

A new diplommatinid genus and two new species from the Philippines (Gastropoda, Caenogastropoda, Cyclophoroidea)

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Abstract

A new diplommatinid genus, *Luzonocoptis* Páll-Gergely & Hunyadi, **gen. n.** is erected for two new species, *Luzonocoptis antenna* Páll-Gergely & Hunyadi, **sp. n.** and *L. angulata* Páll-Gergely & Hunyadi, **sp. n.** Both species inhabit the northeastern part of Luzon Island, Philippines. The genus *Luzonocoptis* **gen. n.** is mostly characterized by a very slender shell with 14–18 whorls, a strongly expanded peristome, an interrupted, weak columellar lamella, the absence of any additional plicae or lamellae, and a rachidian tooth having five cusps.

Keywords

Land snail, Luzon, rock habitat, systematics, taxonomy

Introduction

Diplommatinidae (Caenogastropoda: Cyclophoroidea) are mostly characterized by small shells, a body whorl with a distinctive constriction, and teeth or plicae, which are situated inside the last whorl. This family is widely distributed in eastern and southern Asia, northern Australia, the Pacific islands, and some isolated distributions in South America and Madagascar (Kobelt 1902, Thiele 1929, Wenz 1939, Haas 1961, Simone 2013, Egorov 2013).

The Diplommatinidae of the Philippines were mainly described in 12 papers by Otto von Möllendorff (von Möllendorff 1887a, 1887b, 1887c, 1887d, 1888a, 1888b, 1890a, 1890b, 1891, 1893, 1898, Quadras and von Möllendorff 1893–1896). Although many species were described without figures, Zilch (1953) published photos of all known Philippine diplommatinids. For more than a century, since the last description, no information on the Philippine members of this family has been published. Recently, Poppe et al. (2015) described two species of the Diplommatinidae from the Philippines.

To date, the following species have been described from Cagayan Province, northern Luzon island: *Palaina conspicua* Möllendorff, 1893, *P. conspicua versicolor* Möllendorff, 1893, *P. cristata* Quadras & Möllendorff, 1893, *Diplommatina cagayanica* Möllendorff, 1893, *D. latilabris* Kobelt, 1886, *Diplommatina (Sinica) concolor* Quadras & Möllendorff, 1893, and *D. (S.) filicostata* Möllendorff, 1893 (see Zilch 1953). In this paper, two new rock-dwelling diplommatinid species are described from Cagayan Province, which possess characteristic unusual shell characters, not known in any other genera of the family. Therefore, a new genus, *Luzonocoptis* gen. n. is erected for them.

Materials and methods

Determination of number of shell whorls (precision to 0.25 whorl) follows Kerney and Cameron (1979: 13). The radulae of two specimens were examined. Individual desiccated bodies were soaked in 2 M KOH solution overnight before extracting the radula, which was preserved in 70 % ethanol. Shells, operculae and radulae were directly observed without coating under a low vacuum SEM (Miniscope TM-1000, Hitachi High-Technologies, Tokyo). Measurements of the shell were taken as follows:

| | |
|------------------------|--|
| shell width | diameter of the penultimate whorl perpendicular to coiling axis; |
| shell height | length from apical tip to the edge of the basal section of the peristome parallel to coiling axis; |
| aperture height | length from upper palatal to basal section of peristome parallel to coiling axis. |

The mostly widely used terms were used in the descriptions, with the exception of the following: “post-constriction bay” refers to the widened area just anterior to operculum; “neck region” indicates the part of the body whorl on the opposite (“back”) side of the aperture.

Abbreviations

| | |
|-------------|--|
| D | shell diameter |
| H | shell height |
| HA | collection András Hunyadi (Budapest, Hungary) |
| HNHM | Hungarian Natural History Museum (Budapest, Hungary) |
| PGB | Collection Barna Páll-Gergely (Mosonmagyaróvár, Hungary) |

Systematic part

Diplommatinidae Pfeiffer, 1856

Genus *Luzonocoptis* Páll-Gergely & Hunyadi, gen. n.

<http://zoobank.org/A1561D65-F5BF-47B1-90B4-D10B9E913CF8>

Diagnosis. Shell sinistral; apex blunt, club-like; shell very slender with 14–18 whorls, rather regularly, finely ribbed; aperture round with a weak columellar lamella visible from standard apertural view; columellar lamella interrupted, its inner, short portion blunt thorn or tubercle-like, situated inside post-constriction bay; other inner plicae and lamellae absent; outer surface of operculum matt, smooth; inner surface with a very slightly elevated arcuate ridge; rachidian tooth with five cusps (central one blunt, larger than other four cusps), marginal teeth with four pointed cusps.

Differential diagnosis. *Luzonocoptis* gen. n. differs from *Palaina* Semper, 1865 (type species: *Diplommatina macgillivrayi* Pfeiffer, 1854) by the unique shell shape, the strongly expanded peristome, and most importantly, the presence of a columellar tooth, which continues to a strongly developed lamella (see Yamazaki et al. 2013 and Neubert and Bouchet 2013). The most similar diplommatinid genus in terms of shell characters is *Hungerfordia*. *Luzonocoptis* gen. n. differs from *Hungerfordia* by the presence of an interrupted columellar lamella, and the rachidian tooth, which possess five well-developed cusps. In contrast, the columellar lamella of *Hungerfordia* is not interrupted, and the rachidian tooth is simpler, with a single, or three cusps.

Etymology. The first part of the name derives from the name of the island (Luzon), where the included new species have been found. The second part (“-coptis”) refers to the similarity with Middle American urocotid taxa in terms of shell size, shape, colour and habitat. Gender feminine.

Type species. *Luzonocoptis antenna* sp. n.

Content. *Luzonocoptis antenna* sp. n. and *L. angulata* sp. n.

Distribution. This genus is known so far from northeastern Luzon Island. The distance between the type localities of the two species is approximately 34 km in a straight line.

***Luzonocoptis antenna* Páll-Gergely & Hunyadi, sp. n.**

<http://zoobank.org/842D519D-51D9-496F-9422-5806F625E234>

Figures 1A–H, 2A–F, H

Type material. Philippines, Luzon, Cagayan Province, 20 km south-southeast from Baggao, Barangay San Miguel, environment of the Duba Cave, limestone rock wall on the bank of the Pared River, 50 m, 17°49.967'N, 121°56.042'E, leg. Hunyadi, A., 07.01.2014., HNHM 99995 (holotype, H = 9.4 mm, D = 1.7 mm), HNHM 99997 (5 paratypes), HA/166 paratypes, PGB/3 paratypes.

Type locality. Philippines, Luzon, Cagayan Province, 20 km south-southeast from Baggao, Barangay San Miguel, environment of the Duba Cave, limestone rock wall on the bank of the Pared River, 50 m, 17°49.967'N, 121°56.042'E.

Diagnosis. A tall, yellowish, very slender diplommatinid with club-shaped apex, dense, low ribs on the last whorl, rounded lower whorls, strongly expanded and reflected peristome that is strongly oblique to the shell axis, and a weak interrupted columellar lamella.

Description of the shell (Figs 1A–H, 2F, H). Shell sinistral, tall, very slender; apex thickened; penultimate whorl wide, body whorl constricted, peristome strongly expanded; whorls 16.5–18; shell colour overall pale yellow or corneous, sometimes seemingly darker due to the desiccated body, subtranslucent; protoconch consists of approximately 1.25–1.5 whorls, finely pitted; first whorls of teleoconch conspicuously narrower than protoconch; teleoconch rather regularly, obliquely ribbed with fine spiral striation, which is most conspicuous on lower whorls; ribs straight on upper whorls but become more wavy on last whorl (especially near suture); upper whorls concave, slowly, rather regularly increasing; constriction deep, situated on penultimate whorl; last whorl conspicuously narrower than preceding whorl; lower whorls rounded; aperture strongly oblique to shell axis, rounded, with a weak columellar lamella visible from standard apertural view; columellar lamella low, interrupted, its inner, separate, blunt thorn-like part situated inside post-constriction bay (widened area just anterior to operculum); no other plicae or lamellae found; peristome overall strongly expanded and reflected; boundary between inner and outer peristome clearly visible due to sharp, usually reddish brown edge of inner peristome; outer peristome mostly responsible for expanded profile of peristome; upper, parietal part of peristome free from penultimate whorl; umbilicus absent.

Measurements. Shell height: 8.7–10.3 mm; shell width: 1.6–1.8 mm; aperture height: 2.2–2.7 mm (n = 6).

Operculum (Figs 2A–D). Corneous, flat (not concave); outer surface smooth, without any signs of whorls, but with a very thin matt layer; under matt layer glossy; inner surface overall rather smooth, with a very low arcuate ridge on one side, and a low central nipple, which is also visible from outside (because the operculum is semi-transparent).

Radula (Fig. 2E). Radula taenioglossate. Teeth arranged in v-shaped rows, each transverse row with seven teeth (2-1-1-1-2). Rachidian tooth strongly constricted in its

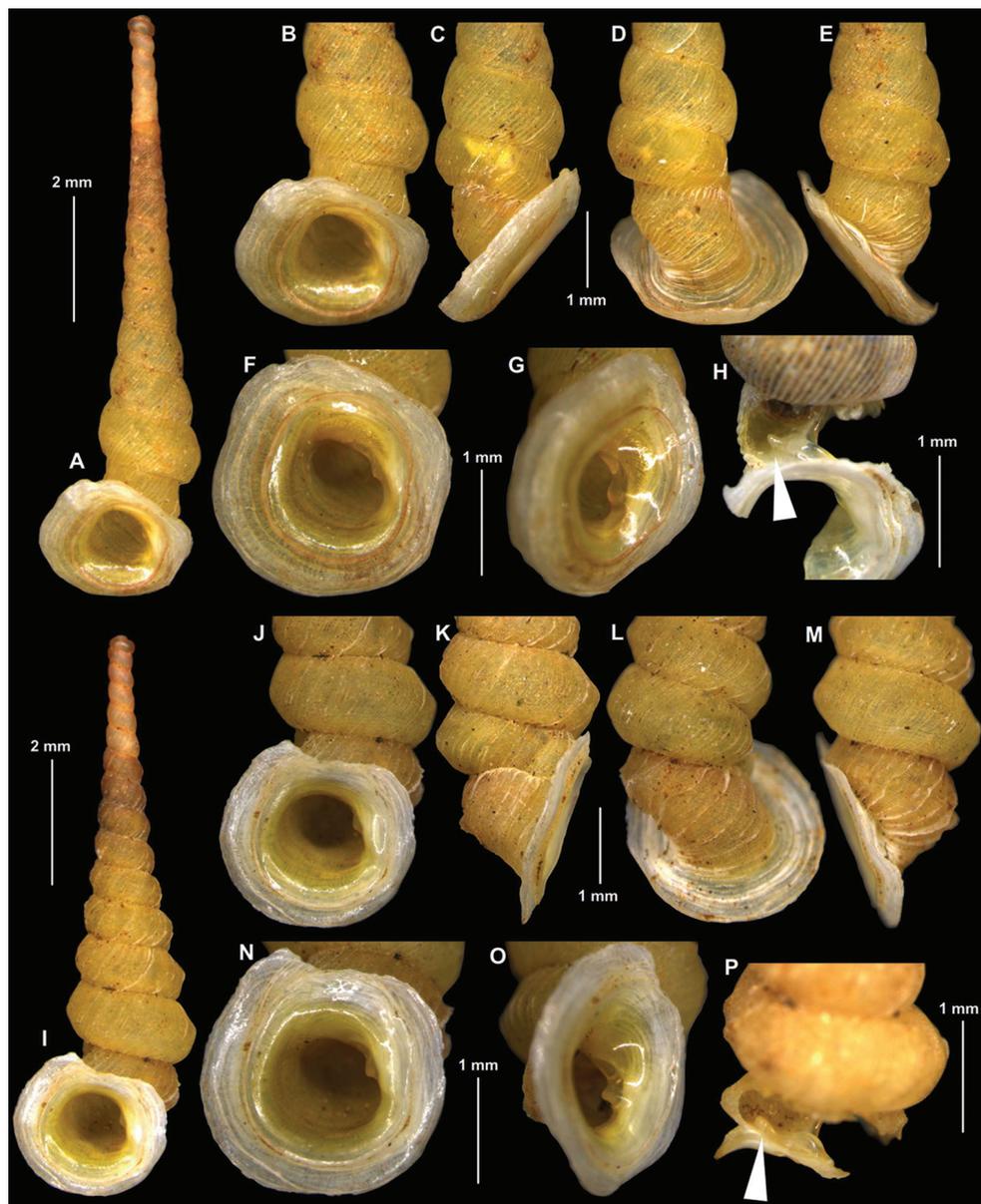


Figure 1. Shells of *Luzonocoptis* gen. n. species. **A–H** *Luzonocoptis antenna* sp. n. (**A–G** holotype HNHM 99995 **H** paratype HNHM 99997) **I–P** *Luzonocoptis angulata* sp. n. (**I–O** holotype HNHM 99996 **P** paratype HNHM 99998). Arrows indicate the inner, separate portion of the columellar lamella. All photos B. Páll-Gergely.

middle part, having five cusps (central cusp largest, blunt, other four cusps pointed); inner marginal and two outer marginal teeth have shallower constriction of plates, and are slightly longer and more slender than central tooth; inner marginal teeth with four

pointed cusps, third one (counting from the side of rachidian tooth) is largest; outer marginal teeth with four pointed cusps.

Etymology. The shell shape of this new species (wide aperture, very slender upper whorls, and a club-shaped apex) resembles a radio antenna. The specific epithet *antenna* to be used as a noun in apposition.

Habitat and distribution. Living specimens were found on a limestone rock wall. This species is known from the type locality only, which is situated ca. 34 km in a straight line from the type locality of *L. angulata* sp. n.

Comparisons. Most sinistral diplommatinids from the Philippines belong to the genera *Palaina* and *Diancta* Martens, 1867, and have conical, ovoid, or cylindrical shells. However, most *Diplommatina* species from the Philippines are dextral, and the very few sinistral species have much lower spire, and triangular or ovoid shell shape (Zilch 1953). The only similar species in the region is *Luzonocoptis angulata* sp. n., which differs from *L. antenna* sp. n. in the following traits: whorls fewer; lower whorls keeled; aperture less oblique to the shell axis; peristome much less reflected; constriction situated approx. half whorl anteriorly (behind the parietal part of the peristome); ribs more widely-spaced on the neck region; inner, separated part of the columellar lamella blunter.

***Luzonocoptis angulata* Páll-Gergely & Hunyadi, sp. n.**

<http://zoobank.org/CB277A41-0983-42BB-BA44-A5515DB37D1B>

Figures 1I–P, 2G, I

Type material. Philippines, Luzon, Cagayan Province, 10 km southeast from Gattaran, Barangay Naddungan, environment of the Ar-Aro Cave, rock wall facing east, 90 m, 18°4.477'N, 121°44.128'E, leg. Hunyadi, 08.01.2014. HNHM 99996 (holotype, H = 9.1 mm, D = 2.1 mm), HNHM 99998 (3 paratypes), HA/238 paratypes, PGB/3 paratypes.

Type locality. Philippines, Luzon, Cagayan Province, 10 km southeast from Gattaran, Barangay Naddungan, environment of the Ar-Aro Cave, rock wall facing east, 90 m, 18°4.477'N, 121°44.128'E.

Diagnosis. A tall, yellowish, moderately slender diplommatinid with club-shaped apex, widely spaced, sharp ribs on the last whorl, angled lower whorls, strongly expanded peristome that is slightly oblique to the shell axis, and a weak interrupted columellar lamella.

Description of the shell (Figs 1I–P, 2G, I). Shell sinistral, tall, very slender; apex thickened; penultimate whorl wide, body whorl constricted, peristome strongly expanded; whorls 14–15; shell colour overall pale yellow or corneous to light reddish, sometimes seemingly darker due to the desiccated body, subtranslucent; protoconch consists of approximately 1.25–1.5 whorls, finely pitted; first whorls of teleoconch conspicuously narrower than teleoconch; first whorls of teleoconch with low, irregular growth wrinkles, which gradually change to a scarcely, regularly ribbed surface; some

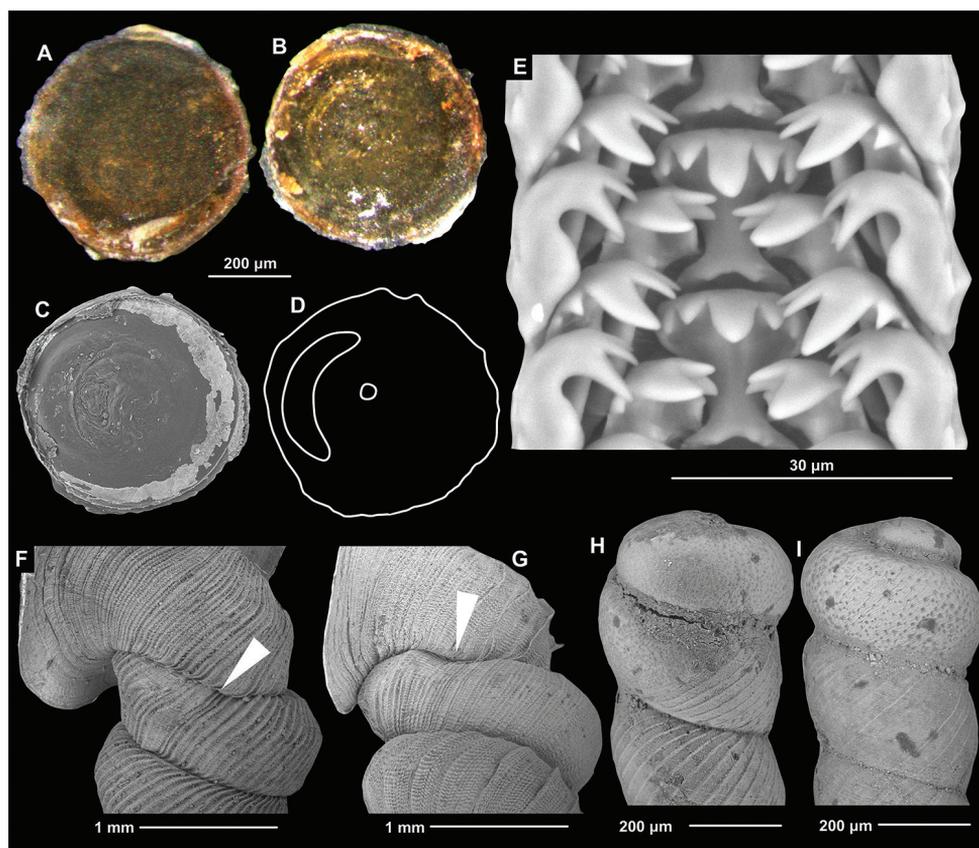


Figure 2. Shells, operculum and radula of *Luzonocoptis* gen. n. species. **A–F** *Luzonocoptis antenna* sp. n. **A** outer side of the operculum **B** inner surface of the operculum **C** SEM of the inner surface of the operculum **D** schematic drawing of the inner side, showing the slightly elevated ridge and the central nipple **E** radula (paratype no. 7.) **F** Neck region **G** Neck region of *Luzonocoptis angulata* sp. n. **H** protoconch of *Luzonocoptis antenna* sp. n. **I** protoconch of *Luzonocoptis angulata* sp. n. White arrow shows the constriction. All images B. Páll-Gergely.

weak spiral striation visible between ribs; ribs are strongest on last whorl, where they are sometimes lamella-like; upper whorls slightly concave or not concave, slowly, rather regularly increasing; constriction very deep, situated between penultimate and last whorl (just behind parietal part of peristome); deep constriction results in formation of a conspicuous post-constriction bay (widened area just anterior to operculum); last whorl conspicuously narrower than preceding whorl; lower 3–4 whorls slightly keeled at their middle; aperture moderately oblique to shell axis, rounded, with a weak columellar lamella visible from standard apertural view; columellar lamella low, interrupted; its inner, separate, elongated tubercle-like part situated inside post-constriction bay; no other plicae or lamellae found; peristome overall strongly expanded but varies from not reflected to slightly reflected; boundary between inner and outer peristome clearly visible due to sharp edge of inner peristome; outer peristome mostly responsible for ex-

panded profile of peristome; upper, parietal part of peristome is attached to penultimate whorl, although expanded part extends above penultimate whorl; umbilicus absent.

Measurements. Shell height: 7.8–9.3 mm; shell width: 1.8–2.1 mm; aperture height: 2.2–2.6 mm (n = 5).

Operculum. Unknown.

Etymology. The specific epithet *angulata* (Latin: angled) refers to the keeled lower whorls, which distinguishes this species from *L. antenna* sp. n.

Habitat and distribution. Empty shells were found at the base of a limestone rock wall. This species is known from the type locality only, which is situated ca. 34 km in a straight line from the type locality of *L. antenna* sp. n.

Comparisons. See under *Luzonocoptis antenna* sp. n.

Discussion

Although molecular phylogenetic studies involving numerous species were recently published (Webster et al. 2012, Liew et al. 2014), molecular information is still lacking on some important members of the family, such as the type species of *Diplommatina* from the southwestern Himalaya and the type species of several other genus-group taxa, mainly from oceanic islands. As a result, we still largely have to rely on morphology-based taxonomy of diplommatinid species. Placing the two new species described herein into any previously established genera would not be possible without strongly affecting the existing generic definitions (Páll-Gergely 2017). Therefore, from a typological perspective, a new genus, *Luzonocoptis* gen. n. must be introduced for them.

The two *Luzonocoptis* gen. n. species are similar to species of the Palawan endemic genus *Hungerfordia* (type species: *Hungerfordia pelewensis* Beddome, 1889) in the rock-dwelling lifestyle, the sinistral coiling direction, the absence of parietal and palatal plicae or lamellae, and the low arcuate ridge on the inner surface of the operculum (Yamazaki et al. 2013, 2015a, 2015b). Although the slender shell having numerous (14–18) whorls is unique to the two new *Luzonocoptis* gen. n. species, it is insufficient alone for genus-level distinction from the conchologically diverse *Hungerfordia*. However, the interrupted columellar lamella, and the rachidian tooth having five well-developed cusps justifies the distinction of the two new species from *Hungerfordia* species on the genus level.

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A new species of *Notodiaptomus* from the Amazon basin (Crustacea, Copepoda, Calanoida, Diaptomidae)

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Abstract

A new Diaptomidae species is presented from the Neotropical region. It was found in two Amazonian lakes, Ressaca and Arapujá, both in Pará State, Brazil. The lakes are 400 km apart and threatened by the building of reservoirs for hydropower generation and pollution by human settlements. The new species resembles *N. paraensis* Dussart & Robertson, 1984, but it can be distinguished from this species and other congeners in having a special process on the fifth leg basis of the male, by the place of insertion of lateral spine in the last segment of right P5 of male, the shape and relationship between length and width of segments of male and female P5 exopodite 2 with stout inner process bearing short setules and outer small spine, exopodite 3, with two terminal setae, outer smaller; endopodite 1-segmented with one subterminal seta and oblique comb of spinules, the presence of a line of dorsal spinules at the distal margin of thoracic somites in both sexes. A brief comparison with other *Notodiaptomus* species is presented in the discussion.

Keywords

Amazonian Region, Brazil, Neotropical, pollution, reservoirs, Tocantins River, Xingu River

Introduction

Among freshwater copepods, the family Diaptomidae is remarkable by its high endemism and high diversity. For example, no diaptomid species is shared between North and South America (Suárez-Morales et al. 2005; Perbiche-Neves et al. 2014). The endemicity of the South American species stands out for its high species richness, and is directly associated with the area of ecoregions (Perbiche-Neves et al. 2014).

Studies have been developed in Central and South America regarding biogeographic pattern and ecology as well as the description of new species (e.g. Paggi 2011, Perbiche-Neves et al. 2013), and the geographic distribution being constantly revised (Suárez-Morales et al. 2005; Santos-Silva 2008; Previattelli et al. 2013). There are also many problems concerning taxonomy of these organisms, such as the existence of synonyms and misidentifications. Despite of these advances, large portions of the continent are still poorly known, a situation that persists since first pointed out by Brandorff (1976), and reaffirmed by Santos-Silva (2013).

Moreover, the diversity of Diaptomidae is greatly biased by the concentrated investment of time of the researchers in certain areas, resulting in a distribution that has to do more with the distribution of the taxonomists than the true biogeographic patterns of the organisms (Previattelli et al. 2013). Even at present we still find new species in remote areas such as the Xingu and Tocantins river basins, nowadays the target of large reservoirs construction for hydropower generation. Other examples of gap areas in South America are reported in Perbiche-Neves et al. (2014).

The distribution of the species among Diaptomidae genera is uneven, with the genus *Notodiaptomus* Kiefer, 1936 being by far the most specious, with 39 of the 94 known species. Twenty-four of these species occur in Brazil (Santos-Silva 2008, 2013). During studies on two Amazonian lakes (Ressaca and Arapujá), located in Pará State, Brazil, a new species of *Notodiaptomus*, *Notodiaptomus nelsoni* sp. n., has been identified. The lakes are 400 km apart and threatened by building of reservoirs for hydropower generation and pollution by human settlements. A detailed description of a new species of *Notodiaptomus* is presented below.

Materials and methods

Samples were collected using plankton nets of 60 µm mesh size and preserved in 70% alcohol. Vouchers containing ten females and ten males were deposited at the Museu de Zoologia da Universidade de São Paulo (MZUSP) and at the Instituto Nacional de Pesquisas da Amazônia (INPA).

Males and females were dissected using mounted entomological pins, and the most important structures drawn using a microscope equipped with drawing tube. Lactophenol added with glycerine was used as a mounting medium for these temporary preparations on slides. The morphologic terminology employed was according to Huys and Boxshall (1991), Santos-Silva et al. (1999), and Previattelli and Santos-Silva (2007).

