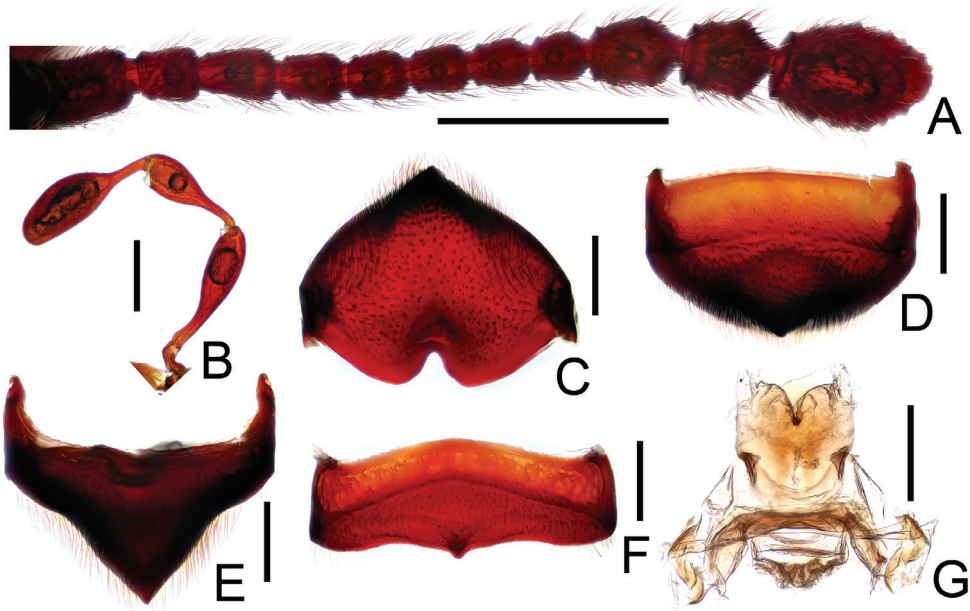


**Figure 3.** Diagnostic features of female *M. tengchongensis*. **A** antenna **B** maxillary palpus **C** tergite VIII, in posterior view **D** same, in dorso-posterior view **E** same, in dorsal view **F** sternite VIII **G** female genital complex, in dorsal view. Scales (mm): **A** = 0.5; **B–G** = 0.2.

**Description.** Female (Fig. 1B). Length 3.71 mm. Head longer than wide, HL 0.79 mm, HW 0.65 mm; eyes each composed of about 35 facets; maxillary palpi as in Fig. 3B; antennae (Fig. 3A) with scapes simple; terminal three antennomeres enlarged. Pronotum slightly longer than wide, PL 0.74 mm, PW 0.71 mm, lateral margins nearly parallel, evenly narrowed apically at middle. Elytra wider than long, EL 0.93 mm, EW 1.43 mm. Legs simple. Abdomen broad at base and narrowed apically, AL 1.25 mm, AW 1.46 mm. Tergite VIII as in Fig. 3C–E; sternite VIII as in Fig. 3F. Genital complex weakly sclerotized, width 0.55 mm, with dorsal and ventral sclerites (Figs 3G).

Male. Unknown.

**Comparative notes.** In general, *Megatyrus* males are morphologically similar to females, and possess indistinct second sexual characters. Proportions of head, pronotum and abdomen between male and female are close, except that females have much shorter elytra, as well illustrated in Nomura et al. (2011: 123). The single female of *Megatyrus tengchongensis* is very similar to that of *M. menglianensis* Hlaváč & Nomura by the tergite VIII possessing a large and thick median projection, but the two species can be separated by the maxillary palpomeres I being more elongate in *M. tengchongensis*, and the clearly different structure of the genital complex. From *M. schuelkei* described above, *M. tengchongensis* can be separated by the relatively much shorter and stouter pronotum.

**Distribution.** Southwest China: Yunnan.

**Biology.** The adult was collected from sifted leaf litter in a deciduous forest.

**Etymology.** The new species is named after the type locality, Tengchong County.

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## References

Hlaváč P, Nomura S (2003) A taxonomic revision of Tyrini of the Oriental Region III. *Megatyrus* (Coleoptera, Staphylinidae, Pselaphinae), a new genus of the Tyrina from China and Vietnam. Elytra 31: 165–174.

Nomura S, Sakchoowong W, Chanpaisaeng J (2011) Three new species of the genus *Megatyrus* (Coleoptera, Staphylinidae, Pselaphinae) from Thailand. Special publication of the Japanese Society of Scarabaeoidology 1: 121–130.