Abbreviations used

| | |
|----------------|-------------------------------|
| Th1–Th6 | thoracic somites 1 to 6 |
| Ur | Urosome somites |
| GS | Genital double somite |
| A1 | Antennule |
| A2 | Antenna |
| Md | Mandible |
| Mxl | Maxillule |
| Mx | Maxilla |
| Mxp | Maxilliped |
| P1–P4 | First to fourth swimming legs |
| P5 | Fifth leg |
| Enp | Endopod |
| Exp | Exopod |

Exp-1 (-2, -3) refer to the first, second and third segments of leg exopods. The abbreviation Enp-1 (-2, -3) refers to segments 1-3 of the leg endopods.

The previously called “vestigial seta” found in segments of the A1 is present and follows the same pattern as the other members of the genus. The term is not used since it is not clear whether it is a proper armature element (a reduced seta), as proposed by Santos-Silva et al. (1999).

Taxonomy

Family Diaptomidae Baird, 1850

Subfamily Diaptominae Kiefer, 1932

Genus *Notodiaptomus* Kiefer, 1936

***Notodiaptomus nelsoni* Previattelli, Perbiche-Neves & Rocha, sp. n.**

<http://zoobank.org/DE18F426-3DCE-4789-B8E7-3515F33AD6D2>

Figures 1–9

Material examined. *Holotype.* One male, entire, alcohol + glycerine (MZUSP30604), Arapujá Lake, 3°12'54"S, 52°11'28"W, Xingu River Basin, in front of Altamira, Pará State, 21 October 1997, Jansen Zuanon col. *Paratypes.* Ten males and ten females, entire, alcohol + glycerine (MZUSP30605), one male and one female dissected and mounted on slides in glycerine (MZUSP30606), Arapujá Lake, Xingu River, Altamira city, Pará State, 21 October 1997, Jansen Zuanon col. *Additional material.* Males, females and copepodids from Ressaca Lake, Tocantins River Basin, 5°11'36"S, 49°15'45"W, June 1983, Pedro Mera col.

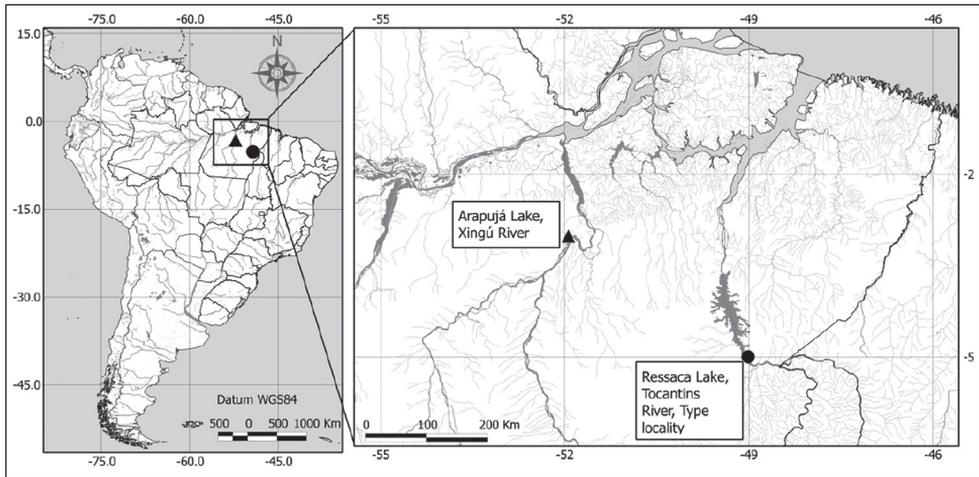


Figure 1. Study area with records of *Notodiptomus nelsoni* sp. n., at Arapujá Lake and Ressaca Lake.

Etymology. Named in honour of Dr. Edinaldo Nelson dos Santos Silva (Instituto Nacional de Pesquisas da Amazônia, INPA, Manaus, Brazil), for his invaluable contributions to taxonomy and ecology of the Diaptomidae.

Diagnosis. *Male* (Figures 2B, 10A). Length excluding caudal setae (mean \pm SD of ten specimens: 907 ± 60 μm from Ressaca Lake; 859 ± 18 μm from Arapujá Lake). Transverse, narrow nuchal organ ahead cephalic suture, with pair of small sensilla internally and another larger pair of sensilla adjacent to suture (Figure 2B). Rows of fine dorsal spinules along posterior margins of Th2 to Th6 (Figure 2B). Pair of lateral wings symmetrical, with curved row of spinules on each wing. First segment of left A1 with patch of spinules. Segment 13 of right geniculate antennule produced into well-developed, spinous process. Segments 15 and 16 with small process each. Pair of P5 asymmetrical, both with rudimentary, unarmed praecoxae and coxae bearing posterior conical process projecting over basis. Right P5 bearing outgrowth on posterior basal surface with deep oblique groove with minute tubercles along edge; semicircular lamella on inner margin of basis covered with fine setae; exopod 2-segmented, exp-1 with posterior distal margin produced into pair of conical outgrowths ending as blunt tip; Exp-2 with lateral outer spine basally placed at the distal third and terminal claw strong and curved in two planes. Right P5 endopod one-segmented partially fused to the basis, anteriorly.

Female (Figure 2A). Length excluding caudal setae (mean of ten specimens: $1,063 \pm 35$ μm from Ressaca Lake; 933 ± 31 μm from Arapujá Lake). Rows of dorsal spinules along posterior margins of Th2 to Th6 (Figure 2A, C). Posterolateral wings of Th5 asymmetrical; left wing produced into a semicircular expansion with sensilla at tip. GS slightly asymmetrical. Left spiniform sensilla with bifid apex (Figure 2A, C). P5 with fused intercoxal plate, making legs be closely placed. Dorsal expansions of coxa symmetrical and less than $\frac{1}{4}$ of segment; strong spiniform sensilla at apex of expansions. Lateral seta of basis reaching from half and $\frac{2}{3}$ of length of Exp1; Exp three-

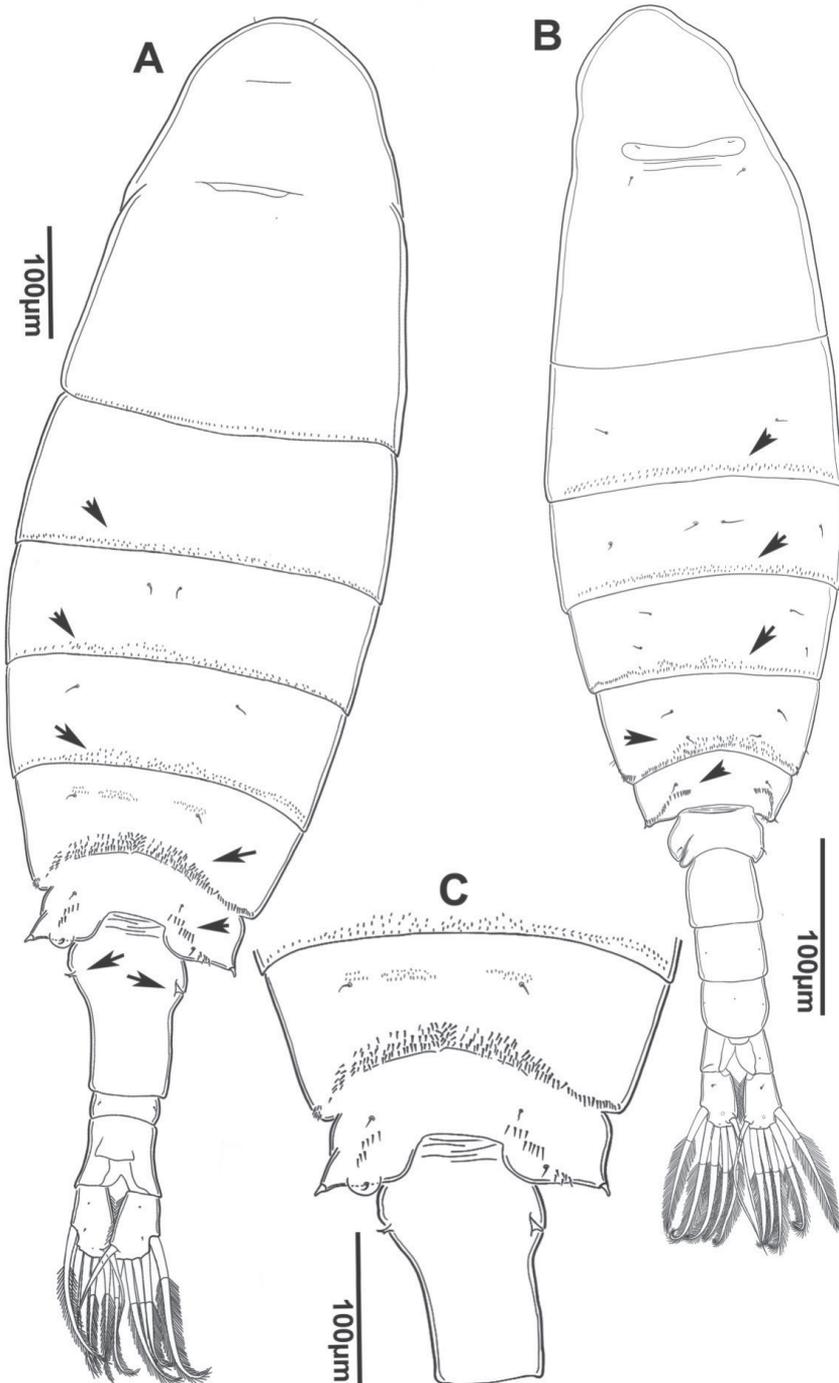


Figure 2. *Notodiaptomus nelsoni* sp. n. **A** Habitus of female, dorsal **B** Habitus of male, dorsal **C** Detail of last pedigerous somites and genital double somite in female, dorsal. Arrows points lines of spinules on dorsal surface and sensilla at GS.

segmented, Exp 1 unarmed, Exp2 with stout inner process bearing short setules and outer small spine, not fused to segment. Exp3 reduced, with two unequal spines, the outer smallest and reaching more than 1/2 length of inner spine. Enp one-segmented, with no sutures; length reaching 2/3 of Exp1 at least (Figure 9D, E).

Description - male (Figure 2B). Length of holotype, excluding caudal setae, 1,075 μm .

Prosome. Male shorter than female. Maximum width of prosome (275 μm) at Th1. Rostrum asymmetrical (Figure 8E). Cephalosome with nuchal organ just anterior to suture level; two pairs of sensilla next to lateral borders. Prosome 5-segmented. Th5 and Th6 fused, with suture line represented by rows of spinules (Fig. 2B). Lateral wings little developed, each with small spiniform sensilla at apex, similar in size and shape to spinules composing a dorsal row (Figure 2B).

Urosome (Figures 2B, 10A). Consisting of four somites plus anal segment, genital somite asymmetrical, with left genital aperture at the middle portion; pair of sensilla at similar regions on both sides of the segment. Ur1 to 3 longer than wide, with small pores laterally; small anal operculum at Ur4.

Caudal rami (Figure 2B). Symmetrical, longer than wide, with six plumose setae at posterior portion; innermost setae slender and smooth; two dorsal sensilla and setules along inner margin.

Antennules (Figures 3A, B, 4A–C). Asymmetrical, extending beyond prosome but not extending past the distal portion of the Ur3. Ancestral segments II–IV, XXI–XXII, XXIV–XXV and XXVII–XXVIII completely fused. Tip of setae on segments 3 (V), 7 (IX), 9 (XI) and 14 (XVI) blunt.

Right antennule (Figures 3A, 4A–C). Composed by 22 segments; fusion pattern and armature presented in Table 1. Sensilla present at segments 2 (III), 3 (V), and 5 (VII). Conical seta of segment 8 (X) longer and more robust than the one at segment 12 (XIV). Modified seta on segment 10 1/3 smaller than modified seta on segment 11. Seta-like aesthetasc present at segments 17 and 18 (XIX, XX). Tips of large setae on segments 3, 7, 9 and 14 blunt. Segment 19 with one very long and one short setae. Modified seta forming strong process on segment 13. Segments 15 and 16 with small spinous process.

Left antennule (Figure 3B). 25-segmented; armature of segments presented in Table 1. Tips of large setae on segments 3, 7, 9 and 14 blunt, as in right antennule. Seta inserted ventrally on segment 24 (XXVI).

Antenna (Figure 5A). Biramous; coxa presenting one inner seta. Basis with two setae inserted posteriorly. Exopod 8-segmented; second (II–IV) and penultimate (IX–X) segments compounded with regions of discontinuous cuticle surface; penultimate segment elongated; distal segment small, with three long, apical setae. Endopod 2-segmented; outer margin of first segment ornamented with one patch of spinules (approx. 15); inner margin with two setae and pore between patch of spinules and setae; second segment bilobed, with groove between lobes; outer lobe with seven (eight visible on Fig. 5A) marginal setae and one group of spinules on dorsal/outer margin; inner lobe with eight distal setae.

Mandible (Figure 5B, C, D). Gnathobase strongly sclerotized; gnathal blade with six multicuspid teeth and distal sub-triangular tooth. Basis with inner seta. Mandibu-

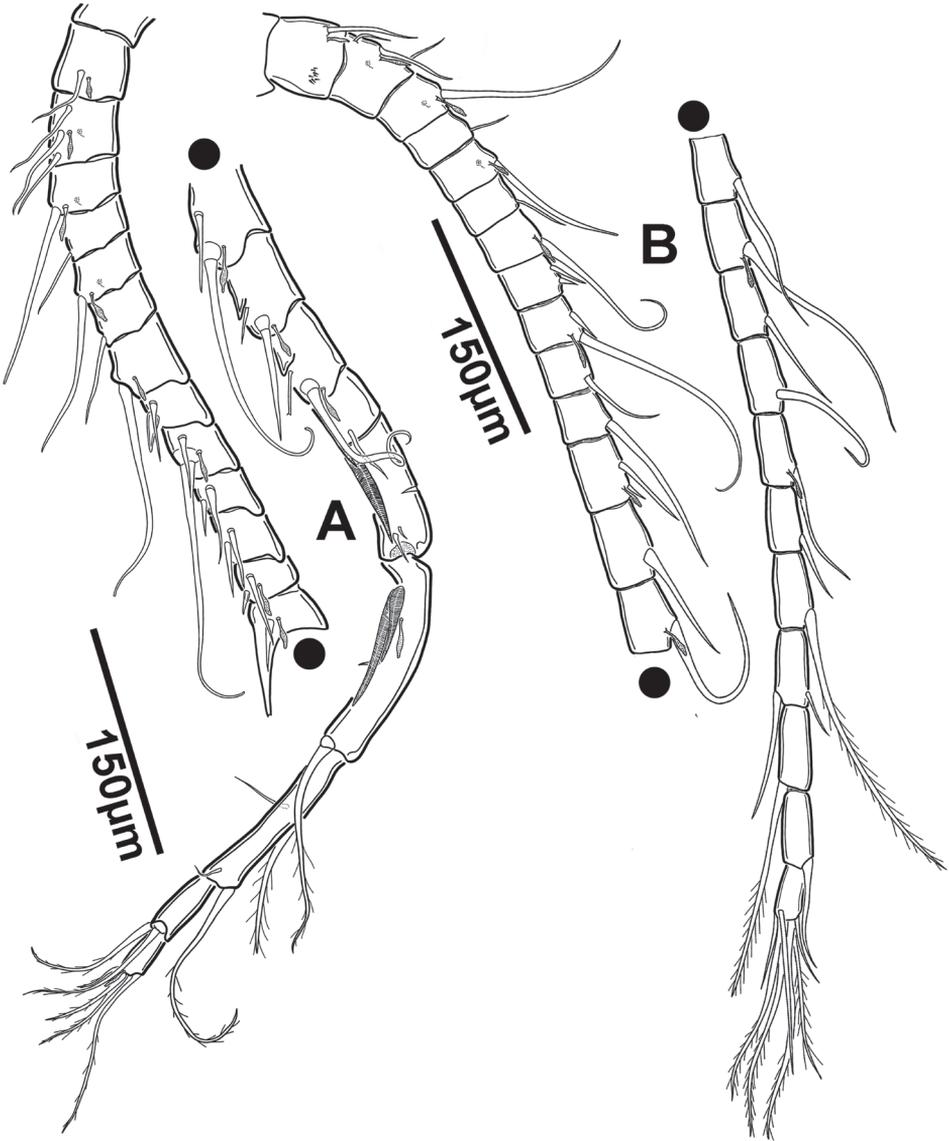


Figure 3. *Notodiaptomus nelsoni* sp. n. **A** Right geniculate antennule of male **B** Left antennule of male.

lar palp biramous. Basis of the palp with four inner setae (three distal). Exp with four segments, setal formula 1, 1, 1, 3. Enp 2-segmented; first segment with distal lobe bearing four setae; second segment with nine distal setae and three rows of spinules on posterior margin.

Maxillule (Figures 6B, 7A). Coxal epipodite with nine setae and row of spinules on distal surface. Coxal endite with four distal setae. Outer seta representing basal exite present; four setae on proximal basal endite, distal basal endite with four setae. Endo-

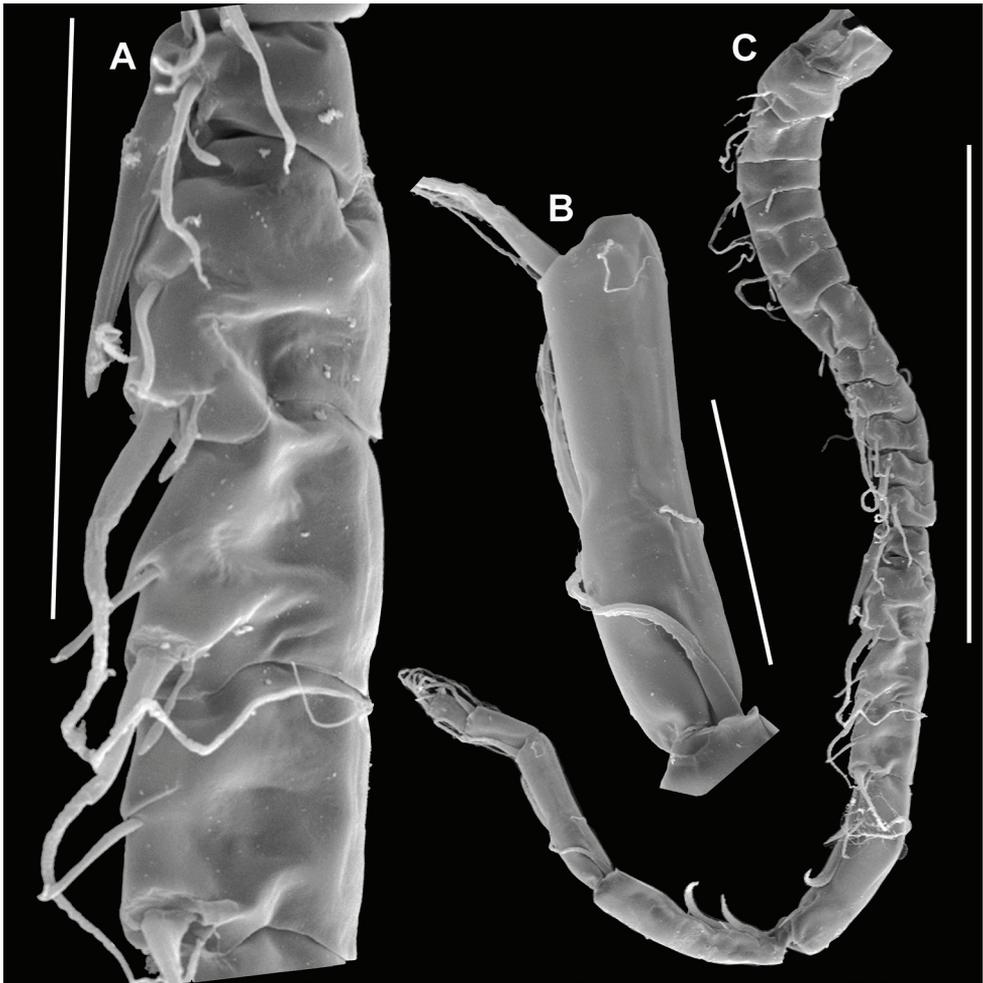


Figure 4. *Notodiaptomus nelsoni* sp. n. male. **A** Right geniculate A1, segments 13–16 (100 μ m), arrow point the spinous process at segment 13 of antennule **B** Right geniculate A1, segment 20 (50 μ m) **C** Complete right geniculate A1 (300 μ m).

pod two-segmented; with three setae on margin of proximal segment, and five distal setae on second segment. Exopod with six distal setae.

Maxilla (Figure 6A). Proximal praecoxal endite with five setae and one spine (setules present on these setae but not figured here); distal praecoxal endite with three setae: proximal and distal coxal endites each with three setae; allobasis with four setae; free endopod with five setae in total.

Maxilliped (Figures 6C, D). First syncoxal endite represented by one seta with row of spinules at base; second to fourth syncoxal endites from proximal to distal with 2, 3, 3 setae, distal angle of syncoxa extended into lobe with row of small spinules; basis with three setae, double row of setules proximally; endopod six-segmented, with 2, 3, 2, 2, 1+1, 4 setae.

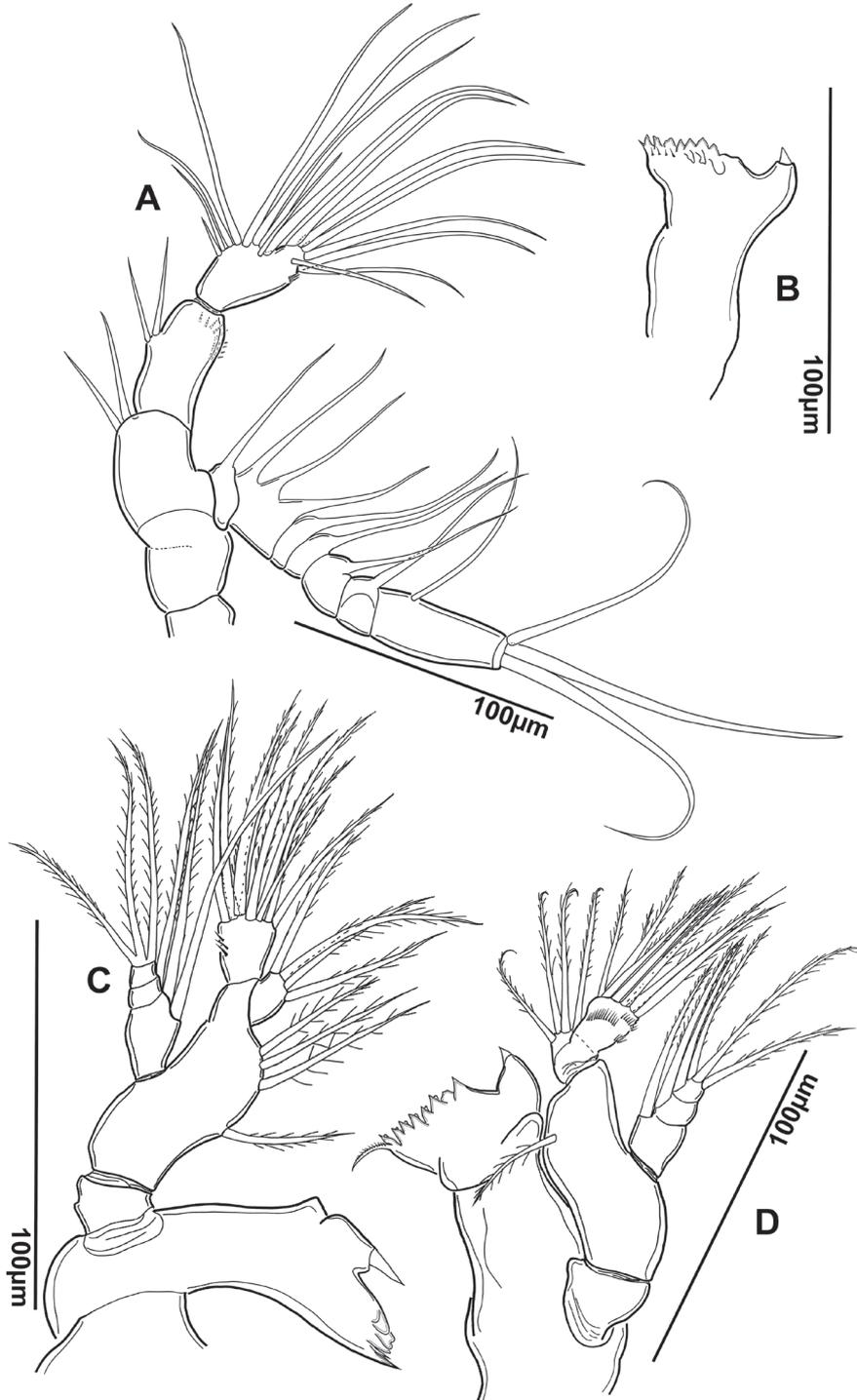


Figure 5. *Notodiaptomus nelsoni* sp. n. male. **A** Right antenna **B** Coxal gnathobase of right mandible **C** Mandible, ventral view **D** Mandible, dorsal view.

Table 1. Segmentation and armament of the antennules in both adult male and female of *Notodiptomus nelsoni* sp. n. A, ancestral segments according to Huys and Boxshall (1991); ae, aesthetasc; ms, modified seta; N, segments in adults; p, process; s, seta; vs, vestigial seta.

| A | N | Male right antennule | N | Male left antennule | Female antennules |
|--------|----|----------------------|----|---------------------|-------------------|
| I | 1 | 1s + 1ae | 1 | 1s + 1ae | 1s + 1ae |
| II | 2 | 3s + 1ae | 2 | 3s + 1ae | 3s + 1ae + 1vs |
| III | | | | | |
| IV | | | | | |
| V | 3 | 1s + 1ae | 3 | 1s + 1ae | 1s + 1ae + 1vs |
| VI | 4 | 1s | 4 | 1s | 1s |
| VII | 5 | 1s + 1ae | 5 | 1s + 1ae | 1s + 1ae + 1vs |
| VIII | 6 | 1s | 6 | 1s | 1s |
| IX | 7 | 1s + 1ae | 7 | 1s + 1ae | 1s + 1ae |
| X | 8 | 1s + 1cs | 8 | 1s + 1cs | 1s + 1cs |
| XI | 9 | 2s + 1ae | 9 | 2s + 1ae | 2s + 1ae |
| XII | 10 | 1s + 1ms | 10 | 1s | 1s |
| XIII | 11 | 1s + 1ms | 11 | 1s | 1s |
| XIV | 12 | 1s + 1ae + 1cs | 12 | 1s + 1ae + 1cs | 1s + 1ae + 1cs |
| XV | 13 | 1s + 1ae + 1ms | 13 | 1s | 1s |
| XVI | 14 | 2s + 1ae | 14 | 1s + 1ae | 1s + 1ae |
| XVII | 15 | 2s + 1ae + 1p | 15 | 1s | 1s |
| XVIII | 16 | 2s + 1ae + 1p | 16 | 1s + 1ae | 1s + 1ae |
| XIX | 17 | 2s + 1ms | 17 | 1s | 1s |
| XX | 18 | 1s + 1ms | 18 | 1s | 1s |
| XXI | 19 | 2s + 1ae + 2ms | 19 | 1s + 1ae | 1s + 1ae |
| XXII | | | 20 | 1s | 1s |
| XXIII | | | 21 | 1s | 1s |
| XXIV | 20 | 4s | 22 | 2s | 2s |
| XXV | | | 23 | 2s | 2s |
| XXVI | 21 | 2s | 24 | 2s | 2s |
| XXVII | 22 | 4s + 1ae | 25 | 4s + 1ae | 4s + 1ae |
| XXVIII | | | | | |

P1 (Figure 7A). Coxa with inner seta inserted distally, adjacent to a small round expansion ornamented with setules; outer margin bearing one patch of setules and one line of spinules. Basis with setules line at outer margin. Exp 3-segmented; setules along inner margin of the first segment, and outer margin of the second and third segments. Exp-3 spine with serrate margin at external side, and internal surface of Exp-3 without line of spinules. Enp 2-segmented; setules present along all outer margins.

P2 (Figures 7B–D, 8B, C). Coxa with inner seta inserted distally. Posterior surface ornamented with a patch of spinules. Basis with no setal element or ornaments. Exp 3-segmented, with one outer spine each; setules along inner margin of the first, inner and outer of the second segment. Anterior surface of Exp-3 with distal row of

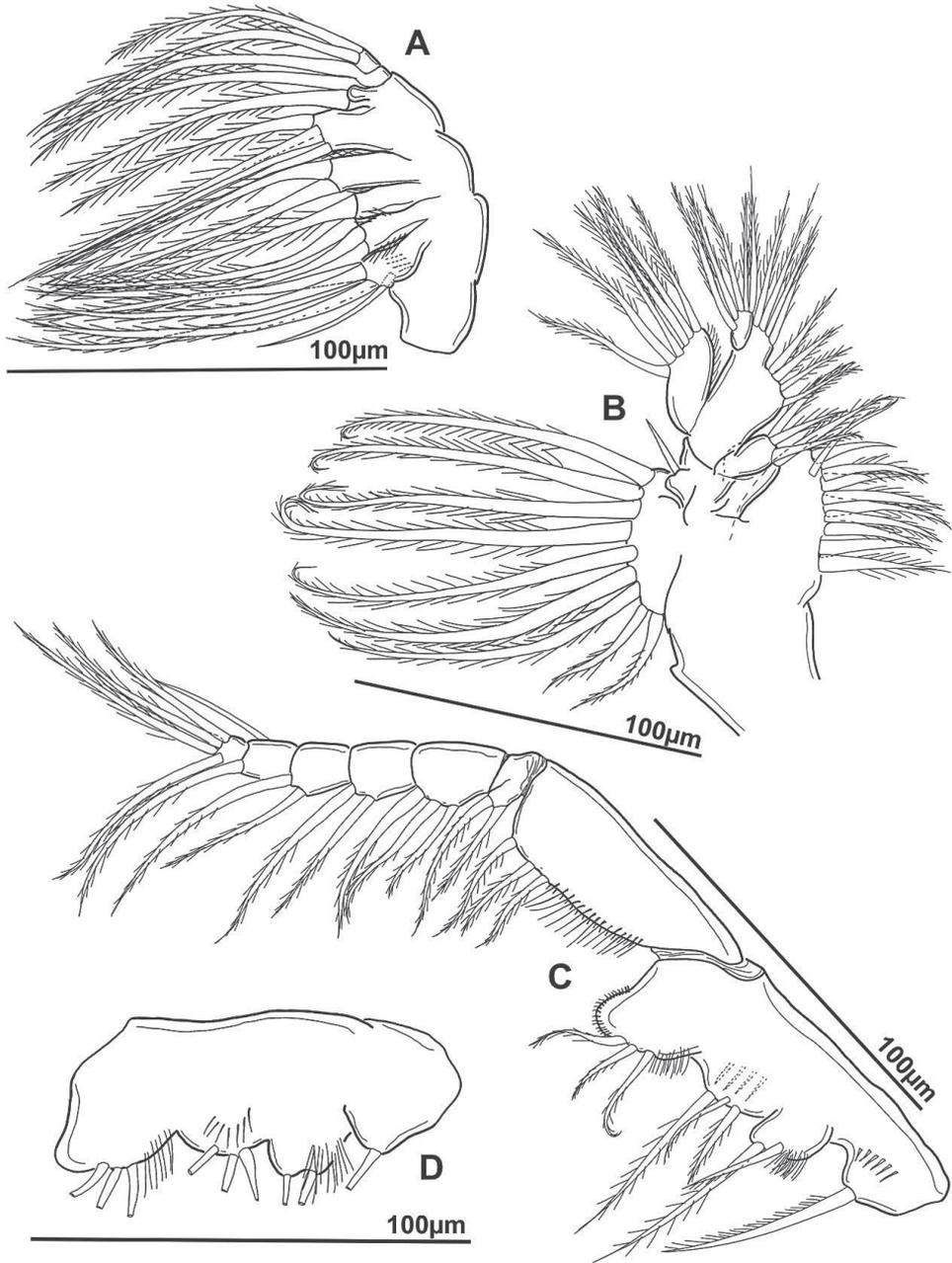


Figure 6. *Notodiaptomus nelsoni* sp. n. male, mouth parts. **A** Left maxilla **B** Maxillule **C** Frontal view of maxilliped **D** Caudal view of maxilliped.

spinules. Enp 3-segmented. Schmeil's organ present on posterior surface of segment 2. Setules along outer margin of all segments. Enp-3 anterior surface with two distal rows of spinules.

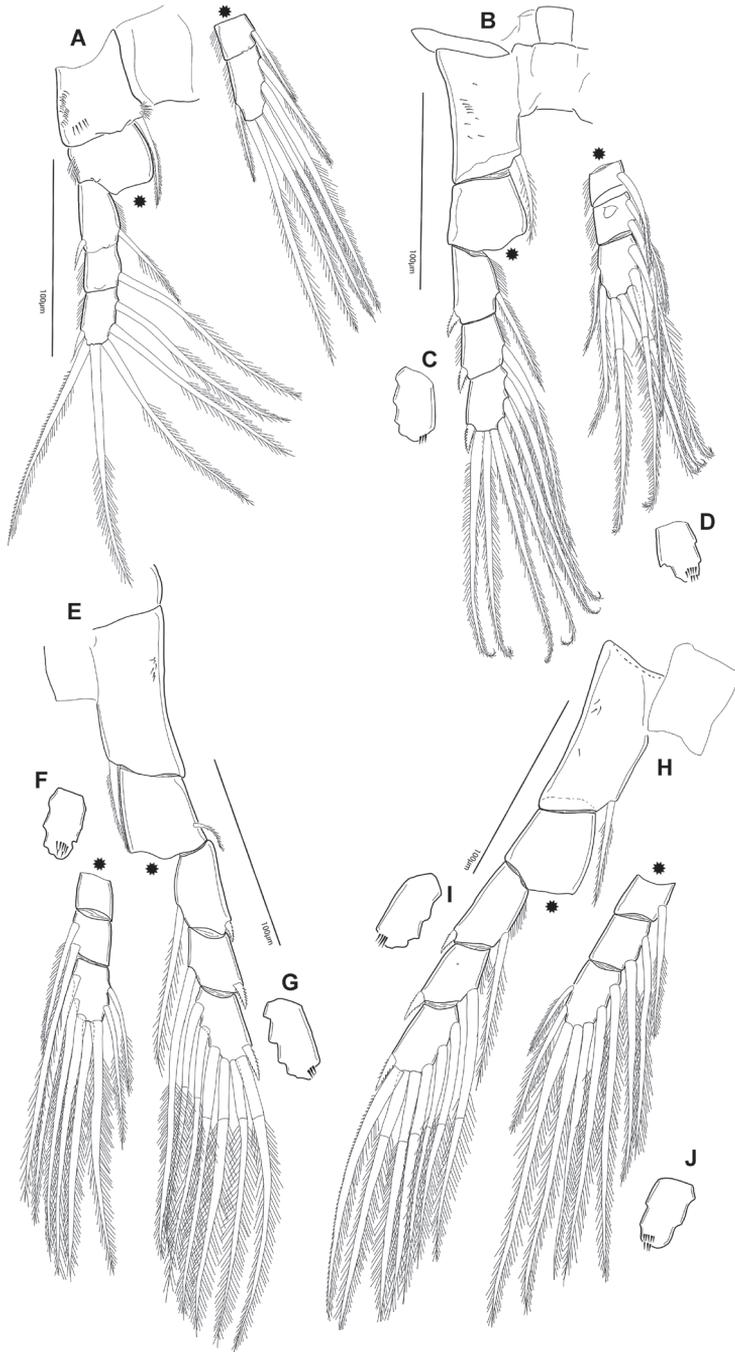


Figure 7. *Notodiptomus nelsoni* sp. n. Male **A** P1, anterior view **B** P2 **C, D.** Detail of caudal view of last segment of exopodite (**C**) and endopodite (**D**) of P2 **E** P3 **F, G** Detail of caudal view of last segment of endopodite (**F**) and exopodite (**G**) of P3 **H** P4 **I, J** Detail in caudal view of last segment of exopodite (**I**) and endopodite (**J**).

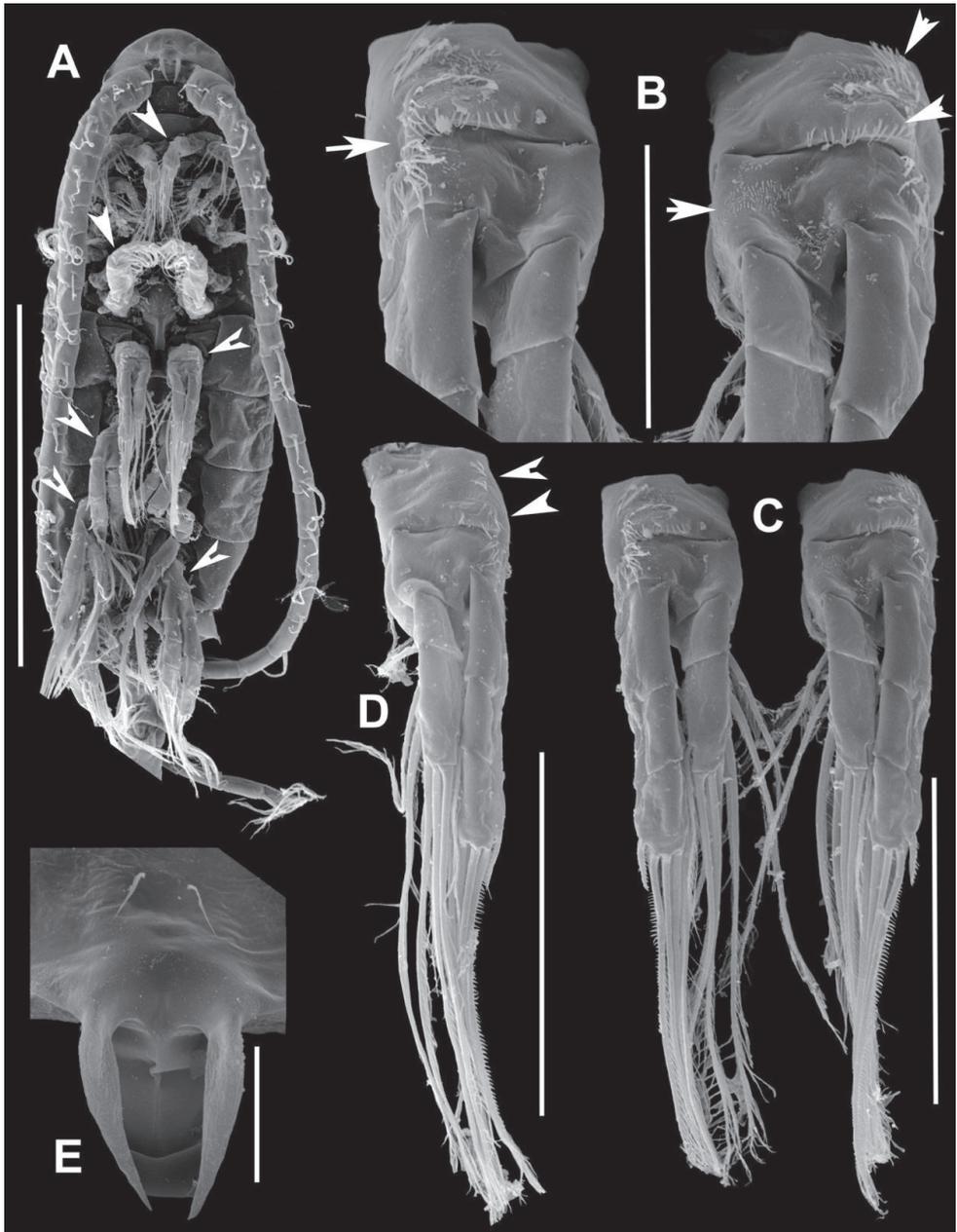


Figure 8. *Notodiaptomus nelsoni* sp. n. male. **A** Habitus, ventral view (400 μm), arrows point to antenna, maxilliped, P1, P2, P3, P4 **B** Frontal view with detail of coxa and basis of P2 (50 μm), arrows point to small patches of spinules **C** P2 (100 μm), arrows point to small patches of spinules **D** Frontal view of left P4 (100 μm), arrows point to small patches of spinules **E** Detail of rostrum filaments (20 μm).

Table 2. Setae and spine formula for swimming legs of *Notodiptomus nelsoni* sp. n.

| | Coxa | Basis | Exopod | Endopod |
|----|------|-------|-----------------|-----------------|
| P1 | 0-1 | 0-0 | I-1; 0-1; I,I,4 | 0-1; 1,2,3 |
| P2 | 0-1 | 0-0 | I-1; I-1; I,I,5 | 0-1; 0-2; 2,2,3 |
| P3 | 0-1 | 0-0 | I-1; I-1; I,I,5 | 0-1; 0-2; 2,2,3 |
| P4 | 0-1 | 1-0 | I-1; I-1; I,I,5 | 0-1; 0-2; 2,2,3 |

P3 (Figure 7E, F, G). Coxa with inner seta inserted distally. Posterior surface ornamented with small spinules patch. Basis with no setal element or ornaments. Exp with setules along inner margin of the first and second segments. Anterior surface of Enp-3 with one line of spinules at distal part. Remaining characters like P2.

P4 (Figures 7H–J, 8D). Coxa with inner seta inserted distally. Posterior surface ornamented with small patch of spinules. Basis with one seta inserted at the posterior/outer margin. Exp without setules along inner or outer margins. Anterior surface of Exp-3 and Enp-3 with one and two lines of spinules at distal part, respectively. Armature formula of all legs represented in Table 2.

P5 (Figures 9A–C, 10). P5 asymmetrical and biramous; rudimentary praecoxa present; intercoxal plate (coupler) longer than wide.

Right P5 (Figures 9A–C, 10A). Coxa with conical process projecting over basis with spiniform sensilla acute at tip (Figure 7C). Basis with lateral seta inserted at distal part. Outgrowth on posterior basal surface with deep oblique groove ornamented with minute tubercles along edge, Enp one-segmented, as endopodal lobe with comb of spinules on inner anterior surface. Exopod 2-segmented; first segment with acute sclerotized outgrowth on distal margin, posteriorly; second segment with curved ridge on posterior surface, lateral spine on distal third of segment; terminal claw strong and curved proximally, with row of spinules along inner margin. Endopodal lobe with comb of spinules on inner anterior surface.

Left P5 (Figures 9A–C, 10). Well developed, reaching distal margin of right Exp-1. Coxa with conical process projecting over basis with spiniform sensilla at tip, very similar to the one at right. Basis with seta on outer margin; inner margin slightly curved; Exopod bisegmented. Exp-1 with convex outer margin; inner margin with rounded process bearing setules. Exp-2 with semicircular process bearing setules proximally on inner margin, inner small spine and apical spiny process.

Description – female (Figure 2A). Length, excluding caudal setae 1,670 μm . Maximum width at distal margin of the Th1, with 510 μm . Body larger than male. Prosome. Rostrum symmetrical, with paired filaments, right broader in mid part than left. Prosome with incomplete dorsal suture separating Th5 and Th6, suture marked by spinules dorsally and laterally. Posterolateral wings of Th6 small and slightly asymmetrical; left wing slightly larger than right and with semicircular shaped protrusion on distal margin; right wing elongate; both lateral wings with spiniform sensilla (Figure 2A, C).

Urosome (Figure 2A, C). Ur3-segmented; GS inflated anteriorly and nearly symmetrical, longer than all the other somites combined; anal segment with weakly de-

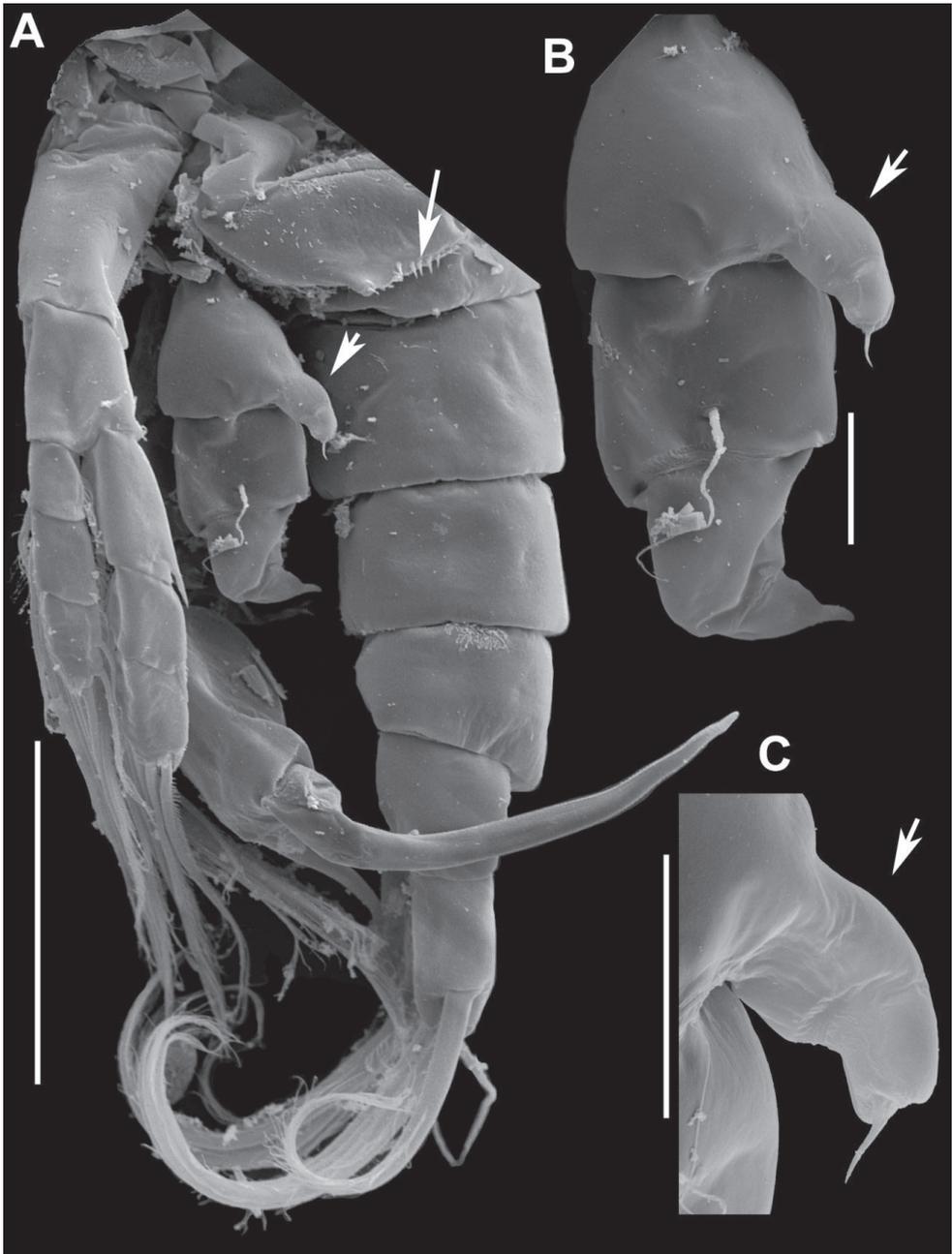


Figure 9. *Notodiaptomus nelsoni* sp. n. male. **A** P4, P5, and Ur (100 µm), arrow points to the line of spinules on the distal margin of pediger 5, to the process at the basis of left P5, and to the exopodite 2 of right P5 **B** Left P5 (20 µm), arrow points to the expansion in the basis of left P5 **C** Detail of the conical process in the basis of left P5 (20 µm), arrow points to the expansion in the basis of left P5.

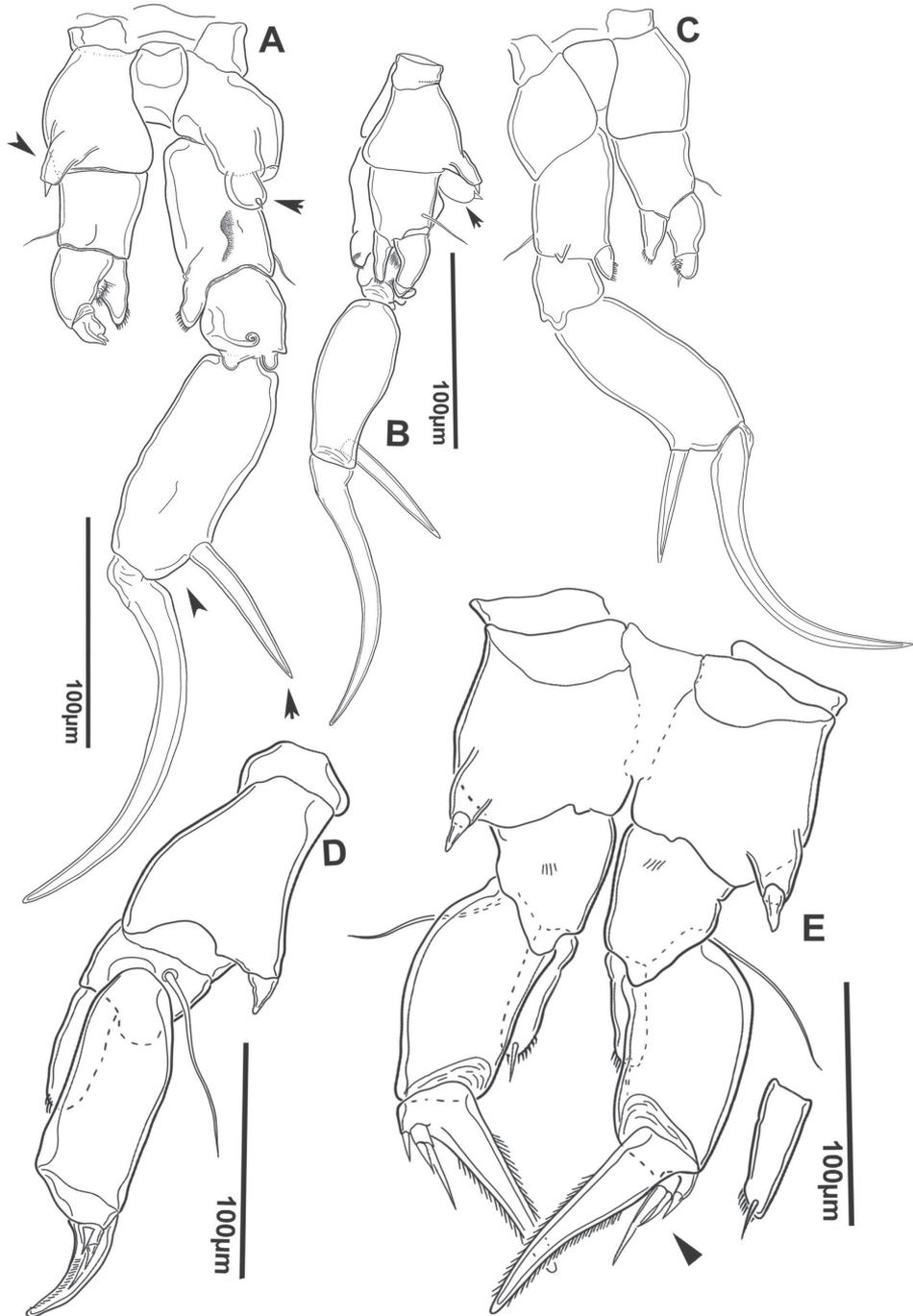


Figure 10. *Notodiaptomus nelsoni* sp. n. **A, B** Fifth leg (P5) of male, caudal (**A**) and in a lateral view (**B**), arrows point to process expansion at basis in left and right P5, and the short distance between lateral spine and terminal claw **C** P5 of male in anterior view **D** P5 of female in latero-caudal view **E** P5 of female in anterior view, arrow points to the external seta of exopodite 2.

veloped operculum; caudal rami symmetrical with setules along inner margin; genital area, located centrally with prominent lateral processes on opercular pad.

A1. Symmetrical, 25-segmented; similar to left *A1* of male (Figure 3B); extending beyond half of the *GS*.

P5 (Figure 9D, E). Symmetrical, coxa with conical process with sensilla at tip, basis subtriangular with long seta reaching beyond half of *Exp-1* and bearing a small row of setules on anterior surface (Figure 9E). *Exp-1* larger than second, *Exp2* with stout terminal claw with denticles along lateral margins bearing short setules and outer small spine, not fused to segment. *Exp-3* with two terminal setae, lateral smaller; *enp 1*-segmented with two setae and oblique comb of spines sub terminally on anterior surface. Number of armature elements as in Table 2.

Discussion

The new species shares homologies with the genus *Notodiaptomus* and fits well the generic characters as presented by Santos-Silva et al. (1999). It is close to *Notodiaptomus paraensis* Dussart & Robertson, 1984, from which it differs by the presence of dorsal rows of spinules at the distal border of all prosomites in male (Fig. 2A, B), by the size of the conical process at the distal margin of the coxa in the male right and left *P5* (Fig. 9A, B,C), in female, the position of the lateral setules on *GS* (Figure 2A), as well as the shape and element configuration of the *P5* exopodite 2 (Figure 9D, E). A more detailed comparison between these two species composes Table 3 that compiles morphological characters found, in which the new species is compared to the original description of *N. paraensis* (Dussart & Robertson, 1984) and the re-description from Santos-Silva et al. (1989).

The new species also differs of other species from the *Notodiaptomus* genus sensu Santos-Silva (1999). Particularly, compared to the type, *Notodiaptomus deitersi* (Poppe, 1891), the new species differs by the segments 2 and 3 of male geniculate antennule, by the presence of dorsal spinules on thoracic somites, in the length proportions between lateral spine and terminal claw of male right *P5*, the length of the seta of the coxa of the female *P5*, etc. Compared to *Notodiaptomus henseni* (Dahl, 1894), this last seems longer than the new species, and about the structures they are different in the shape of lateral projections of genital segment of female, the length of lateral spine of right *P5* of male. Compared to *Notodiaptomus amazonicus* (Wright, 1935), this species doesn't have lines of spinules at dorsal surfaces of thoracic somites, both male and female are longer, the shape of genital segment of female differs from the new species, *P5* right male of *N. amazonicus* have a notch at basis inner margin. Finally, our new species is also different from *Notodiaptomus nordestinus* (Wright, 1935) regarding the male and female *P5* basis with small spinules in the inner margin and in coxa, as well as the dorsal surface of the thoracic somites.

The description of this new species increases the number of valid species of the genus according to Santos-Silva (2008) to 40. Phylogenetic studies are necessary to clarify relationships and rearrangements in the genus *Notodiaptomus*. Currently it is

Table 3. Comparison between differential characters between *N. nelsoni* sp. n. and *N. paraensis*, based on Dussart and Robertson (1984) and Santos-Silva et al. (1989).

| Structures | <i>N. nelsoni</i> sp. n. | <i>N. paraensis</i> |
|--|--|--|
| Male | | |
| Rostrum filaments | Filaments length at least three times longer than the width of the basis of these filaments | Filaments length no more than three times the width of the basis |
| Dorsal spinules at distal margin of thoracic somites | Multiple fine lines at distal margin | Without dorsal spinules |
| Last segment of right antennule | Without any process | With falciform process |
| Right P5 | Well-developed (1.8 times longer than broad) projection at distal margin of coxa | Small projection at distal margin of coxa |
| Right P5 | Lateral spine inserted at the distal third of Exp2 | Lateral spine inserted at the middle of Exp2 |
| Right P5 | Exp2 up to two times longer than wide | Exp2 less to two times longer than wide |
| Left P5 | Well-developed (1.7 times longer than broad) projection at distal margin of coxa | Small projection at distal margin of coxa |
| Left P5 | Short sensilla at the top of projection at the distal margin of coxa, until three times longer than the width of the basis of this sensilla. | Longer sensilla at the top of projection at the distal margin of coxa, up to four times longer than the width of the basis of this sensilla. |
| Female | | |
| Double genital segment | Lateral sensilla in the same position in a dorsal view. | Lateral sensilla in different positions on a dorsal view, right one located more anteriorly than left one. |
| Dorsal spinules at distal margin of thoracic somites | Multiple fine lines at distal margin | Without dorsal spinules |
| P5 Exp2 | Two times longer than broad, short lateral seta, less than ¼ of the length of the segment of Exp3 | 1,5 times longer than broad, long lateral setae, reaching 2/3 of the length of Exp3 |

considered as an artificial and problematic one (Santos-Silva 2013), and a new phylogeny combining morphological and molecular characters should probably reduce the number of valid species in this genus.

The Amazon basin is the richest area in the Neotropical region concerning the presence of diaptomid species, due in large part to its area extension (Perbiche-Neves et al. 2014). It is expected that some new species will be described from this region, as well as in other large river basins in this zoogeographical area. Large tributaries of Amazonas River have high potential to contain new species, as often mentioned in the literature.

During the period in which the samples were obtained (1983 and 1997) until today, many changes have already occurred in some of the large tributaries of Amazonas River. Especially, we refer to the intense activities of deforestation (agriculture and livestock), and the construction of large reservoirs for hydropower generation. The new species was found in old samples collected before the intense human activity, and

their presence today in the same places is not known, but its probable absence might indicate how strong such interference has been.

The results also emphasize the need of intense research in other rivers threatened by the already mentioned activities, such as the rivers Teles Pires, Tapajós, and Madeira, in Brazil, as well as in other countries of the Amazon basin, such as Peru, Ecuador, Colombia, Venezuela, etc.

Acknowledgements

We would like to thank to Dr. Edinaldo Nelson dos Santos Silva (INPA, Brazil), Dr. Danielle Defaye, and the anonymous referees for very valuable suggestions in preliminary versions of this paper.

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The collection of Bathynellacea specimens of MNCN (CSIC) Madrid: microscope slices and DNA extract

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Resource Citation: Collection of Ana I. Camacho, Museo Nacional de Ciencias Naturales. **Contributions:** The main collectors are J. Notenboom & I. Meijers, R. Rouch, A.I. Camacho (AIC) especially C. Puch and speleologist F. Molinero and A.M. de Juan, J. Robador and F. Lázaro members of G.E. Edelweiss, plus some particular donations by other Spanish researchers: E. Ortiz, D. Jaume, A. Tinaut, J. Rodríguez, A. García-Valdecasas, P. Rodríguez, E. Bello, C. Noreña, P. Martínez-Arbizu, J. Comas, L. Barrera, F. Mezquita and C. Prieto and other foreign researchers: E. Serban, N. Coineau, C. Boutin, C. Bou, L. Knight, J. Mathieu, M-J. Dole-Olivier, F. Castellerini, C. des Chatelliers, E. Castella, F. Malard, F. Stoch, D. Galassi, T. di Lorenzo, M.C. Bruno, B. Sket, P. Trontelj, P. Leclerc, Y. Ranga Reddy, M. Peralta, I. Pandoursky, S. Watiroyram, R. Newell, E. Snyder, J. Stanford, B. Reid, B. Hutchins, Gibson, J. Little, Z. Crete, P. Hancock and L. Knight. **Online at** <http://www.gbif.es/ipt/resource?r=mncn-artpl>; <http://www.gbif.org/dataset/07f0789f-c777-4c99-acb3-815c78c7db81>; <http://doi.org/10.15470/t1lssy>

Abstract

This is the first published database of a Bathynellacea Chappuis, 1915 collection of slices and DNA extracts. It includes all data of bathynellaceans (Crustacea: Syncarida) collected in the last 48 years (1968 to 2016) on the Iberian Peninsula and Balearic Islands, studied since 1984. It also includes specimens studied across many countries of Europe (Portugal, Romania, France, Italy, Slovenia, Bulgaria, and England), as well as some specimens obtained from samples of North America (Montana, Washington, Alaska and Texas), South America (Brazil, Chile and Argentina), Asia (China, Thailand, Vietnam, Mongolia and India), Africa (Morocco and Chad) and Australia (New South Wales –NSW– and Queensland). The samples come from groundwater (caves, springs, wells and hyporrheic habitat associated with rivers) obtained from both, sampling campaigns and occasional sampling efforts.

The data set includes 3399 records (2657 slices and 742 DNA extracts) corresponding to three families (Parabathynellidae Noodt, 1965, Leptobathynellidae Noodt, 1965 and Bathynellidae Grobben, 1905) of the order Bathynellacea; *the existence of three families is accepted, but this is a controversial issue and here is not the appropriate context to address this problem*; 52 genera and 92 species formally described, in addition to 30 taxa under study and, thus, still unpublished. This represents more than half of all the genera known worldwide (80) and almost one third of the species currently known in the world (329, which increases every year).

This dataset contains especially relevant collection that includes holotypes and type series of 43 new species of Bathynellacea (33 from the Parabathynellidae and ten from the Bathynellidae) described by Ana I. Camacho (AIC hereinafter); eleven of these are the type species for new genera described from all around the world, ten belonging to the Parabathynellidae and one from the Bathynellidae. As previously mentioned, these new species come from all continents, although 26 of them are from the Iberian Peninsula.

The most important feature of this collection is that it has been created and reviewed by a specialist of the group (AIC), and each specimen, regardless of its shape (either permanent slices or DNA extracts), includes taxonomic, geographical and authorship information. The specialist has been involved in all stages of the process, from field sampling to the digitization of the results we are now presenting, and has worked in close collaboration with the curators responsible for the different collections involved in this project.

Keywords

Bathynellacea, collections, Crustacea, DNA extract, groundwater fauna, invertebrate, MNCN (CSIC), permanent preparations, type collection

General description

Purpose: The collections of the MNCN in Madrid hold the largest collection of Crustacea Bathynellacea in the world, with 3399 records (Figure 1) corresponding to 2657 permanent slices and 742 DNA extracts and their relevant taxonomic, geographical, and authorship information. From these, 2169 records (1683 permanent slices and 486 DNA extracts) belong to the Parabathynellidae, 1211 (974 permanent slices and 237 DNA extracts) belong to the Bathynellidae, and 20 (all DNA extracts) to the Leptobathynellidae (Figure 1). The objective of this work is to highlight the value of this collection by presenting it to the researcher community. Its importance is not only due to the number of specimens, but also due to their representativeness both taxonomically and spatially. What is also important is the number of types and type series it includes (holotypes and type series of 43 species coming from all continents) (Figure 2) and in their state of preservation which ensures its future utility. There are specimens from 31 different genera, from the 80 in total that are recognized worldwide (Figure 3), which belong to the three families currently known. This adds up to almost one third of all the species known in the world (94 of the 329 species formally described) (Table 1) (Figure 4). The collection includes specimens from all continents, from populations in Alaska to the South of Australia, although there is a predominance of European species, particularly from the Iberian Peninsula.

This particular group of crustaceans is slowly showing the true magnitude of its diversity, and the collection presented here is a proof of this. It was traditionally

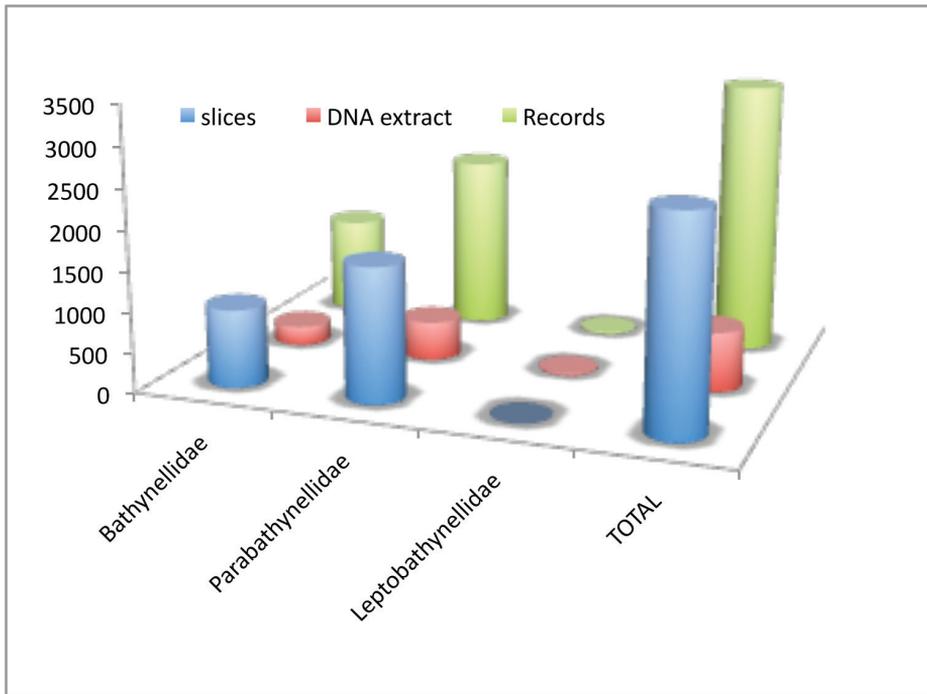


Figure 1. Family records in the MNCN collections.

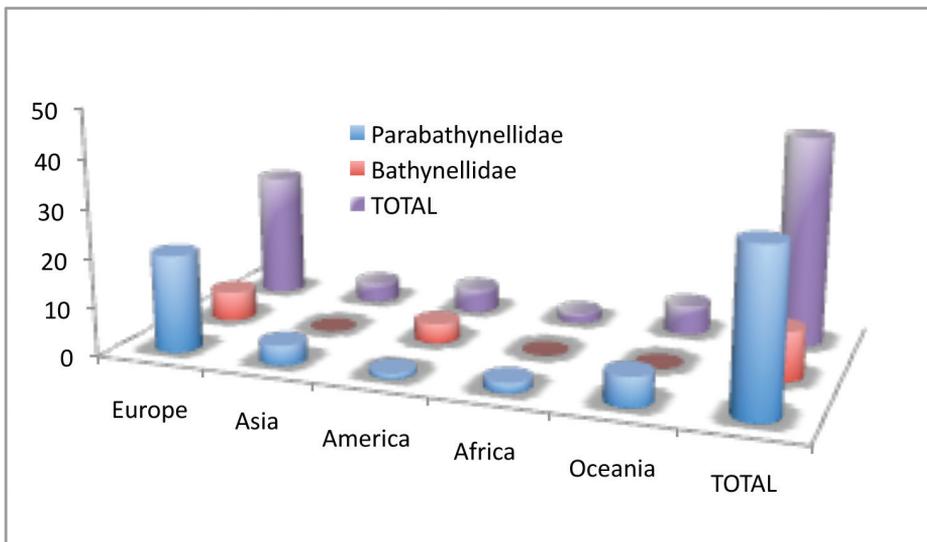


Figure 2. Bathynellacea holotypes by families and continents in the MNCN collections.

considered a rare group with very low diversity mainly due to the fact that its habitat (groundwater) is rarely sampled, and that its presence and density is on average low. This, together with the difficulty for humans to access its environment, as well as the

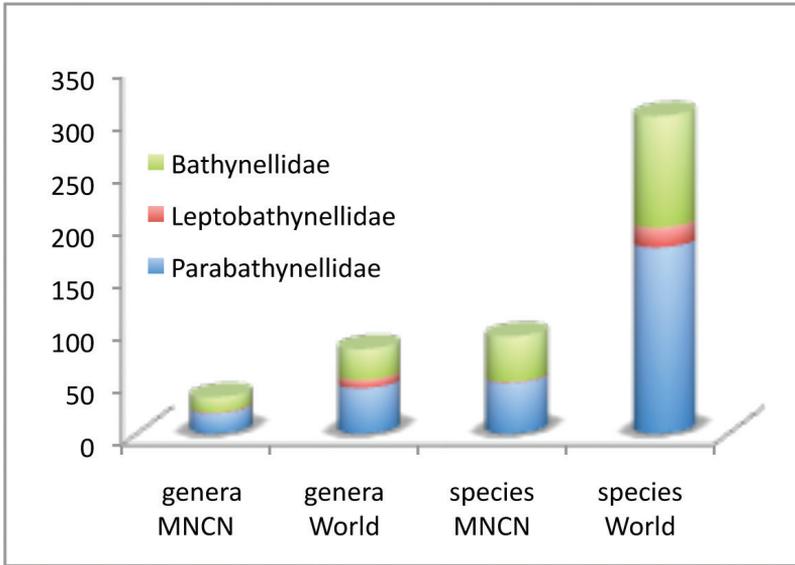


Figure 3. Bathynellacea genera by families in the MNCN collections versus world.

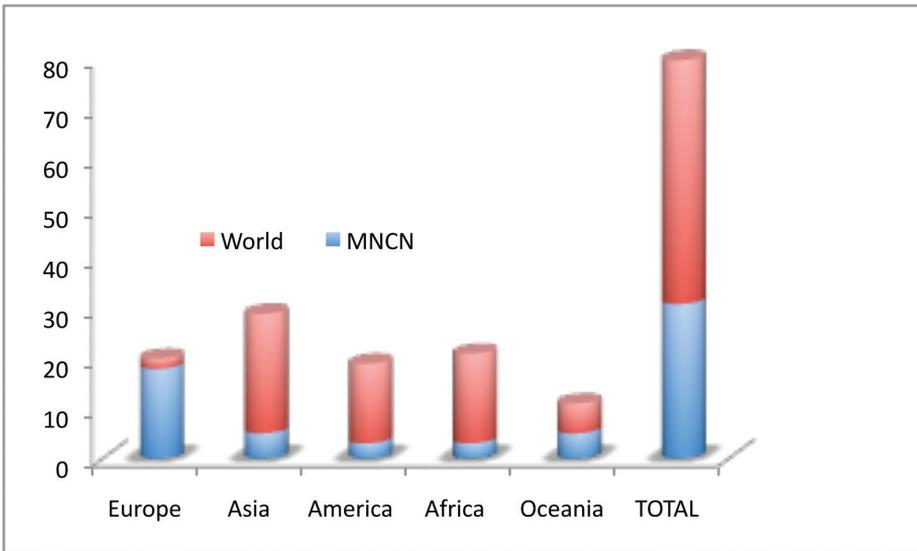


Figure 4. Number of genera of Bathynellacea by continents present in the MNCN collections versus world.

complex and time-consuming taxonomic research the group implies due to the small size of the species (most of the species are not larger than a millimeter) and their morphological complexity of their numerous appendices (e.g., thoracopod VIII male transformed into a copulatory organ), has prevented many researchers devoting their time to their study over the years. Nevertheless, one of the authors (AIC) has devoted over 30 years of work to produce the collection we are presenting here. We are con-

Table 1. Present taxa (families and genera) and species number from these genera in the collections of the MNCN and in the world by continent. % world representation in this database. *Oceania= Geopolitic region (Australia and New Zealand in this paper). ** Total number of world species is approximate, because there are new species in study and “in press”, and the number change every year.

| Taxa | Species Number (MNCN collection/continent) | | | | | | TOTAL species MNCN (%) | **TOTAL species World | Species number with DNA extract Collection MNCN | Indetermined species number/with DNA extract Collection MNCN |
|-----------------------------|--|------------|-------------|------------|------------|-------------|------------------------|-----------------------|---|--|
| | Europe | Asia | America | Africa | *Oceania | | | | | |
| <i>Parabathynellidae</i> | 33/41 | 4/73 | 3/19 | 3/23 | 7/51 | 50 (28.2) | 207 | 26 | 17/9 | |
| <i>Iberobathynella</i> | 21/22 | 0/0 | 0/0 | 0/0 | 0/0 | 21 (95.4) | 22 | 14 | 6/6 | |
| <i>Paraiberobathynella</i> | 2/2 | 0/0 | 0/0 | 1/1 | 0/0 | 3 (100) | 3 | 3 | 2/2 | |
| <i>Guadalopebathynella</i> | 1/1 | 0/0 | 0/0 | 0/0 | 0/0 | 1 (100) | 1 | 1 | 0/0 | |
| <i>Hexaiberobathynella</i> | 2/2 | 0/0 | 0/0 | 0/0 | 0/0 | 2 (100) | 2 | 2 | 0/0 | |
| <i>Parabathynella</i> | 2/3 | 0/0 | 0/0 | 0/0 | 0/0 | 2 (66.6) | 3 | 0 | 1/0 | |
| <i>Hexabathynella</i> | 5/11 | 0/0 | 1/6 | 0/3 | 1/3 | 7 (30.4) | 23 | 3 | 3/0 | |
| <i>Paraeobathynella</i> | 0/0 | 1/1 | 0/0 | 0/0 | 0/0 | 1 (100) | 1 | 0 | 0/0 | |
| <i>Sketbinella</i> | 0/0 | 1/1 | 0/0 | 0/0 | 0/0 | 1 (100) | 1 | 0 | 0/0 | |
| <i>Sinobathynella</i> | 0/0 | 1/1 | 0/0 | 0/0 | 0/0 | 1 (100) | 1 | 0 | 0/0 | |
| <i>Siambathynella</i> | 0/0 | 1/1 | 0/0 | 0/0 | 0/0 | 1 (100) | 1 | 1 | 0/0 | |
| <i>Montanabathynella</i> | 0/0 | 0/0 | 1/1 | 0/0 | 0/0 | 1 (100) | 1 | 0 | 0/0 | |
| <i>Octobathynella</i> | 0/0 | 0/0 | 0/0 | 0/0 | 1/1 | 1 (100) | 1 | 0 | 0/0 | |
| <i>Notobathynella</i> | 0/0 | 0/0 | 0/0 | 0/1 | 2/8 | 2 (22.2) | 9 | 0 | 2/0 | |
| <i>Chilibathynella</i> | 0/0 | 0/1 | 0/1 | 0/0 | 2/3 | 2 (40) | 5 | 0 | 2/0 | |
| <i>Orychobathynella</i> | 0/0 | 0/0 | 0/0 | 0/0 | 1/1 | 1 (100) | 1 | 0 | 0/0 | |
| <i>Haplopballonella</i> | 0/0 | 0/0 | 0/0 | 1/2 | 0/0 | 1 (50) | 2 | 1 | 0/0 | |
| <i>Racovitzabathynella</i> | 0/0 | 0/0 | 0/0 | 1/3 | 0/0 | 1 (33.3) | 3 | 1 | 0/0 | |
| <i>Texanobathynella</i> | 0/0 | 0/0 | 1/2 | 0/0 | 0/0 | 1 (50) | 2 | 0 | 1/1 | |
| Leptobathynellidae | 0/0 | 1/4 | 0/10 | 0/5 | 0/0 | 1(5) | 19 | 1 | 0 | |
| <i>Paruulobathynella</i> | 0/0 | 1/3 | 0/3 | 0/2 | 0/0 | 1 (12.5) | 8 | 1 | 0 | |
| Bathynellidae | 33/51 | 1/33 | 6/13 | 0/5 | 1/1 | 43 (40.6) | 103 | 10 | 16+?/13 | |
| <i>Vejdovskymbathynella</i> | 5/7 | 0 | 0 | 0 | 0 | 5 (71.4) | 7 | 3 | 3/3 | |
| <i>Pacificabathynella</i> | 0/0 | 0 | 4/5 | 0 | 0 | 4 (80) | 5 | 1 | 1/0 | |

| Taxa | Species Number (MNCN collection/continent) | | | | TOTAL species MNCN (%) | **TOTAL species World | Species number with DNA extract Collection MNCN | Indetermined species number/with DNA extract Collection MNCN |
|------------------------------|--|-------|---------|--------|---------------------------|--------------------------|---|--|
| | Europe | Asia | America | Africa | | | | |
| <i>Paradoxicalamoussella</i> | 2/2 | 0 | 0 | 0 | 2 (100) | 2 | 2 | 3/3 |
| <i>Clamoussella</i> | 1/1 | 0 | 0 | 0 | 1 (100) | 1 | 0 | 3/3 |
| <i>Grallobathynella</i> | 3/4 | 0 | 0 | 0 | 5 (71,4) | 7 | 3 | 2/2 |
| <i>Meridiobathynella</i> | 2/2 | 0 | 0 | 0 | 2 (100) | 2 | 0 | 2/0 |
| <i>Bathynella</i> | 15/29? | 1/16 | 2/5 | 0 | 1/1 | 19 (38?) | 0 | 2/2 |
| <i>Delamaretribathynella</i> | 1/1 | 0 | 0 | 0 | 0 | 1 (33,3) | 0 | 0/0 |
| <i>Pseudobathynella</i> | 1/2 | 0 | 0 | 0 | 0 | 1 (50) | 0 | 0/0 |
| <i>Sardobathynella</i> | 1/1 | 0 | 0 | 0 | 0 | 1 (100) | 0 | 0/0 |
| <i>Vandelitibathynella</i> | 1/1 | 0 | 0 | 0 | 0 | 1 (100) | 0 | 0/0 |
| <i>Anitrobathynella</i> | 1/1 | 0/1 | 0 | 0 | 0 | 1 (50) | 1 | 0/0 |
| Total Bathynellacea | 66/92 | 6/110 | 9/42 | 3/33 | 8/52 | 94 (30) | 37 | 33+?/22 |

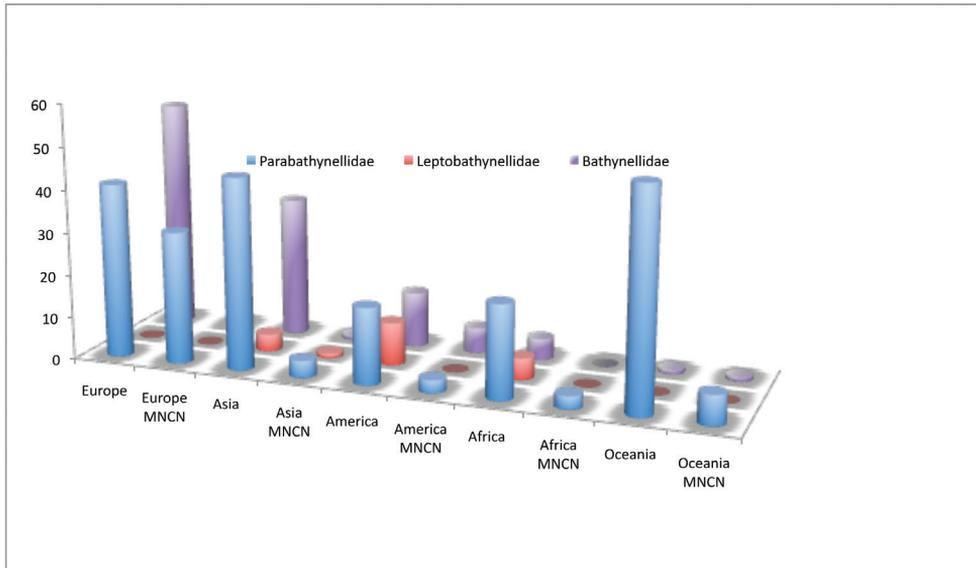


Figure 5. Number of species by families and continents present in the MNCN collections versus world.

vinced that the relevance of the collection is already reason enough for its publication, especially due to the important information on the Iberian Peninsula and Balearic Islands, which is currently one of the best-studied regions in terms of bathynellaceans, and linked with this effort, also the region with the highest diversity of this group of crustaceans in the world (Camacho et al., 2014). There are 58 species known for this particular region, 41 formally described, and at least 17 more that have been identified as new species, but are pending description. This includes many cryptic species identified thanks to molecular studies (Camacho et al., 2011, 2012, 2013a, b). All of the above are represented through permanent slices in the collection we present here, plus DNA extracts of 41 of the species, although currently not all of them include the gene sequences. In addition to all of these, the collection also includes many other European species (66), as well as species from Asia (6), America (9), Australia (8) and Africa (3) (see Table 1 and Figure 5).

The present paper is an important contribution that offers basic and rigorous taxonomic information, which is updated and can be potentially useful for subterranean biodiversity studies (identifying hotspots), and also for ecology and conservation studies, particularly for estimating future global changes as the specimens recorded range from 1986 to the present.

Our aims for publishing this dataset are 1) describing the Bathynellacea collection of permanent slices and DNA extract of the MNCN, 2) show the first data set of holotype and type series collection of Bathynellacea in the world, 3) providing information on the diversity and distribution of groundwater fauna in the world and 4) offering the first dataset of Bathynellacea permanent slices in the world to the scientific community in the hopes of promoting other researchers to publish their different groundwater fauna datasets.

Additional information

Table 1 shows the present taxa (families, genera and species) in the collections of the MNCN and in the world by continent with % representation in the collections.

Table 2 includes information on all the new species of Bathynellacea described by authors, including the catalogue number of holotype and DNA voucher from specimens of type localities (where available) from classic Crustacea and “Tissue and DNA” collections of the MNCN and the numbers of specimens of type series.

Table 3 is a short list of species and localities of Bathynellacea of which there are DNA extracts in the collection of the MNCN.

Section 1 of the bibliography includes a list of the publications citing the bathynellaceans included in this dataset.

Project details

Project title: Data Base of Bathynellacea specimens collection of MNCN (CSIC) Madrid: microscope slices (permanent slices) and DNA extracts.

Personnel digitization: Camacho AI

Determination specialist: Camacho AI

Administrative contact: Dorda BA

Bathynellacea determination specialist: Camacho AI

Funding: Fauna Ibérica I (DGICYT PB87-0397); Fauna Ibérica II (DGICYT PB89-0081); Fauna Ibérica III (DGICYT PB92-0089); Inferencia de Patrones Biogeográficos a pequeña escala (DGICYT PB96-0894); Inventario y Catalogación informática de la Biodiversidad acuática subterránea de la Península Ibérica, Baleares y Macaronesia (CICYT REN2000-2004 GLO); Protocols for the Assessment and Conservation of aquatic life in the subsurface (PASCALIS), European Union Proposal EVK2-2001-00086 (Contract: EVK2- CT-2001-00121); Biodiversidad Faunística en el sector turístico del Complejo Ojo Guareña: Evaluación de la Influencia de la presión humana en algunas de sus poblaciones de invertebrados (Contract CSIC- Junta de Castilla León, 2002-2004); Sobre el origen y distribución de la fauna acuática subterránea (CICYT CGL2005-02217/BOS); Colonización, Éxito Evolutivo y Biodiversidad Faunística del Complejo Kárstico de Ojo Guareña” En el Monumento Natural de Ojo Guareña (Burgos) (Contract CSIC- Junta de Castillay León, 2006-2009); Estudio piloto para la detección a diferentes escalas geográficas de procesos evolutivos relacionados con el origen de la biodiversidad en grupos de invertebrados singulares (MICINN CGL2010-15786, subprograma BOS; Identificación de especies crípticas mediante análisis filogeográficos y filogenias multigénicas: una revisión de la diversidad real en grupos taxonómicamente complejos (MINECO CGL2015-66571-P/ FEDER).

Study area descriptions/descriptor: The area of study includes the whole world. There are over 200 sites from the Iberian Peninsula and Balearic Islands (Camacho et al.,

Table 2. List of species of Bathynellacea with holotypes and type series deposited in the collections (Arthropods and Tissues and DNA) of the Museo Nacional de Ciencias Naturales de Madrid (CSIC) (Spain). (H) Hyporheic habitat; gravel bank of rivers; (*) Genus described by author(s) of this paper. (**) The holotype and type series of new species described from Spain not deposited in MNCN.

| Taxa | Habitat | Type locality | Province | Country | Description year | Type serie male/ female | Holotype voucher MNCN 20.04/ | Loc. type voucher MNCN:ADN: |
|--------------------------------------|-----------|--------------------|-----------|----------|------------------|----------------------------|---------------------------------|--------------------------------|
| Parabathynellidae | | | | | | | | |
| <i>Iberobathynella</i> | | | | | | | | |
| <i>I. imuniensis</i> | Cave | Torca Morteros | Burgos | Spain | 1987 | 10/4 | 4642 | 29146-29446 |
| <i>I. rouchi</i> | River (H) | Guadalupe | Teruel | Spain | 1987 | 5/4 | 4641 | |
| <i>I. ortizi</i> | Cave | Rei Cintolo | Lugo | Spain | 1989 | 4/5 | 4643 | 54609-54622 |
| <i>I. cantabriensis</i> | Cave | El Calderón | Cantabria | Spain | 1998 | 5/3 | 4639 | |
| ** <i>I. magna</i> | Cave | Del Infierno | Asturias | Spain | 1998 | ** | – | |
| <i>I. parasturiensis</i> | Cave | Treslajorá, CO.209 | Asturias | Spain | 1998 | 7/2 | 4640 | |
| <i>I. paraguacilipes</i> | Well | Quejigo | Huelva | Spain | 1998 | 8/10 | 4638 | |
| <i>I. celiána</i> | River (H) | Arroyo Torrecilla | Sevilla | Spain | 2003 | 0/1 | 5323 | 29452 |
| <i>I. serbani</i> | River (H) | Lima | – | Portugal | 2003 | 1/3 | 5321 | |
| <i>I. pedroi</i> | River (H) | Mondego | Coimbra | Portugal | 2003 | 1/5 | 5320 | |
| <i>I. guarenensis</i> | Cave | Erizo, Ojo Guareña | Burgos | Spain | 2003 | 0/4 | 5322 | |
| <i>I. lamasonensis</i> | Cave | Estraguëña | Cantabria | Spain | 2005 | 5/7 | 5911 | |
| <i>I. cornejoensis</i> | Cave | Redonda | Burgos | Spain | 2005 | 5/2 | 5912 | 29946-29952 |
| <i>I. burgalensis</i> | Cave | Ojo Guareña, OG53 | Burgos | Spain | 2005 | 5/3 | 6063 | 29220-29542 |
| <i>I. andalusica</i> | Well | Fuentes Andalucía | Sevilla | Spain | 2007 | 3/8 | 7966 | 29418-29438 |
| *<i>Paruibero bathynella</i> | | | | | | | | |
| <i>Pi. notenboomii</i> | Well | Orihuela | Alicante | Spain | 1989 | 4/4 | 4644 | |
| *<i>Guadalopec bathynella</i> | | | | | | | | |
| <i>G. puchi</i> | River (H) | Guadalupe | Teruel | Spain | 1998 | 14/12 | 4450 | |
| *<i>Hexaibero bathynella</i> | | | | | | | | |
| <i>Hi. hortezuelensis</i> | Well | Hortezuela | Soria | Spain | 1998 | 10/10 | 4451 | |
| <i>Hexabathynella</i> | | | | | | | | |
| <i>H. nicoleitana</i> | River (H) | Jarama | Madrid | Spain | 1986 | 10/14 | 4645 | |

| Taxa | Habitat | Type locality | Province | Country | Description year | Type serie male/female | Holotype voucher MNCN 20.04/ | Loc. type voucher MNCN:ADN: |
|-----------------------------|-----------|-------------------|--------------|-----------|------------------|------------------------|------------------------------|-----------------------------|
| <i>H. valdecasasi</i> | River (H) | Torcón | Guadalajara | Spain | 2003 | 1/2 | 4866 | |
| <i>H. sevillanensis</i> | Cave | Santiago Grande | Sevilla | Spain | 2005 | 8/7 | 5913 | 29545-29565 |
| *Paracoathymella | | | | | | | | |
| <i>P. vietnamensis</i> | Cave | Hang Trinh | Dao Bo Hon | Vietnam | 2005 | 15/13 | 5911 | |
| *Skethinella | | | | | | | | |
| <i>S. ironetlji</i> | Cave | Hon Rom | Vinh Ha Long | Vietnam | 2005 | 3/0 | 5912b | |
| *Sinobathymella | | | | | | | | |
| <i>S. decamera</i> | Cave | Si Haizi | Dens | China | 2006 | 1/1 | 7048 | |
| *Siambathymella | | | | | | | | |
| <i>S. laorsiae</i> | Cave | Tham Yai Nam | Petchabun | Thailand | 2011 | 6/3 | 8568 | |
| *Montanabathymella | | | | | | | | |
| <i>M. salish</i> | River (H) | Junko | Montana | USA | 2009 | 1/1 | 7970 | |
| *Octobathymella | | | | | | | | |
| <i>O. peelensis</i> | Well | Tamworth | NSW | Australia | 2011 | 1/3 | 8226 | |
| Notobathymella | | | | | | | | |
| <i>N. octocamera</i> | Well | Bundaberg | Queensland | Australia | 2011 | 2/4 | 8229 | |
| <i>N. pentatrachion</i> | Well | Bundaberg | Queensland | Australia | 2011 | 4/2 | 8232 | |
| Chilibathymella | | | | | | | | |
| <i>C. joshuai</i> | Well | Dubbo | NSW | Australia | 2011 | 3/1 | 8558 | |
| <i>C. digitus</i> | Well | Tamworth | NSW | Australia | 2011 | 3/3 | 8561 | |
| *Onychobathymella | | | | | | | | |
| <i>O. bifurcata</i> | Well | Hunter | NSW | Australia | 2011 | 0/3 | 8564 | |
| Haplophallonella | | | | | | | | |
| <i>H. irenae</i> | River (H) | Uet Duar | Toutous | Chad | 2016 | 16/9 | 10148 | 29986-29987 |
| Racovitzabathymella | | | | | | | | |
| <i>R. dumonti</i> | River (H) | Uet Duar | Toutous | Chad | 2016 | 16/9 | 10150 | 29981-29988 |
| Bathynellidae | | | | | | | | |
| Vejidonskybathymella | | | | | | | | |
| <i>V. edelweiss</i> | Cave | Ojo Guareña, OG16 | Burgos | Spain | 2007 | 11/20 | 7791 | 29414-29482 |

| Taxa | Habitat | Type locality | Province | Country | Description year | Type serie male/ female | Holotype voucher MNCN 20.04/ | Loc. type voucher MNCN:ADN: |
|------------------------------------|-----------|------------------|-----------|---------|------------------|----------------------------|---------------------------------|--------------------------------|
| <i>V. caroloi</i> | Cave | Molino, Matienzo | Cantabria | Spain | 2007 | 5/10 | 7792 | |
| <i>V. pascalis</i> | Cave | Cubilla, Ogarrio | Cantabria | Spain | 2007 | 1/1 | 7793 | |
| <i>V. vasconica</i> | Cave | Goikoetxe | Vizcaya | Spain | 2013 | 7/18 | 9119 | 29623-29889 |
| <i>Pacificabathynella</i> | | | | | | | | |
| <i>P. kalispellensis</i> | Well | Flathead County | Montana | USA | 2009 | 3/3 | 8090 | |
| <i>P. stanfordi</i> | Well | Graham Channel | Montana | USA | 2009 | 4/7 | 8093 | |
| <i>P. ruthae</i> | Well | Flathead County | Montana | USA | 2009 | 6/4 | 8096 | |
| <i>P. yupik</i> | River (H) | Kwethluk | Alaska | USA | 2015 | 3/21 | 10092 | 29963-29967 |
| *<i>Paradoxyclamourella</i> | | | | | | | | |
| <i>P. fidelii</i> | Cave | Pozo Agua, CO69 | Asturias | Spain | 2013 | 6/14 | 8855 | 29746-29753 |
| <i>P. pirata</i> | Cave | Río Chico | Cantabria | Spain | 2013 | 2/5 | 8877 | 29998-29999 |

2014), as well as other European localities from France, Italy, Slovenia, Bulgaria, Rumania and England. In the case of the American continent, the collection includes specimens from a locality in Brazil, another one in Chile, and one more in Argentina, together with several localities across the USA: Texas, Montana, Washington and Alaska. The Asian specimens were collected in several caves in China, Vietnam, Thailand, and some localities in South India. The specimens from Australia are from New South Wales and Queensland. The African samples come from two localities in Morocco and one in Chad.

Several sampling dates ranging from 1968 to 2016.

The samples come from groundwater caves, springs, wells and interstitial environment (hyporheic) of the epigeal river where the stygobionts fauna living in them can be collected.

Design description: This dataset was developed to contribute to the knowledge of a group of groundwater Crustacea, Bathynellacea, of worldwide distribution and sparse study; to identify endemic fauna at different geographic scales (country, counties and localities); to value this collection of Madrid MNCN and encourage other colleagues to show less striking results of their work. Prior to digitization, the taxonomic identification pre-existing was reviewed by the specialist AIC. The dataset is exported to Darwin Core v1.2 format and uploaded to the IPT of the GBIF Spanish node (<http://www.gbif.es/ipt/resource?r=mncn-artp>). Darwin Core elements included in the dataset structure are listed in the dataset description section.

Data published through GBIF: <http://www.gbif.es/ipt/resource?r=mncn-artp>; <http://www.gbif.org/dataset/07f0789f-c777-4c99-acb3-815c78c7db81>

Taxonomic coverage

General taxonomic coverage description: This is a collection of slices and DNA extracts of Bathynellacea, a group of Crustacea Malacostraca (Figure 6) containing specimens from all known species for Spain, and high percentages of all species known in Europe, as well as some of those described in recent years (2006 onwards) in the other continents (Tables 1, 2 and 3). The collection includes all the samples obtained in the Iberian Peninsula and Balearic Islands since 1983 by AIC, also donated material from these areas and from different parts of the world to AIC for study, as detailed above. Most of the collection is identified to species level. The specimens still without identification to species level have been identified to genus or family level.

The three families of the order Bathynellacea: Bathynellidae, Parabathynellidae and Leptobathynellidae, are all represented in the collection, and in the case of the first two, in the shape of both DNA extracts and permanent slices (Table 3, Figs 1, 3, 7). Leptobathynellidae has been found in North America and southern hemisphere (Asia, Africa and South America) and includes 8 genera and 19 species, while in the collection of the MNCN contains 20 specimens in the shape of DNA extracts, which belong to a species from southern India *Parvulobathynella distincta* Ranga Reddy et al., 2011 (Table 1).

Table 3. List of species and localities of Bathynellacea with extracts of DNA in the collection of the MNCN.

| Taxa | Habitat | Type locality | Province | Country | Voucher ADN/ |
|-------------------------------|-----------|--------------------|------------|----------|--------------|
| Parabathynellidae | | | | | |
| <i>Iberobathynella</i> | | | | | |
| <i>I. andalusica</i> | Well | Fuentes Andalucía | Sevilla | Spain | 29418-29438 |
| <i>I. asturiensis</i> | Cave | Pruneda | Asturias | Spain | 29190-29828 |
| <i>I. asturiensis</i> | Cave | Tresavarilla | Cantabria | Spain | 29192-29826 |
| <i>I. burgalensis</i> | Cave | Ojo Guareña, OG53 | Burgos | Spain | 29220-29542 |
| <i>I. cantabriensis</i> | Cave | Calderón, CO.099 | Cantabria | Spain | 29376-29838 |
| <i>I. cantabriensis</i> | Cave | Pelacristo, CO261 | Asturias | Spain | 29148-29492 |
| <i>I. cantabriensis</i> | Cave | Treslajorá, CO.209 | Asturias | Spain | 29295-29571 |
| <i>I. cantabriensis</i> | Cave | Lobos, CO.276 | Cantabria | Spain | 29537-29798 |
| <i>I. cavadoensis</i> | River (H) | Cavado River | | Portugal | 29183-29840 |
| <i>I. cavadoensis</i> | River (H) | Tamuxo stream | Pontevedra | Spain | 29234-29832 |
| <i>I. celiana</i> | River (H) | Viar stream | Sevilla | Spain | 29452 |
| <i>I. cornejoensis</i> | Cave | Redonda | Burgos | Spain | 29946-29952 |
| <i>I. imuniensis</i> | Cave | Torca Morteros | Burgos | Spain | 29146-29446 |
| <i>I. imuniensis</i> | Cave | Bernías | Burgos | Spain | 29776-29792 |
| <i>I. imuniensis</i> | Cave | Lunada | Burgos | Spain | 29989-29994 |
| <i>I. imuniensis</i> | Cave | V-142 | Burgos | Spain | 54559-54564 |
| <i>I. cf imuniensis</i> | Cave | El Becerral | Cantabria | Spain | 54569 |
| <i>I. cf imuniensis</i> | Cave | Fonda | Vizcaya | Spain | 54658-54663 |
| <i>I. lusitanica</i> | River (H) | Cavado River | | Portugal | 29184-29842 |
| <i>I. magna</i> | Cave | Helechosa, CO | Cantabria | Spain | 29939 |
| <i>I. magna</i> | Cave | Treslajorá, CO.209 | Asturias | Spain | 29294-29575 |
| <i>I. magna</i> | Cave | Pelacristo, CO.261 | Asturias | Spain | 29367-29494 |
| <i>I. ortizi</i> | Cave | Rei Cintolo | Lugo | Spain | 54609-54622 |
| <i>I. paragracilipes</i> | Well | Quejigo, Jabugo | Huelva | Spain | 29821-29248 |
| <i>I. paragracilipes</i> | Well | Ermita San Isidro | Huelva | Spain | 29209 |
| <i>I. parasturiensis</i> | Cave | Treslajorá, CO.209 | Asturias | Spain | 29553-29589 |
| <i>I. parasturiensis</i> | Cave | La Nava, CO.044 | Cantabria | Spain | 29609-29916 |
| <i>I. parasturiensis</i> | Cave | Divisada, CO.275 | Asturias | Spain | 29193-29312 |
| <i>I. rouchi</i> | River (H) | Guadalope River | Teruel | Spain | 29174-29238 |
| <i>I. rouchi</i> | River (H) | Cinca River | Huesca | Spain | 29178-29213 |
| <i>I. rouchi</i> | River (H) | Alfambra River | Teruel | Spain | 29176-29254 |
| <i>I. sp</i> | River (H) | Mondego River | Coimbra | Portugal | 29868 |
| <i>I. sp</i> | Cave | Treslajorá, CO.209 | Asturias | Spain | 29587-54558 |
| <i>I. sp</i> | Cave | Pozo Agua, CO.069 | Asturias | Spain | 29704-29738 |
| <i>I. sp</i> | Cave | Torca Tejo, CO.246 | Asturias | Spain | 29264-29831 |
| <i>I. sp</i> | Cave | Grañaja, CO.150 | Cantabria | Spain | 29290-29830 |
| <i>I. sp</i> | Cave | del Pilar, CO.314 | Asturias | Spain | 29168-54547 |
| <i>I. sp</i> | Cave | Si 44 | Alava | Spain | 29219-29616 |
| <i>I. sp</i> | Cave | San Juan | Vizcaya | Spain | 29968 |
| <i>I. sp</i> | Cave | Soplao Mina Elvira | Vizcaya | Spain | 29969-29974 |
| <i>I. sp</i> | Cave | Astui | Vizcaya | Spain | 29978-29980 |
| <i>I. sp</i> | Cave | Lamiñas | Vizcaya | Spain | 29975-29977 |

| Taxa | Habitat | Type locality | Province | Country | Voucher ADN/ |
|-----------------------------|-----------|--------------------|-----------|----------|--------------|
| <i>I. sp</i> | Cave | Monasterio (CO231) | Asturias | Spain | 29300 |
| <i>I. sp 1</i> | Cave | del Pilar, CO.314 | Asturias | Spain | 9001-29759 |
| <i>I. sp 1</i> | Cave | Lobos, CO.276 | Cantabria | Spain | 29538-29539 |
| <i>I. sp 2</i> | Cave | Treslajorá, CO.209 | Asturias | Spain | 29559-29658 |
| <i>I. sp 2</i> | Cave | del Pilar, CO.314 | Asturias | Spain | 29472-29756 |
| <i>I. sp 2</i> | Cave | Carnero, CO.220 | Cantabria | Spain | 29734 |
| <i>I. sp 3</i> | Cave | Pozo Agua, CO.069 | Asturias | Spain | 29705-54542 |
| <i>I. sp 3</i> | Cave | del Pilar, CO.314 | Asturias | Spain | 29473 |
| <i>I. sp 4</i> | Cave | Los Orios, CO.089 | Asturias | Spain | 29488 |
| *Paraiberobathynella | | | | | |
| <i>Pi. cf fagei</i> | Cave | Sima La Higuera | Murcia | Spain | 29665-54552 |
| <i>Pi. cf fagei</i> | Cave | La Pileta | Málaga | Spain | 54581-54591 |
| <i>Pi. cf fagei</i> | River (H) | Jucar River | Valencia | Spain | 54663-54636 |
| <i>Pi. cf fagei</i> | River (H) | Vélez River | Málaga | Spain | 29819-29820 |
| <i>Pi. cf fagei</i> | River (H) | Turia River | Valencia | Spain | 54566-54567 |
| <i>Pi. cf fagei</i> | River (H) | Alcanadre River | Huesca | Spain | 29929 |
| <i>Pi. cf maghrebensis</i> | Well | Nador-Bercome | Maghreb | Morocco | 29931-29962 |
| <i>Pi. fagei</i> | Cave | Campanet | Mallorca | Spain | 29200 |
| <i>Pi. fagei</i> | Cave | Génova | Mallorca | Spain | 29660 |
| <i>Pi. fagei</i> | Cave | Son Berenguer | Mallorca | Spain | 29292-29293 |
| <i>Pi. fagei</i> | Cave | Sa Bassa Blanca | Mallorca | Spain | 29194-29928 |
| <i>Pi. fagei</i> | River (H) | Areta River | Navarra | Spain | 29180-29818 |
| <i>Pi. fagei</i> | River (H) | Ter River | Gerona | Spain | 29475 |
| <i>Pi. fagei</i> | Well | Los Picos | Valencia | Spain | 29221-29802 |
| <i>Pi. fagei</i> | River (H) | Lima River | | Portugal | 29805-29806 |
| <i>Pi. fagei</i> | River (H) | Esla River | León | Spain | 29807-29808 |
| <i>Pi. fagei</i> | River (H) | Orza River | León | Spain | 29182 |
| <i>Pi. fagei</i> | River (H) | Sella River | Asturias | Spain | 29235-29812 |
| <i>Pi. fagei</i> | Well | German | Almería | Spain | 29297-29800 |
| <i>Pi. fagei</i> | River (H) | Frio stream | Granada | Spain | 29809-29810 |
| <i>Pi. fagei</i> | River (H) | Lucainena stream | Granada | Spain | 29181-29816 |
| <i>Pi. fagei</i> | River (H) | Alfambra River | Teruel | Spain | 29803 |
| <i>Pi. notemboomi</i> | Well | Los Picos | Valencia | Spain | 29189 |
| <i>Pi. sp</i> | Well | Navas de Riofrío | Segovia | Spain | 29661 |
| Hexaiberobathynella | | | | | |
| <i>Hi. hortezuelensis</i> | Well | Hortezuella | Soria | Spain | 29186-29851 |
| <i>Hi. mateusi</i> | River (H) | Jarama | Madrid | Spain | 29187-29847 |
| Guadalopebathynella | | | | | |
| <i>G. puchi</i> | River (H) | Guadalope | Teruel | Spain | 29177-29260 |
| <i>H. minuta</i> | River (H) | Pinhao | Balsa | Portugal | 29261 |
| <i>H. minuta</i> | River (H) | Rivera de Huelva | Sevilla | Spain | 29173 |
| <i>H. nicoleiana</i> | River (H) | Jarama | Madrid | Spain | 29231-29845 |
| <i>H. sevillaensis</i> | Cave | Santiago Grande | Sevilla | Spain | 29545-29565 |
| Haplophallonella | | | | | |
| <i>H. irenae</i> | River (H) | Uet Duar | Toutous | Chad | 29986-29987 |

| Taxa | Habitat | Type locality | Province | Country | Voucher ADN/ |
|------------------------------------|-----------|---------------------|-------------|----------|--------------|
| <i>Racovitzabathynella</i> | | | | | |
| <i>R. dumonti</i> | River (H) | Uet Duar | Toutous | Chad | 29981-29988 |
| <i>Siambathynella</i> | | | | | |
| <i>S. laorsrae</i> | Cave | Tham Yai | Phetchabum | Thailand | 29617-29549 |
| <i>Texanobathynella</i> | | | | | |
| <i>T. sp</i> | River (H) | Live Oak creek | Texas | USA | 54641-56646 |
| Bathynellidae | | | | | |
| <i>Vejdovskybathynella</i> | | | | | |
| <i>V. caroloi</i> | Cave | Gándara | Cantabria | Spain | 29978-29900 |
| <i>V. edelweiss</i> | Cave | Ojo Guareña, OG09 | Burgos | Spain | 29415-29482 |
| <i>V. edelweiss</i> | Cave | Ojo Guareña, OG01 | Burgos | Spain | 29471-29483 |
| <i>V. edelweiss</i> | Cave | Ojo Guareña, OG16 | Burgos | Spain | 29414 |
| <i>V. edelweiss</i> | Cave | La Mina | Burgos | Spain | 29945 |
| <i>V. edelweiss</i> | Cave | Racino | Burgos | Spain | 29953-29958 |
| <i>V. edelweiss</i> | Cave | Huesos | Burgos | Spain | 29440-29450 |
| <i>V. vasconica</i> | Cave | Goikoetxe | Vizcaya | Spain | 29623-29889 |
| <i>V. sp 1</i> | Cave | Ojo Guareña, Erizos | Burgos | Spain | 29487 |
| <i>V. sp 1</i> | Cave | Río Chico | Cantabria | Spain | 294722-54632 |
| <i>V. sp 2</i> | Cave | Redonda | Burgos | Spain | 29523-29524 |
| <i>V. sp 2</i> | Cave | Imunía | Burgos | Spain | 29917-29918 |
| <i>Pacificabathynella</i> | | | | | |
| <i>P. yupik</i> | River (H) | Kwethluk | Alaska | USA | 29963-29967 |
| <i>Paradoxyclamoussella</i> | | | | | |
| <i>P. fideli</i> | Cave | Pozo Agua, CO069 | Asturias | Spain | 29746-29753 |
| <i>P. fideli</i> | Cave | Fuente Carnero | Cantabria | Spain | 29375-29735 |
| <i>P. fideli</i> | Cave | Pilar, CO314 | Asturias | Spain | 29717-29718 |
| <i>P. cf fideli</i> | Cave | Treslajorá, CO209 | Asturias | Spain | 29593-29596 |
| <i>P. cf fideli</i> | Cave | La Nava, CO034 | Asturias | Spain | 29914-29915 |
| <i>P. pirata</i> | Cave | Río Chico | Cantabria | Spain | 29998-29999 |
| <i>P. sp1</i> | River (H) | Alcanadre | Huesca | Spain | 29286-29804 |
| <i>P. sp2</i> | River (H) | Pinhao | | Portugal | 29283 |
| <i>Gallobathynella</i> | | | | | |
| <i>G. boui</i> | Cave | Deveze | Courniou | France | 54600-54601 |
| <i>G. coiffaiti</i> | Cave | Falgas | Rieussec | France | 54602-54603 |
| <i>G. tarissei</i> | Cave | Limousis | | France | 54592-54593 |
| <i>G. sp</i> | Cave | Les Perles | Melagues | France | 54594-54595 |
| <i>G. sp</i> | Cave | Lacombe | Camboumes | France | 54596-54597 |
| <i>G. sp</i> | Spring | Janoye-Figuiet | Penne | France | 54598-54599 |
| <i>G. sp1</i> | River (H) | Jarama | Madrid | Spain | 29307-29860 |
| <i>Antrobathynella</i> | | | | | |
| <i>A. stammeri</i> | Cave | Ogof Draemen | South Wales | England | 54647-54657 |
| <i>Bathynella?</i> | | | | | |
| <i>B.?</i> sp | | Edwards Aquifer | Texas | USA | 29943-54640 |
| <i>B.?</i> sp | River (H) | Guadiato | Córdoba | Spain | 29622 |
| Undetermined genus | Cave | Menor | Asturias | Spain | 29843 |
| Undetermined genus | Cave | Fuentemolinos | Burgos | Spain | 29866-29867 |
| Undetermined genus | River (H) | Stream | Sevilla | Spain | 29142-29453 |

| Taxa | Habitat | Type locality | Province | Country | Voucher ADN/ |
|------------------------------------|-----------|---------------|---------------|----------|--------------|
| <i>Clamoussella</i> Unpublished | | | | | |
| <i>C. sp 1</i> | River (H) | Stream | | Portugal | 29204-29852 |
| <i>C. sp2</i> | River (H) | Pinhao Stream | | Portugal | 29282 |
| <i>C. sp3</i> | River (H) | Stream | Valencia | Spain | 29288-29289 |
| Leptobathynellidae | | | | | |
| <i>Parvulobathynella</i> | | | | | |
| <i>P. distincta</i> | River (I) | Godavari | Andhra Prades | India | 29683-29942 |

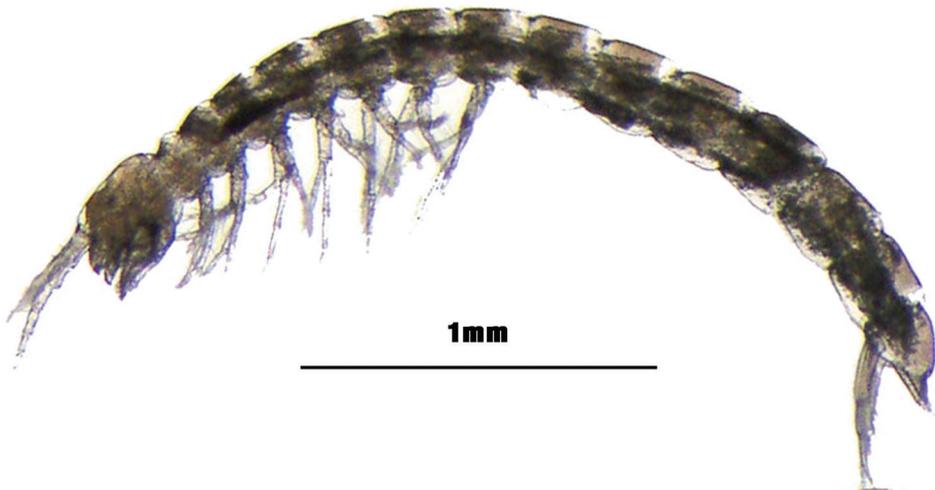


Figure 6. Habitus of Parabathynellidae family: *Paraiberobathynella* cf. *fagei* (Delamare Deboutteville & Angelier, 1950) from Higuera cave, Murcia (Spain). Lateral view.

All in all, of the 80 genera known worldwide, almost 40% (31 genera) are represented in the collection (Table 1). This is around 40% of the genera belonging to families Parabathynellidae (18 genera out of 43) and Bathynellidae (12 genera out of 29), and 13% of the genera from Leptobathynellidae (Figure 3). Europe is the continent with most representation in the collection, with 90% of the total genera known included (18 out of 20), followed by Australia with 45% of the genera (five out of 11). On the other hand, Africa remains with the lowest representation with only 14% of the known genera present in the collection (three out of 21). Asia (six out of 29) and America (four out of 19) are equally represented with 21% of the known genera included in the collection (Figure 4). Within the whole set of specimens included in the collection of the MNCN, the family Parabathynellidae has a higher number of genera included (18) when compared to Bathynellidae (12). Nevertheless if we only consider the European species, although the collection includes 100% of the Parabathynellidae

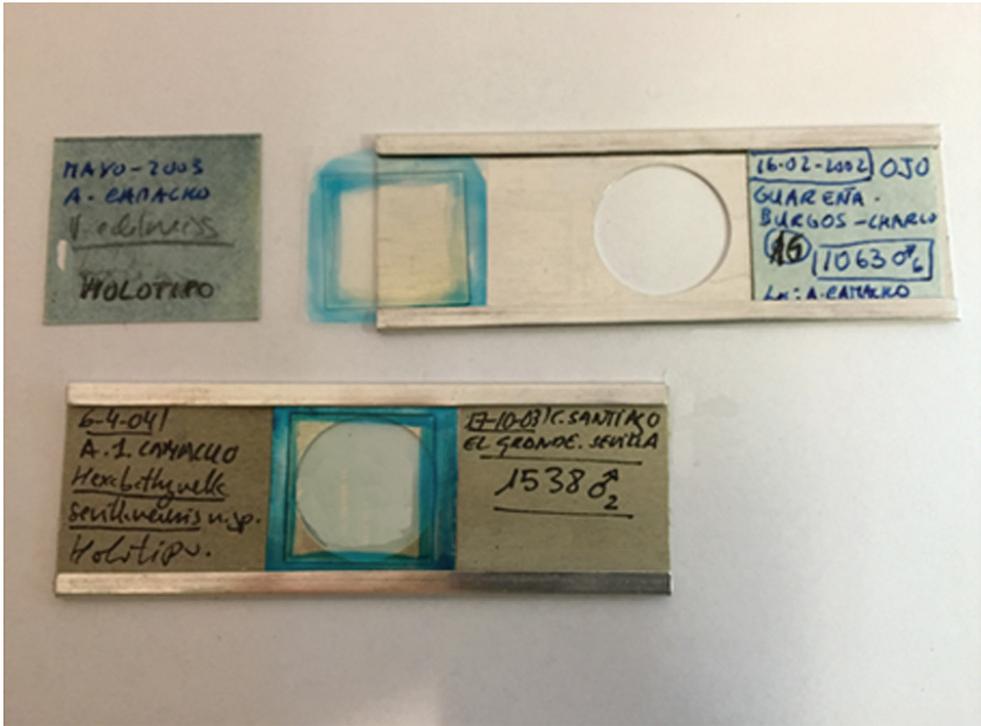


Figure 7. Permanent slides (special metal slides) of holotypes of the MNCN collections. Mounting medium: glycerine gelatin stained with methylene blue.

species known (6), there are more species of Bathynellidae in total (11), due to their higher diversity. In the case of Africa, the collection does not include a single genus of the Bathynellidae family. In the case of America, Asia and Australia, only one genus is included (Figure 8).

The family Parabathynellidae includes approximately 207 species in total, and 50 of these are preserved in the collection (Tables 1, 2, 3). Out of these, more than half (27 species) are also represented by DNA extracts. There is also a high number of undetermined species, most with DNA extracts. The continent most widely represented in the collection is Europe with 100% of the known genera included, and over 75% (31) of all species known (41) (Figure 5). On the other hand, the least represented continent is Asia with hardly 9% of the known species included in the collection (four of 45 species). The rest of continents range between 13% and 17% of the species included in this collection. The genus *Iberobathynella* Schminke, 1973, endemic to the Iberian Peninsula and Balearic Islands, is the most diverse with 22 species, and also the most represented in the collection with 20 species. In addition, the collection of the MNCN also includes the 3 known species of the genus *Paraiberobathynella* Camacho & Serban, 1998, the 2 known species of *Hexaiberobathynella* Camacho & Serban, 1998, and the only known species of the genus *Guadalopecathynella* Camacho & Serban, 1998. The genus *Parabathynella* Chappuis, 1926 has a total of

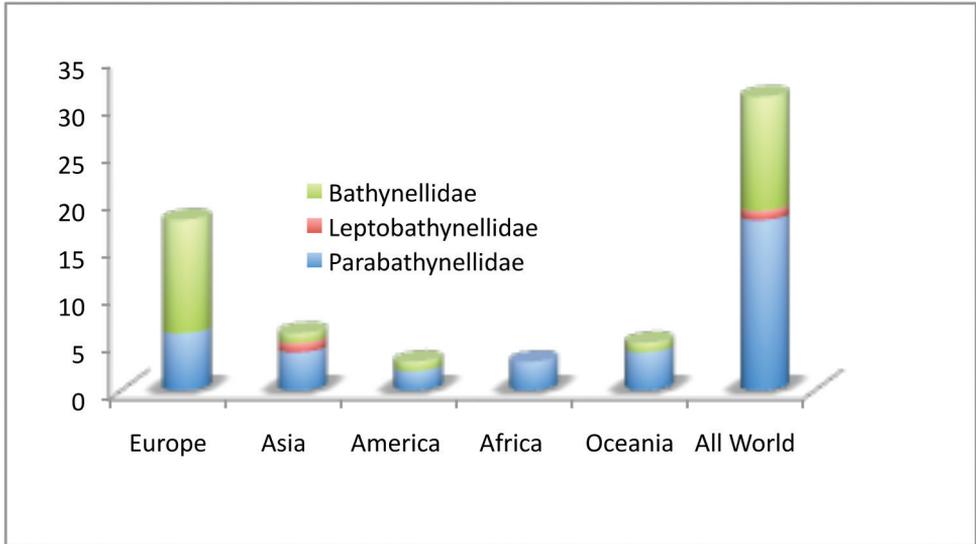


Figure 8. Number of genera of Bathynellacea by families and continents in the MNCN collections versus world.

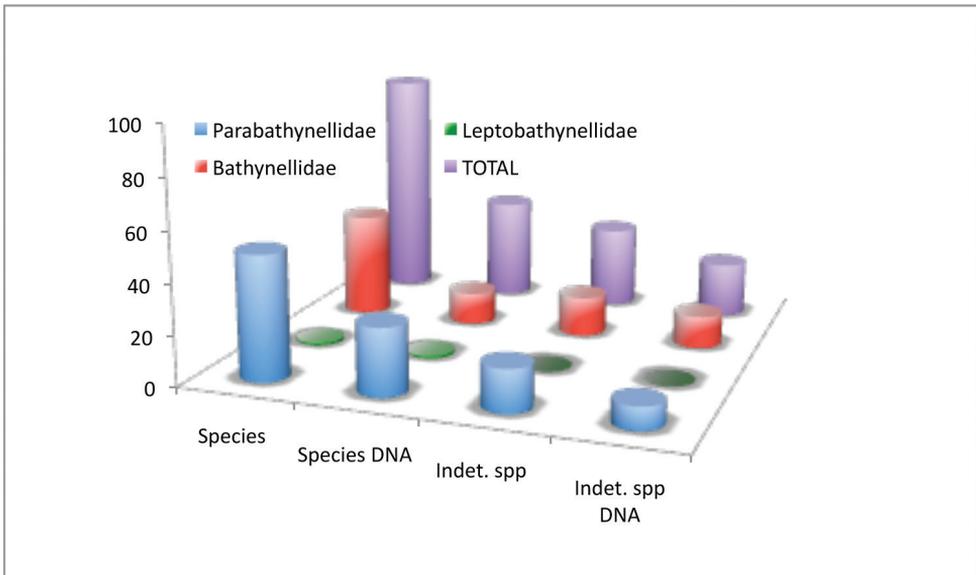


Figure 9. Number of species (total and DNA extract) of Bathynellacea by families in the MNCN collections.

three species in all of Europe, and two of them are included in the collection. Finally, the cosmopolitan genus *Hexabathynella* Schminke, 1972, which includes 23 species worldwide, is represented in the collection by six species, three of them including DNA extracts (Table 3).

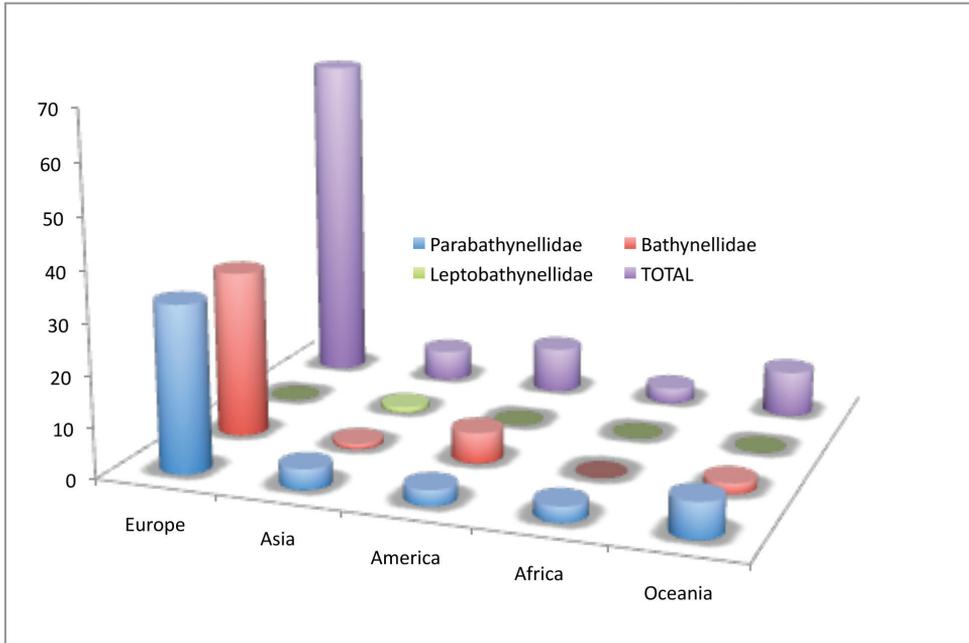


Figure 10. Number of species of Bathynellacea by continents and families in the MNCN collections.

The Leptobathynellidae, only known from North America and the Austral hemisphere in Asia, Africa and America with 19 species, is included in the collection through 20 specimens belonging to a single species.

The Bathynellidae is less known across the world than the Parabathynellidae, although particularly in Europe, where its generic and specific diversity is higher, it is the best known family, as well as the most represented in this collection, with 43 of the 103 known species worldwide included (approximately half of these are dubiously assigned to the genus *Bathynella* Vejdovsky, 1882, which some authors consider cosmopolite) (Figures 5, 9). In total, 13 of these species include DNA extracts in the collection (Table 3). There is also a high number of undetermined species, at least 16, and 13 of these include DNA extracts. The collection includes at least 35 European species in total (Table 1); 15 are assigned to the genus *Bathynella*, but should be revised based on the most recent discoveries offered by molecular techniques. The collection holds five of the seven species known for the genus *Gallobathynella* Serban et al., 1971, five of the seven species known from the genus *Vejdovskybathynella* Serban & Leclerc, 1984, and nine of the ten species assigned to the rest of European genera. There are DNA extracts in the collection of several of these. The presence of the genus *Pacificabathynella* Schminke & Noodt, 1988, in the collection is also important with 4 of the 5 American species known included. In the case of the species *P. yupik* Camacho et al., 2015 from Alaska, DNA extracts are also preserved. The rest of the continents have a relatively low representation (Figure 10).

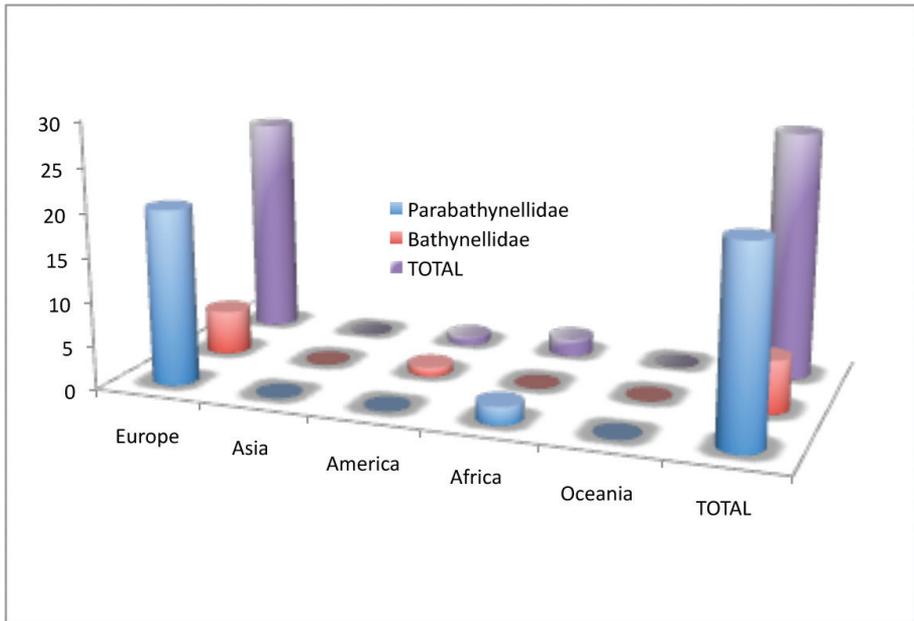


Figure 11. Number of holotypes (DNA extract) of Bathynellacea by continents and families in the MNCN collections.

It is worth noting the holotype collection and the type series of Bathynellacea housed at the MNCN. Table 2 contains a summary of the new taxa (11 genera and 43 species) described by AIC ranging across different families and continents, and whose holotypes and type series are deposited in the collections of the MNCN, either as permanent slices in the arthropod collection (Figure 9), or as DNA extracts in the tissue and DNA collection (Figures 2, 11). The Parabathynellidae includes 33 holotypes and the type series of ten genera coming from all continents: 20 holotypes come from Spain belonging to the genera *Iberobathynella*, *Guadalopebathynella*, *Paraiberobathynella*, *Hexaiberobathynella* and *Hexabathynella*. Four other holotypes belong to new genera and species from Thailand, China and Vietnam, another holotype is a new genus from Montana (USA), and other eight holotypes correspond to six Australian and two African species (Figure 2). In the case of the Bathynellidae, there are en holotypes, six Spanish species from two genera (*Paradoxyclamousella* Camacho et al., 2013a and *Vejdovskybathynella*), and 4 more from the USA (Montana and Alaska), all from the genus *Pacificabathynella* Schminke & Noodt, 1988. Table 4 includes all the details of these species and populations, including information on habitat, locality, year of description, the vouchers of the morphologic holotypes, as well as the molecular type series and the composition of the type series in terms of number of specimens. In the case of most of the newly described European species, from both families, as well as for the two African species and of *Pacificabathynella yupik* from Alaska, there are DNA extracts included in the collection (Figure 11).

Table 4. New taxa by families and continents of Bathynellacea with type series are deposited in the MNCN collection. * Oceania= Geopolitic region (Australia and New Zealand in this paper).

| Taxa | Continent | | | | | TOTAL New genus/new species |
|----------------------------|------------------------|------------|------------|------------|------------|--------------------------------|
| | New genus /new species | | | | | |
| | Europe | Asia | America | Africa | *Oceania | |
| Parabathynellidae | 3/21 | 4/4 | 1/1 | 0/2 | 2/6 | 10/34 |
| Bathynellidae | 1/6 | 0/0 | 0/4 | 0/0 | 0/0 | 1/10 |
| Leptobathynellidae | 0/0 | 0/0 | 0/0 | 0/0 | 0/0 | 0/0 |
| Total Bathynellacea | 4/26 | 4/4 | 1/5 | 0/2 | 2/6 | 11/44 |

Taxonomic ranks

Kingdom: Animalia

Phylum: Arthropoda

Class: Crustacea

Order: Bathynellacea

Family: Bathynellidae, Parabathynellidae, Leptobathynellidae.

Common names: does not exist

Spatial coverage

General spatial coverage: Specimens from all around the world are included, from Alaska (USA) to New South Wales (Australia). Figure 12 includes the number of records per continent, as well as the part corresponding to permanent slices and DNA extracts. The material from the USA comes from a few samples collected in the states of Montana, Washington, Alaska and Texas, and some of the specimens are still pending identification. In total, the database has 200 records (19 corresponding to DNA extracts) from the four species of Bathynellidae and the two species of Parabathynellidae originating from the 18 localities visited in the previously mentioned states. There are also 25 records from three South American localities in Chile, Brazil and Argentina which represent three species in total. The Asian countries included in the collection are China, Thailand, Vietnam and a pair of localities from Mongolia and India, adding up to 149 records corresponding to six species from a total of nine localities. In the case of Africa, there are samples from Morocco (29 records, 12 DNA extracts, and two species in total from two localities) and Chad (41 records, 14 DNA extracts, and with a total of two species from a single locality). Australia is represented by samples from Queensland and New South Wales, adding to a total of 270 records from seven localities that include 13 species in total (some still undetermined).

The most important part of the database is composed by European records, especially from Spain (2064 records, including more than 50 species, with 631 DNA extracts), although other countries are also represented: Italy (256 records, 40 localities and 15 species), France (158 records, 12 DNA extracts, from 24 localities, and 12 species), Portugal

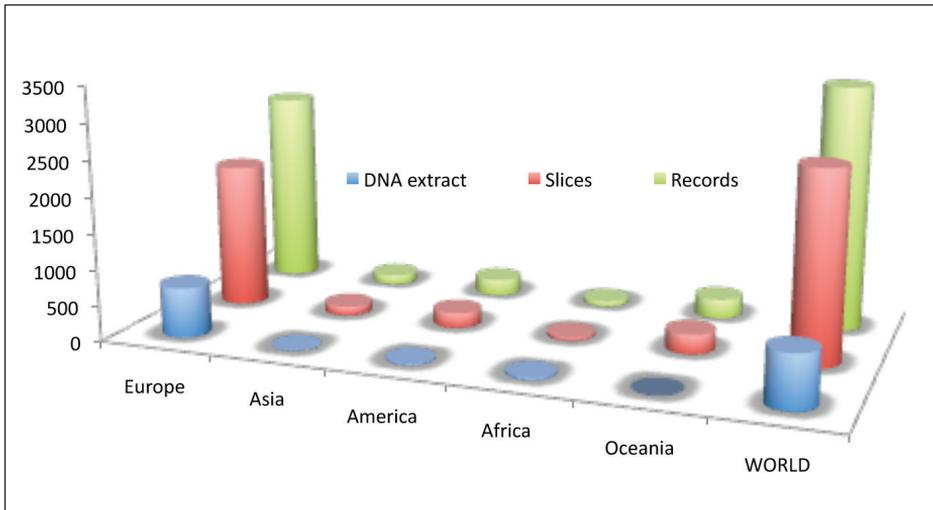


Figure 12. Number of records of Bathynellacea by continents in the MNCN collections.

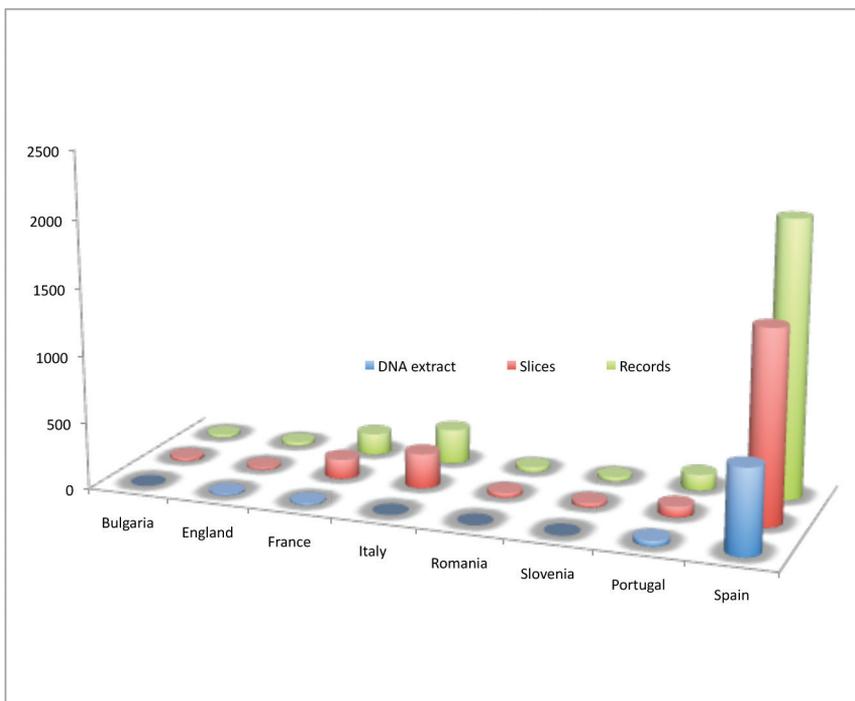


Figure 13. Number of records of Bathynellacea from Europe by countries in the MNCN collections.

(116 records, 38 DNA extracts, five localities and 11 species), England (28 records, 11 DNA extracts, four localities and a single species), Bulgaria (21 records, from three localities and four species), Slovenia (26 records, four localities and two species) and Romania (34 records, seven localities and six species) (Figure 13).

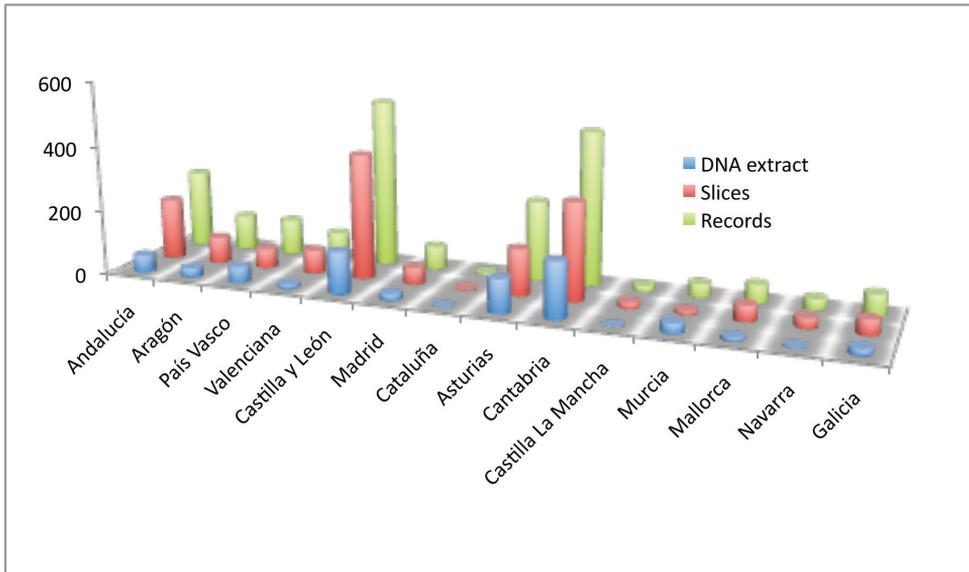


Figure 14. Number of records of *Bathynellacea* from Spain by Autonomous Communities in the MNCN collections.

In the case of Spain, almost all Autonomous Communities are represented (Figure 14), as well as most of the provinces, although Cantabria (472 records) and Burgos (373 records) are the most widely represented, followed by Asturias (245 records) and Soria, Vizcaya, Huesca and Teruel with more than 100 records for each province. There are records for seven of the eight Andalusian provinces (239 records in total): 76 records for Huelva, 57 for Sevilla, Málaga with 41 records, Almería with 35 records, Córdoba 18 records, Granada with nine records and Jaén with only three records. Cádiz is the only Andalusian province without any information in the database. Madrid has 71 records, Galicia 66, the Balearic Islands (only Mallorca) 57, Navarra 33 records and Catalonia with only four records. The rest of the provinces have relatively few records: León 24, Salamanca only 1, Guadalajara 14 records, Ávila and Toledo, both with four records. The only Autonomous Communities not present in the data base are Extremadura and La Rioja (Table 5).

There are 631 DNA specimens coming from basically all provinces, with the exception of Salamanca, Toledo and Jaén. Again the highest number of these specimens come from Cantabria (172 DNA extracts), followed by Asturias (142 DNA extracts) and Burgos (83 extracts). A detailed analysis of the distribution of species and localities where bathynellaceans live in Spain is available in a data paper previously published (Camacho et al., 2014).

Coordinates

Latitude/longitude 62.323016/-148.014001 to -24.75764/152.38247

Table 5. Records of Spanish Bathynellacea from Autonomous Communities and provinces in the collection of the MNCN. * Written in Spanish to keep the original name.

| *Autonomous Communities | *Provinces | Records |
|----------------------------|------------------------|------------|
| Andalucía | Almería | 35 |
| | Cádiz | 0 |
| | Córdoba | 18 |
| | Granada | 9 |
| | Huelva | 76 |
| | Jaén | 3 |
| | Málaga | 41 |
| Aragón | Sevilla | 57 |
| | Huesca | >100 |
| | Teruel | >100 |
| Asturias | Zaragoza | 0 |
| Canarias | Asturias | 245 |
| Cantabria | Las Palmas | 0 |
| | Santa Cruz de Tenerife | 0 |
| Castilla La Mancha | Cantabria | 472 |
| | Albacete | 0 |
| | Ciudad Real | 0 |
| | Cuenca | 0 |
| | Guadalajara | 14 |
| Castilla y León | Toledo | 4 |
| | Ávila | 4 |
| | Burgos | 373 |
| | León | 24 |
| | Palencia | 0 |
| | Salamanca | 1 |
| | Segovia | 1 |
| | Soria | >100 |
| | Valladolid | 0 |
| Zamora | 0 | |
| Cataluña | Barcelona | 0 |
| | Gerona | 1 |
| | Lérida | 3 |
| | Tarragona | 0 |
| Ciudades Autónomas | Ceuta | 0 |
| | Melilla | 0 |
| Comunidad de Madrid | Madrid | 71 |
| Comunidad Foral de Navarra | Navarra | 33 |
| Comunidad Valenciana | Alicante | 75 |
| | Castellón | 3 |
| | Valencia | 23 |
| Extremadura | Badajoz | 0 |
| | Cáceres | 0 |

| *Autonomous Communities | *Provinces | Records |
|-------------------------|------------|---------|
| Galicia | La Coruña | 0 |
| | Lugo | 44 |
| | Orense | 12 |
| | Pontevedra | 13 |
| Islas Baleares | Baleares | 57 |
| La Rioja | La Rioja | 0 |
| País Vasco | Álava | 14 |
| | Guipúzcoa | 0 |
| | Vizcaya | >100 |
| Región de Murcia | Murcia | 44 |

Temporal coverage (specimens' data range)

1968–2016

Temporal coverage (collection formation)

1983–present

Natural collections description

Parent collection identifier: NA

Collection name: Camacho Collection (AIC), Arthropods Collection and Tissues and DNA Collection

Specimen preservation method: permanent slices (glycerin jelly and paraffin) and frozen DNA extracts in water.

Curatorial unit: 3399 with an uncertainty of 0 (records)

Methods

Method step description: The collection has been digitized with MSEXCEL software, compatible with Darwin Core 1.2 or Darwin Core 1.4.

Pre-digitization phase: The identifications of each specimen from each sample has been reviewed recently and some former imprecisions and the discovery of cryptic species (due for example to the use of molecular techniques) have lead modifying some records in the Excel file used as starting point for this work. The initial files were short on the number of fields for each of the records, specimens, sampling sites and dates of sampling (date, locality, province, habitat, collector and the species found with data on the family genus, species and author).

Digitization phase: Starting from the initial Excel file, the standard fields for a Darwin Core1.2 database were added as needed, and the geographical data was included (UTM coordinates) from a GPS in association to the samples taken (PASCALIS samples and all those taken after the year 2000), or were obtained from grey (speleological reports) or published (Notenboom and Meijers 1984; Puch 1998) literature (i.e., the precise location through GPS in the entrance of the caves where bathynellid samples have been collected), or were recorded by the researchers who donated the specimens when possible, as well as from type specimens.

Creation of the dataset: The dataset was exported as a file in Darwin Core1.2 format. Darwin Core elements included in dataset structure are listed in the dataset description section. A Darwin Core table was prepared from the original database project. The field-to-filed mapping was fine-tuned with the support of GBIF-Spain's Coordination Unit. The resulted table was imported into the Darwin Test tool (http://www.gbif.es/darwin_test/Darwin_test_in.php, Ortega-Maqueda and Pando, 2008). This tool allows detailed structuring of metadata of the dataset, and also performs a number of quality checks on the data (dataset structure compliance to Darwin core, geographic consistency, date format, etc. currently over sixty of those checks are carried out). Once the potential errors flagged have been checked and corrected, a Darwin Core Archive is generated, also by the DarwinTest tool. The produced DwC-A is then uploaded to the GBIF-Spain's IPT installation (<http://www.gbif.es/ipt/resource?r=mncn-artp>). From there, the dataset is made public, registered in GBIF and indexed and published by the GBIF data portal.

The dataset was transformed to a Darwin Core Archive format with metadata to ensure rapid discovery of this biodiversity resource and future publishing as a citable academic paper (Chavan and Penev, 2011)

Study extent description: The MNCN bathynellacean collection begins with the sampling campaigns of AIC in northern Spain for her doctoral thesis since 1983. Some samples studied by AIC were obtained between 1976 and 1978 by R. Rouch in three short sampling trips to different areas of the Iberian Peninsula. From 1984 to 1986 J. Notenboom, assisted by I. Meijers, and later P. van der Hurk & R. Leys, took groundwater samples throughout Spain and all Bathynellacea they found in these samples were also donated to AIC for study. The following years AIC has continued obtaining samples of this fauna throughout Spain in the framework of different research projects. It is worth noting the PASCALIS European project (2002–2004) in which AIC and her team conducted intensive sampling of groundwater fauna in the Cantabrian mountain ranges and north of Burgos, an area where continuous sampling has been done since then, together with C. Puch, increasing substantially the number of Bathynellacea records in Spain. Occasional samplings of particular Parabathynellidae species have been done by AIC and C. Puch in touristic Spanish caves in Andalusia, Murcia and Galicia in order to obtain DNA extracts. On top of this, since the beginning of the 2000s, AIC has been receiving donations for her research coming from Spain, but also from other parts of the world (France, Italy, Bulgaria, England, USA, China, Vietnam, Thailand, Mongolia, Chad and Australia).

Sampling description: Material of this collection has been collected in five ways:

- 1) Samples collected by Rouch in two short sampling campaigns in the Iberian Peninsula (1976 and 1977).
- 2) Samples collected in the sampling campaigns of Notenboom, in 1984, 1985 and 1986 in the Iberian Peninsula within the framework of his PhD thesis.
- 3) Samples collected by AIC in 1983 for her PhD thesis (1987), plus samplings done in the framework of several research projects already mentioned, always with the collaboration of C. Puch and other speleologists (F. Molinero, A.M. de Juan, J. Robador, F. Lázaro, J. Bedoya) from 1984 until today.
- 4) Samples collected by AIC and her team as Spanish partners of the European Project "PASCALIS" (Cantabrian mountain range) (2002-2004).
- 5) Some particular samples, with more or less extensive associated information, have been donated to AIC by fellow researchers worldwide: E. Ortiz, D. Jaume, A. Tinaut, J. Rodríguez, A. García-Valdecasas, P. Rodríguez, E. Bello, C. Noreña, P. Martínez-Arbizu, J. Comas, L. Barrera, F. Mezquita, C. Prieto, E. Serban, N. Coineau, C. Boutin, C. Bou, J. Mathieu, M-J. Dole-Olivier, F. Castellerini, C. des Chatelliers, E. Castella, F. Malard, F. Stoch, D. Galassi, T. di Lorenzo, M.C. Bruno, B. Sket, P. Trontelj, P. Leclerc, Y. Ranga Reddy, M. Peralta, I. Pandoursky, S. Watirogram, R. Newell, E. Snyder, J. Stanford, B. Reid, B. Hutchins, Gibson, J. Little, Z. Crete, P. Hancock and L. Knight.

The methods used in collecting this kind of samples can be seen in Camacho, 1992 and 1994. The samples are fixed in the field in formalin 4%, ethanol 96°, or are frozen. Each sample collected is studied under a binocular microscope in order to isolate the bathynellid specimens found.

The specimens used for morphological study are stored in alcohol (70%). The specimens used for molecular study are frozen at -80°C. A complete dissection, of all anatomical parts of specimens, dropped on pure glycerin, is necessary for taxonomic study. Both, entire specimens or all parts of a dissection specimen are preserved together in permanent slides and kept in special metal slides. Glycerin gelatin stained with methylene blue and paraffin is the mounting medium (Figure 7). Anatomical examinations are performed using an oil immersion lens (100X) of an interference microscope. Method modified after Serban's method personally transmitted to AIC in 1993 and 1995 (Perina and Camacho, 2016).

The specific techniques used for molecular analysis for taxonomic application are detailed in Camacho et al. 2011, 2012, 2013a, 2015 and 2016.

Quality control description: Systematics reliability and consistency is backed by the experience of AIC, who made all identifications in the field of Bathynellacea taxonomy. Recently, some identifications made are being confirmed by molecular data. The validation and cleaning of the associated geographical information has been introduced in several steps as a key issue of the digitization process.

Datasets

Dataset description

Object name: Darwin Core Archive The collection of Bathynellacea specimens of MNCN (CSIC) Madrid: microscope slices and DNA extracts.

Character encoding: UTF-8

Format name: Darwin Core Archive format

Format version: 1.2

Distribution: <http://www.gbif.es/ipt/resource?r=mncn-artp>

Publication date of data: 2016/11/22

Update police: Annually when necessary to transmit data of new samples or taxonomic changes.

Language: English

Licenses of use: This dataset [The collection of Bathynellacea specimens of MNCN (CSIC) Madrid: microscope slices and DNA extracts] is made available under the Open Database License: <http://opendatacommons.org/licenses/odbl/1.0/>. Any rights in individual contents of the database are licensed under the Database Contents License: <http://opendatacommons.org/licenses/dbcl/1.0/>.

Metadata language: English

Date of metadata creation: 2016/11/22

Hierarchy level: Dataset

Contributions

The main collectors are J. Notenboom & I. Meijers, R. Rouch, A.I. Camacho (AIC) especially C. Puch and speleologist F. Molinero and A.M. de Juan, J. Robador and F. Lázaro members of G.E. Edelweiss, plus some particular donations by other Spanish researchers: E. Ortiz, D. Jaume, A. Tinaut, J. Rodríguez, A. García-Valdecasas, P. Rodríguez, E. Bello, C. Noreña, P. Martínez-Arbizu, J. Comas, L. Barrera, F. Mezquita and C. Prieto and other foreign researchers: E. Serban, N. Coineau, C. Boutin, C. Bou, L. Knight, J. Mathieu, M-J. Dole-Olivier, F. Castellerini, C. des Chatelliers, E. Castella, F. Malard, F. Stoch, D. Galassi, T. di Lorenzo, M.C. Bruno, B. Sket, P. Trontelj, P. Leclerc, Y. Ranga Reddy, M. Peralta, I. Pandoursky, S. Watiroyram, R. Newell, E. Snyder, J. Stanford, B. Reid, B. Hutchins, Gibson, J. Little, Z. Crete, P. Hancock and L. Knight.

Online at

<http://www.gbif.es/ipt/resource?r=mncn-artp>

<http://www.gbif.org/dataset/07f0789f-c777-4c99-acb3-815c78c7db81>

<http://doi.org/10.15470/t1lssy>

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The identity of three South American “smiliine” treehoppers (Hemiptera, Membracidae) and related taxonomic changes, including description of a new genus in Thuridini

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Abstract

Based on examination of holotypes or interpretation of original descriptions, four taxonomic changes are proposed for South American species erroneously placed in the tribe Smiliini: *Flynnia*, **gen. n.** (Thuridini) and *F. fascipennis* (Funkhouser), **comb. n.** from Bolivia; *Antianthe atromarginata* (Goding), **comb. n.** from Ecuador; *Amastris pilosa* (Funkhouser), **comb. n.** from Peru; and *Thelia planeflava* Fairmaire from Brazil to Polyglyptini *incertae sedis*, **new placement**.

Keywords

New genus, new combination, new placement, Smiliinae, Smiliini

Introduction

Previously, McKamey and Wallace (2015) evaluated the true identities of South American records of the Nearctic tribe Telamonini, which had all been the result of errors in labeling, in published distribution, or species that belonged to other subfamilies. Four species of the related tribe Smiliini (Smiliinae) (*sensu* Wallace 2011) were also described

from South America: *Ophiderma fascipennis* Funkhouser from Bolivia, *Atymna pilosa* Funkhouser from Peru, *Cyrtolobus (Atymna) atromarginata* Goding from Ecuador, and *Thelia planeflava* Fairmaire (Telamonini but most recently placed in the genus *Ophiderma* of Smiliini) from Brazil. Smiliines are principally Nearctic, with numerous species occurring in the mountains of Central America, and throughout their range usually feed on oaks (*Quercus* sp.). Because oaks drop out of the flora in northern Colombia, the existence of true smiliines in South America was highly suspect. Examination of three holotypes and one original descriptions of these species revealed their identities as listed below.

Methods

Holotypes of three species were in the National Museum of Natural History, Washington, DC (USNM). The holotype of the other species could not be located, so its placement is inferred from original descriptions. Morphological terminology follows Deitz (1975).

To examine the holotype of *Ophiderma fascipennis*, the abdomen and right metathoracic leg were removed from the specimen and treated with 8–10% KOH for 45 minutes, rinsed with water and then transferred to glycerin for further dissection and examination. After examination, the dissected male genitalia and metathoracic leg were stored in a microvial with fresh glycerin and pinned below the specimen. The head and pronotum, as a unit, were also separated so that the mesonotum could be examined, to possibly infer nymphal structure. This latter separated body part was pointed on the same pin as the head and pronotum.

All images were captured with a Microvision system and Cartograph 8.0.6 auto-montage software and adjusted in Adobe Photoshop.

Results

Tribe Amastrini Goding

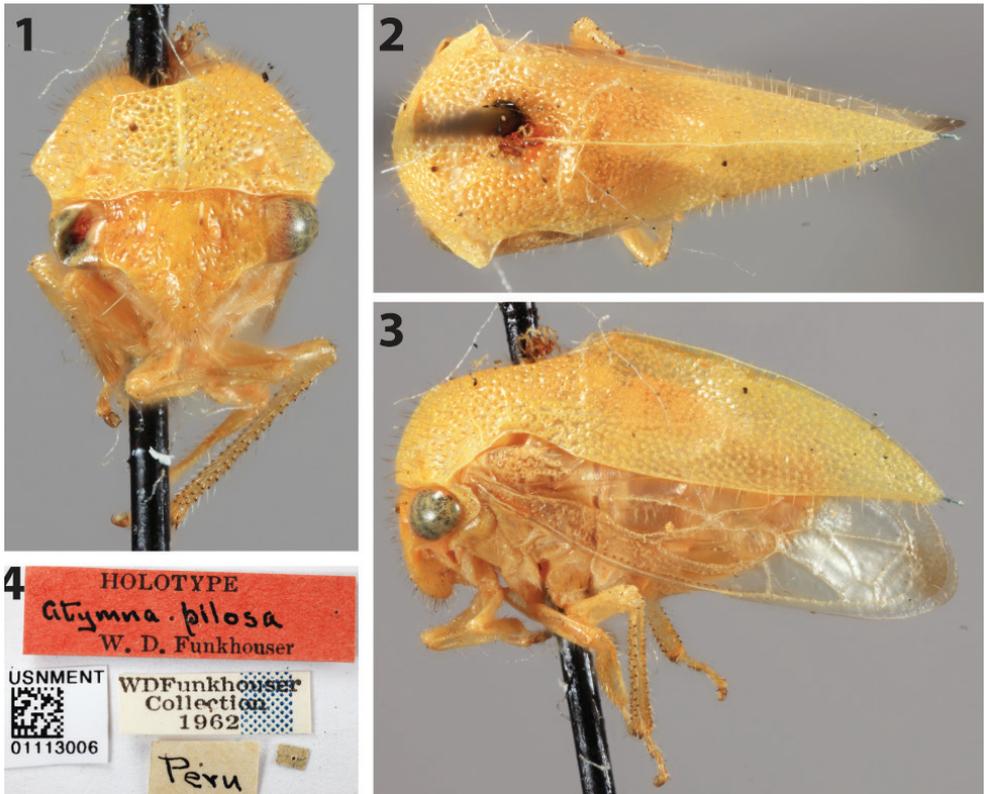
Amastris pilosa (Funkhouser), comb. n.

Figs 1–4

Atymna pilosa Funkhouser 1919: 273 [sp. n.].

Material examined. *Atymna pilosa* female holotype, Peru (USNM; Figs 1–4).

Discussion. The holotype, which has its pronotum partially damaged dorsoanteriorly, exhibits all features of *Amastris* Stål, including the forewing veins R and M initially fused then strongly divergent (a character diagnostic for the tribe). Within the tribe only *Amastris* and *Erosne* Stål have tectiform pronota, and *Erosne* has a sturdier pronotum with a yellow lateral margin.



Figures 1–4. *Amastris pilosa* (Funkhouser) female holotype in anterior, dorsal, and lateral views, respectively, and labels.

Tribe Polyglyptini Goding

Polyglyptini incertae sedis, new placement

Thelia planeflava Fairmaire, 1846: 306. [sp. n.] Brazil.

Heranice planeflava; Funkhouser 1927: 317.

Ophiderma planeflava; Goding 1929: 277.

Discussion. No holotype or other specimen was located. Fairmaire’s (1846) description of *T. planeflava* translates to: “Prothorax projecting backward, very little elevated, rugosely punctate throughout the head; entirely yellow; base of the abdomen a little orange; forewings hyaline, with the internal margin slightly coated.” He reported it as 6 mm long.

In the mid 1800’s, Fairmaire’s period, the concept of *Thelia* Amyot & Serville contained many unrelated taxa that have since been referred to other tribes and subfamilies. Fairmaire’s (1846) publication is a good example, with three of his species now belonging to *Hypheodana* Metcalf (Darninae: Darnini), *Carynota* Fitch (Smiliinae:

Telamonini), and *Heranice* Stål (Smiliinae: Polyglyptini). His placement of his fourth, Brazilian species, *planeflava* in *Thelia*, therefore, offers no clues to its true identity. It is also unfortunately not illustrated, as were the other species.

In his catalogue, without explanation, Funkhouser (1927) moved *planeflava* from *Thelia* to *Heranice*, and Goding (1929) moved it to *Ophiderma* Fairmaire. Schmidt (1931) discussed *planeflava* and ultimately included it in his key to *Heranice*, restating Fairmaire's original description.

Based on Fairmaire's description, the species' length, and reported distribution, it is unlikely to be any of the aforementioned genera; *Thelia*, *Carynota*, and *Ophiderma* have Nearctic distributions (and further, *Ophiderma* feeds on oaks, which do not occur in Brazil). *Heranice* are larger and apparently confined to high elevations in the Andes Mountains, and *Hypheodana* are brown.

Polyglyptini often have the anterior region of the forewing coriaceous and punctate, which may be what Fairmaire considered "coated" and, while no entirely yellow species are known, most Polyglyptini genera have a slightly elevated pronotum that extends backward over the body.

Tribe Thuridini Deitz

Flynnia gen. n.

<http://zoobank.org/FCB8F8E3-36A3-4B4A-889C-B2CC7D40654E>

Type species. *Ophiderma fascipennis* Funkhouser, 1919: 274.

Description. Head. Vertex with dorsal margin sinuate. highest between ocelli and eyes; ocelli slightly closer to inner margin of eyes than to each other; frontoclypeus evenly rounded ventrally; rostrum attaining abdomen. Thorax. Posterior process of pronotum smooth and finely punctate throughout (Figs 5–7), weakly sinuous in lateral view, slightly overlapping forewings in repose. Mesonotum bare, lacking vestigial scoli. Forewing (Fig. 10) with veins R and M fused basally and strongly divergent near middle of wing, veins R_{4+5} and M_{1+2} confluent for a short distance and very strongly divergent more distally, 2 m-cu crossveins present, 1st near mid length of wing. Hind wing without r-m crossvein, veins R_{4+5} and M_{1+2} confluent for short distance and divergent beyond, anal vein unbranched. Metathoracic leg (Fig. 12) without cucullate femoral setae, tibia without cucullate setae in row 1, very few in row II (where the leg is more strongly sclerotized, as indicated by arrows, Fig. 12), first tarsomere with about eight cucullate setae scattered on plantar surface (Fig. 8). Abdomen. Lacking dorsal protrusions or smooth fossae.

Distribution. Bolivia and Ecuador.

Etymology. The genus is feminine and named for Dawn Flynn for her contributions to our knowledge Neotropical treehoppers.

Discussion. Many of the aforementioned features are diagnostic for the tribe Thuridini as listed by Deitz (1975): posterior process of pronotum slightly overlapping forewings; forewing with veins R and M fused basally and strongly divergent near middle of wing; veins R_{4+5} and M_{1+2} confluent for short distance and very strongly divergent more distally; hind wing without r-m crossvein, veins R_{4+5} and M_{1+2} confluent for short distance and divergent beyond; metathoracic leg without cucullate femoral setae, tibia without cucullate setae in row I. An additional similarity of the new genus and *Thuris* Funkhouser is presence of about eight cucullate setae on the first tarsomere of the metathoracic leg, and the dark markings on and around the apical veins of the forewing. Some treehoppers that have scoli on the mesonotum, metanotum, or both (e.g., *Alchisme* Kirkaldy) have shriveled, vestigial scoli in the adults underneath the pronotum. The absence of vestigial scoli cannot be inferred to mean that the nymph lacks thoracic scoli. Nevertheless, taken together with the absence of dorsally paired processes or fossae on the abdomen, it is more likely that the nymph, unknown, may be unarmored, as is the nymph of *Thuris* (McKamey and Porter 2016). Until now, the tribe was composed of one genus and two species (McKamey and Porter 2016). The new genus is easily distinguished from *Thuris*, which has a strongly keeled pronotum posteriorly. Bolivia represents a new country record for the tribe.

***Flynnia fascipennis* (Funkhouser), comb. n.**

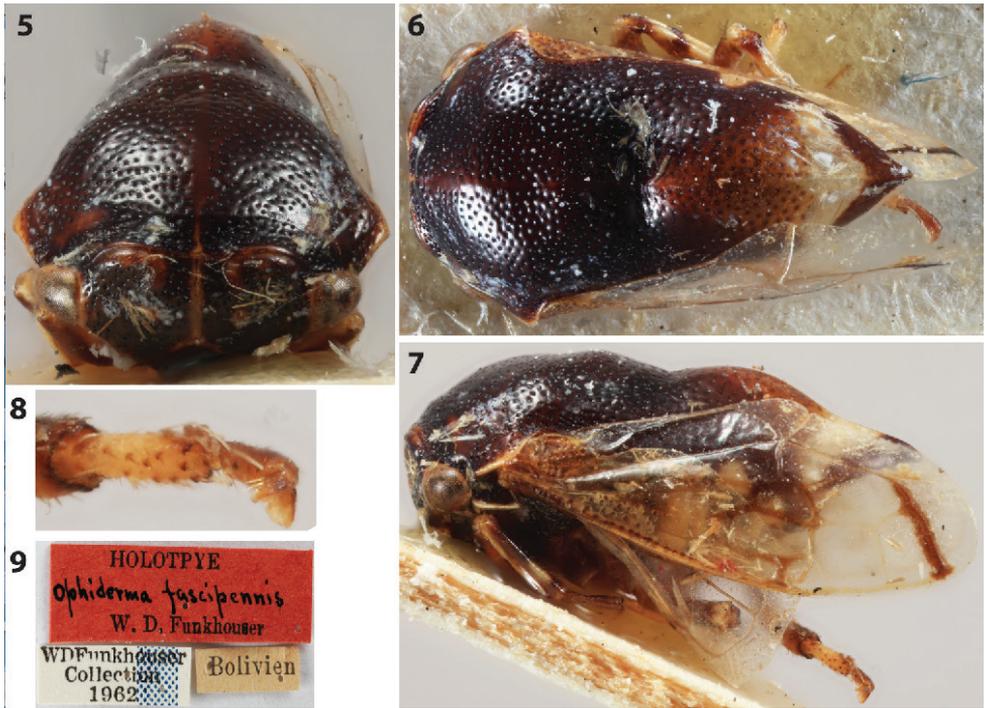
Figs 5–12

Ophiderma fascipennis Funkhouser, 1919: 274 [sp. n.].

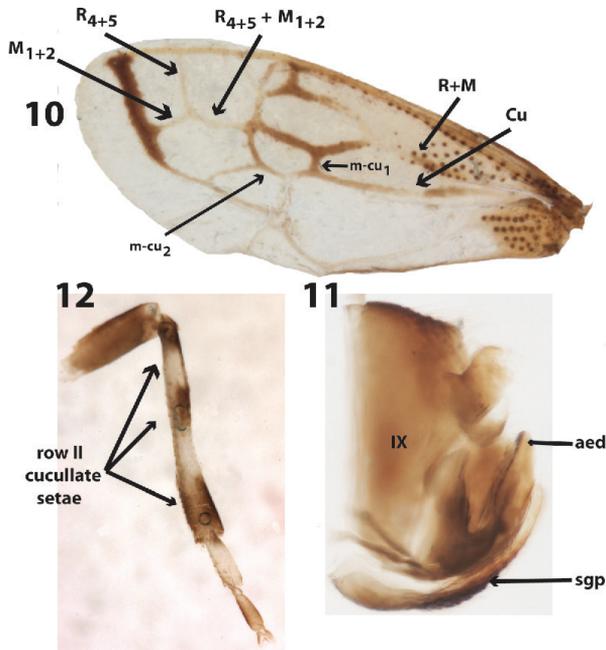
Description of male. Length including wings in repose 3.9 mm, maximum width 1.8 mm. Pronotum, wings, and leg features as described for genus. Pronotum black with small white spot along the lateral margin and white V-shaped band before apex (Fig. 6). Male genitalia (Fig. 11). Pygofer with lateral plate separated; subgenital plates fused basally to about mid length; styles hooked distally, recurved anterolaterally; aedeagus U-shaped, shaft weakly expanded, flat anteriorly, margins and surface without dentae or serrations, gonopore posterior.

Female unknown.

Material examined. *Ophiderma fascipennis* male holotype, BOLIVIA (USNM). *Thuris binodosus* (Goding) holotype (USNM). Unfortunately the locality label of *F. fascipennis* lacks precision, simply stating "Bolivien" (Fig. 9). One male, ECUADOR: Orellana Prov., Reserva Etnica Waorani, 1 km S Onkone Gare Camp Transect Ent. 2163m, 3-Feb-1995, 00°39'25.7"S, 076°27'10.8"W. T.L. Erwin et al. Fogging terre firme forest. Lot#954 (USNM). One male, same data as previous except 6-Jul-1995 and Lot#1115 (USNM).



Figures 5–9. *Flynnia fascipennis* (Funkhouser) male holotype. 5–7 Habitus in anterior, dorsal, and lateral views, respectively 8 Right metathoracic tarsus 9 labels.



Figures 10–12. *Flynnia fascipennis* (Funkhouser) male holotype. 10 left forewing 11 pygofer, subgenital plate, aedeagus 12 Right metathoracic leg. aed, aedeagal shaft, sgp, subgenital plate.



Figures 13–16. *Antianthe atromarginata* (Goding), comb. n., holotype. **13–15** Habitus in anterior, dorsal, and lateral views, respectively. Note that the extended humeral angles are broken off **16** Holotype labels.

Subfamily Smiliinae, *incertae sedis*

Antianthe atromarginata (Goding), comb. n.

Figs 13–16

Cyrtolobus (*Atymna*) *atromarginata* Goding, 1928: 137 [sp. n.].

Atymna atromarginata; Plummer 1938: 237

Material examined. Holotype (USNM). Abdomen, left forewing, and both extended humeral angles missing. The species was described from Ecuador, Guayas Prov., Cerro Manglaralto (Fig. 16).

Goding’s holotype is probably a junior of *A. expansa* (Germar), which is also recorded from Ecuador. Wallace (2011) removed *Antianthe* Fowler from Smiliini. The holotype labels (Fig. 16) erroneously spell the species as “*marginata*” but the species description and locality match the published name “*atromarginata*.” The same mistake (and same missing prefix) was made with the holotype (USNM) labels of *Cymbomorpha atromaculata* Goding.

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Species delimitation of the *Hyphydrus ovatus* complex in western Palaearctic with an update of species distributions (Coleoptera, Dytiscidae)

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Abstract

The species status of *Hyphydrus anatolicus* Guignot, 1957 and *H. sanctus* Sharp, 1882, previously often confused with the widespread *H. ovatus* (Linnaeus, 1760), are tested with molecular and morphological characters. Cytochrome c oxidase subunit 1 (CO1) was sequenced for 32 specimens of all three species. Gene-trees were inferred with parsimony, time-free bayesian and strict clock bayesian analyses. The GMYC model was used to estimate species limits. All three species were reciprocally monophyletic with CO1 and highly supported. The GMYC species delimitation analysis unequivocally delimited the three species with no other than the three species solution included in the confidence interval. A likelihood ratio test rejected the one-species null model. Important morphological characters distinguishing the species are provided and illustrated. New distributional data are given for the following species: *Hyphydrus anatolicus* from Slovakia and Ukraine, and *H. aubei* Ganglbauer, 1891, and *H. sanctus* from Turkey.

Keywords

Dytiscidae, *Hyphydrus*, new records, Palaearctic region, Slovakia, Turkey, Ukraine, GMYC, species delimitation, reciprocal monophyly

Introduction

History of classification

The genus *Hyphydrus* Illiger, 1802 represents a well-defined group of medium sized, globular shaped Dytiscidae. Altogether 139 species occur in all regions of the Old World, with most species distributed in tropical Africa (Miller and Bergsten 2016; Nilsson and Hájek 2017a). A taxonomic revision of the genus was published by Biström (1982).

Only three *Hyphydrus* species occur in Europe (cf. Nilsson and Hájek 2017b). While the Mediterranean *H. aubei* Ganglbauer, 1891 can be easily identified based on black markings on ferruginous dorsal surface, the uniformly dark-ferruginously coloured *H. anatolicus* Guignot, 1957 is very similar to the widespread western Palearctic *H. ovatus* (Linnaeus, 1760) and it was not recognised until 1957. *Hyphydrus anatolicus* was described originally from Angora [= Ankara], Turkey (Guignot 1957). Subsequently Sanfilippo (1963) described the same species under the name *H. carrarai* Sanfilippo, 1963 from Italy. The synonymy of both species was established by Pederzani (1976). The species was later included in the revision of Biström (1982), who synonymized *H. anatolicus* with the older name *H. sanctus* Sharp, 1882, known previously only from the Levant region. Biström (1982) also argued that *H. sanctus* and *H. ovatus* should possibly be regarded as subspecies, but that more work was needed. Although Wewalka (1984) described the differences between *H. anatolicus* and *H. sanctus*, and a habitus photo of *H. anatolicus* was published by Hájek (2009), both mentioned species remain enigmatic, predominantly because of their similarity with *H. ovatus*, and because their distribution is not satisfactorily known.

Molecular data from museum specimens

With the advance of DNA Barcoding, extraction and amplification techniques have moved forwards in two directions. First towards high-throughput low-cost facilities racing from specimens to barcodes (Ivanova et al. 2006) and boosted by next-generation sequencing techniques (Shokralla et al. 2014). Second towards non-destructively generating DNA sequence data from older museum material with degenerated DNA (Gilbert et al. 2007). The latter will get ever more important as local and global extinction of species due to human activities means that getting fresh material of many species will be impossible or increasingly difficult. Therefore the only resort is to old, often dry-pinned or dry-mounted museum material, with the DNA degraded to various degrees. Little is known about exactly how fast DNA degrades under various conditions (but see Allentoft et al. 2012), but any probability model will have longer half-time the shorter the fragment. Thus, aiming for shorter amplicon size has been the preferred method, not least seen in the field of ancient DNA (Thomsen et al. 2009).

In this study, one of the three focal species is very rarely collected hence we attempt to amplify a >800bp segment of cytochrome c oxidase subunit 1 (CO1), from 19–25 years

old dry-mounted specimens. We do this by using additives to standard DNA extraction lysis solutions and designing a number of internal primers to amplify the target segment in six short but overlapping fragments. Extractions are done on whole body but completely non-destructive, an important requirement for invaluable museum specimens.

We also use the general mixed Yule coalescence model (Pons et al. 2006) and a likelihood ratio test to explicitly test whether the *H. ovatus*-complex is better seen as one species (null hypothesis) or several species (alternative hypothesis) in a statistical likelihood framework. The GMYC model was developed as a tool for exploring and delimiting poorly known faunas based on DNA sequences. However here we use it in the context of testing questioned taxa of unsettled taxonomic status in an integrated toolbox where both DNA sequence data, speciation/coalescence models and morphological data bear evidence on the hypothesis.

To clarify the status and distribution of *Hyphydrus anatolicus* and *H. sanctus*, we provide a basal differential diagnosis of both species and related *H. ovatus*. We confirm the specific status of all taxa with molecular analysis. In addition, we review published records and add new faunistic data for *H. anatolicus* and *H. sanctus*, as well as the first record of *H. aubei* from Turkey.

Material and methods

Hyphydrus ovatus was sampled throughout Europe. We acquired fresh material of *H. anatolicus* from Russia and dry-mounted specimens from Turkey, Greece and Slovakia. *Hyphydrus sanctus* was available only as dry-mounted specimens from Israel and Turkey for molecular analysis; *H. aubei* was used as an outgroup in the parsimony and non-clock analyses. The specimens included in this study are deposited in the following institutional collections; for specimens included in molecular analysis, see Table 1.

| | |
|-------------|---|
| BMNH | Natural History Museum [former British Museum (Natural History)], London, Great Britain (Christine Taylor); |
| HFCB | Hans Fery collection, Berlin, Germany (property of NHMW); |
| NHMW | Naturhistorisches Museum, Wien, Austria (Manfred A. Jäch); |
| NHRS | Naturhistoriska Riksmuseet (= Swedish Museum of Natural History), Stockholm, Sweden (Johannes Bergsten); |
| NMPC | Národní muzeum, Praha, Czech Republic (Jiří Hájek); |
| ZMAS | Zoological Institute, Russian Academy of Science, Sankt Petersburg, Russia (Alexander G. Kirejtshuk). |

Molecular analyses

The extraction protocol was different for the fresh alcohol-material of *H. ovatus* and *H. anatolicus* (from Russia) versus the dry-mounted older material of *H. anatolicus* and

Table 1. Data on extracted specimens, depository, catalogue number and genbank accession number for the CO1 fragment.

| Cat. ID | Species | Country | Region | Place | Date | Lat N | Lon E | Collector | Depository | CO1bp | Acc. No. |
|---------|------------------------------|-------------|----------------|--|--------------|--------|--------|-------------|------------|-------|----------|
| 704819 | <i>Hypohydrus ovatus</i> | UK:Scotland | Carrick | Kirkcudbrightshire, Syllodloch | 25:VI:2005 | 55.215 | -4.499 | G.N. Foster | NHM:BMNH | 825 | FN998871 |
| 721926 | <i>Hypohydrus anbei</i> | Spain | Tarragona | riu Algars, Horta de San Joan | 26:V:2005 | 40.991 | 0.277 | I. Ribera | NHM:BMNH | 825 | FN998872 |
| 722129 | <i>Hypohydrus ovatus</i> | UK:England | Norfolk | East Harling Common | 10:VII:2005 | 52.451 | 0.942 | G. Nobes | NHM:BMNH | 825 | FN998873 |
| 722301 | <i>Hypohydrus ovatus</i> | UK:Scotland | Carrick | Boreland of Girthon, Kirkcudbrightshire | 02:VII:2005 | 55.215 | -4.499 | G.N. Foster | NHM:BMNH | 788 | FN998874 |
| 722447 | <i>Hypohydrus ovatus</i> | UK:England | Norfolk | Thompson Common | 03:VII:2005 | 52.532 | 0.855 | G. Nobes | NHM:BMNH | 689 | FN998875 |
| 724810 | <i>Hypohydrus ovatus</i> | UK:England | Norfolk | Thompson Common | 25:IX:2005 | 52.529 | 0.854 | G. Nobes | NHM:BMNH | 731 | FN998876 |
| 749803 | <i>Hypohydrus ovatus</i> | Sweden | Ångermanland | Torrböle | 12:VI:2005 | 63.716 | 19.558 | AN. Nilsson | NHM:BMNH | 751 | FN998877 |
| 729468 | <i>Hypohydrus ovatus</i> | Sweden | Öland | Borgholm, Langlöt | 20:VI:2005 | 56.747 | 16.685 | J. Geijer | NHM:BMNH | 702 | FN998878 |
| 729591 | <i>Hypohydrus ovatus</i> | Sweden | Öland | Borgholm, Högstrum | 19:VII:2005 | 56.795 | 16.598 | J. Geijer | NHM:BMNH | 825 | FN998879 |
| 729653 | <i>Hypohydrus ovatus</i> | Latvia | Riga district | Gaujas National Park, Sigulda, Maža velhala | 10:VI:2005 | 57.152 | 24.865 | L. Hendrich | NHM:BMNH | 825 | FN998880 |
| 729731 | <i>Hypohydrus ovatus</i> | Latvia | Cesis district | Gaujas National Park, Klamani village | 11:VI:2005 | 57.3 | 25.25 | L. Hendrich | NHM:BMNH | 825 | FN998881 |
| 743243 | <i>Hypohydrus ovatus</i> | Germany | Bavaria | Eitring, Eitringter Moos | 19:VI:2005 | 48.3 | 11.933 | M. Balke | NHM:BMNH | 825 | FN998882 |
| 743298 | <i>Hypohydrus ovatus</i> | Germany | Brandenburg | 1.5 km N Friesland | 18:X:2005 | 52.267 | 13.083 | L. Hendrich | NHM:BMNH | 750 | FN998883 |
| 743957 | <i>Hypohydrus ovatus</i> | Germany | Bavaria | Murnauer Moos, Rollisch See | 06:IX:2005 | 47.683 | 11.2 | M. Balke | NHM:BMNH | 825 | FN998884 |
| 743962 | <i>Hypohydrus ovatus</i> | Sweden | Öland | Borgolm, Vanserum | 16:VIII:2005 | 56.691 | 16.641 | J. Geijer | NHM:BMNH | 825 | FN998885 |
| 743968 | <i>Hypohydrus ovatus</i> | Sweden | Öland | Borgolm, Runsten | 07:VII:2005 | 56.716 | 16.633 | J. Geijer | NHM:BMNH | 825 | FN998886 |
| 743973 | <i>Hypohydrus ovatus</i> | Sweden | Öland | Mörbylånga, Algustrum | 27:VIII:2005 | 56.687 | 16.598 | J. Geijer | NHM:BMNH | 825 | FN998887 |
| 800099 | <i>Hypohydrus ovatus</i> | Russia | Volgograd Obl | between Lisov & Polodin | 29:IV:2002 | 48.617 | 43.169 | J. Bergsten | NRM:NHRS | 825 | FN998888 |
| 800100 | <i>Hypohydrus anatolicus</i> | Russia | Volgograd Obl | between Lisov & Polodin | 29:IV:2002 | 48.617 | 43.169 | J. Bergsten | NRM:NHRS | 825 | FN998889 |
| 800104 | <i>Hypohydrus anatolicus</i> | Russia | Volgograd Obl | between Lisov & Polodin | 30:IV:2002 | 48.617 | 43.169 | J. Bergsten | NRM:NHRS | 825 | FN998890 |
| 800105 | <i>Hypohydrus anatolicus</i> | Russia | Volgograd Obl | Artyedinsko Donskie Peski | 03:V:2002 | 49.686 | 43.333 | J. Bergsten | NRM:NHRS | 825 | FN998891 |
| 800108 | <i>Hypohydrus ovatus</i> | Russia | Volgograd Obl | Krasnoslobodsk N.P. | 4-5:V:2002 | 48.7 | 44.6 | J. Bergsten | NRM:NHRS | 825 | FN998892 |

| Cat. ID | Species | Country | Region | Place | Date | Lat N | Lon E | Collector | Depository | COIbp | Acc. No. |
|---------|-----------------------------|------------|---------------|----------------------------------|--------------|--------|--------|-------------|------------|-------|----------|
| 800109 | <i>Hypbydrus anatolicus</i> | Russia | Volgograd Obl | Kretskiy | 05.V:2002 | 48.608 | 44.706 | J. Bergsten | NRM:NHRS | 825 | FN998893 |
| 800115 | <i>Hypbydrus ovatus</i> | Russia | Volgograd Obl | Baybaev, river Don | 8-11.V:2002 | 49.175 | 44.007 | J. Bergsten | NRM:NHRS | 825 | FN998894 |
| 824863 | <i>Hypbydrus ovatus</i> | UK:England | Cornwall | The Lizard Hayle Kimbro pool | 01.VII:2005 | 50.255 | -5.242 | D. Bilton | NHM:BMNH | 825 | FN998895 |
| JLKB241 | <i>Hypbydrus sanctus</i> | Israel | | Hula reserve | 21.III:1985 | 33.103 | 35.609 | M. Jäch | NMPC:ENT | 825 | FN998896 |
| JLKB242 | <i>Hypbydrus sanctus</i> | Israel | | Talme Elazar | 21.IV:1986 | 32.445 | 34.978 | M. Jäch | NMPC:ENT | 825 | FN998897 |
| JLKB243 | <i>Hypbydrus sanctus</i> | Turkey | Mugla | Köycegiz | 27.V:1991 | 36.973 | 28.686 | M. Jäch | NMPC:ENT | 147 | FN998898 |
| JLKB244 | <i>Hypbydrus sanctus</i> | Turkey | Mugla | Köycegiz | 27.V:1991 | 36.973 | 28.686 | Schödl | NMPC:ENT | 665 | FN998899 |
| JLKB518 | <i>Hypbydrus anatolicus</i> | Turkey | Mugla | Köycegiz | 27.V:1991 | 36.973 | 28.686 | Schödl | NMPC:ENT | 825 | JX221701 |
| JLKB519 | <i>Hypbydrus anatolicus</i> | Slovakia | Slov. Mer. | Tvrdošovec, 1 km N of Tvrdošovec | 24.IV:2000 | 48.147 | 18.065 | T. Kopecky | NMPC:ENT | 825 | JX221702 |
| JLKB520 | <i>Hypbydrus anatolicus</i> | Greece | Chalkidiki | Sithonia, 2 km S Kalamitsi | 12.VIII:2000 | 39.97 | 23.988 | J. Horovy | NMPC:ENT | 825 | JX221703 |

H. sanctus. The former was extracted in 96-well Wizard SV plates following the manufacturers instructions (Promega). The 3' end of cytochrome c oxidase subunit 1 (CO1) was amplified with the primers PatDyt or RonDyt (Isambert et al. 2011) and Jerry (Simon et al. 1994) using 1ul of DNA, Bioline Taq and the following cycling conditions: 94° for 2min, 35 to 40 cycles of 94° for 30s, 51–53° for 60s and 70° for 90–120s, and a final extension of 70° for 10 min. PCR products were cleaned with a 96-well Millipore multiscreen plate, sequenced in both directions using a Big Dye 2.1 terminator reaction, and analysed on an ABI 3730 automated sequencer. PatDyt and Jerry were used as sequencing primers. The older dry-mounted specimens were extracted using the QIAamp® DNA Micro Kit (QIAGEN®), following the tissue protocol with the addition of 20ul of DTT (Dithiothreitol)(Sigma-Aldrich). PCR was done with a set of 6 newly designed primer pairs (Table 2) amplifying the complete 825bp CO1 segment in shorter overlapping segments between 147 and 228bp long. We used Ready-ToGo™ PCR beads (Amersham Biosciences) together with 1ul of 10uM of each primer, 2ul of DNA and 21ul water in a 25ul reaction. Cycling conditions started with a 5 min denaturation step at 95°C followed by two cycles of 30 s at 95°C, 30 s at 45°C (first, second and fourth fragments) or 50°C (third, fifth and sixth fragments), and 40 s at 72°C, then two cycles of 30 s at 95°C, 30 s at 43°C or 48°C and 40 s at 72°C, and 39 cycles of 40 s at 95°C, 40 s at 41°C or 46°C, 50 s at 72°C, then a final extension step of 8 min at 72°C. PCR reactions were purified with Exonuclease I and FastAP (Fermentas) in the proportion 1:4, and sequenced with a BigDye™ Terminator ver. 1.1 Cycle Sequencing Kit (Applied Biosystems), cleaned with a DyeEx 96 kit (QIAGEN) and run on an ABI Prism 3100 Genetic Analyzer (Applied Biosystems). Sequences are submitted to Genbank under accession codes FN998871-FN998899 and JX221701- JX221703.

Sequences were assembled and edited in Sequencher 4.8 (Gene Codes Corporation) and aligned in ClustalX 2.0 (Larkin et al. 2007) with default settings of 15 as gap opening penalty and 6.66 as gap extension penalty. The alignment contained no gaps.

Table 2. Newly designed primers (apart from Jerry and PatDyt) used to amplify 825bp of CO1 in 6 overlapping fragments from 11-25 years old, dry-pinned, *Hyphydrus* specimens.

| Primer | 5' à 3' | Pair | Length |
|----------|---------------------------|------|--------|
| Jerry | CAACATTTATTTTGATTTTTTGG | 1 | 178bp |
| Hyp178rw | AATATGCTCGAGTATCAAC | 1 | |
| Hyp161fw | GTTGTATGAGCTCATCATATA | 2 | 189bp |
| Hyp349rw | TAGATGAATTTGCAAGGACTAC | 2 | |
| Hyp276fw | AGCTACCCCTTCACGGATCTC | 3 | 125bp |
| Hyp400rw | CATAATGAAAGTGAGCCACTAC | 3 | |
| Hyp371fw | GTAGTCCTTGCAAATTCATCT | 4 | 228bp |
| Hyp598rw | CAGGATAGTCTGAGTAACG | 4 | |
| Hyp507fw | TTACAGGACTATCATTAAATTCTA | 5 | 147bp |
| Hyp653rw | CTCCAATAAATGATATAGTAGATC | 5 | |
| Hyp616fw | CTCGACGTATTTCAGACTATCC | 6 | 210bp |
| Patdyt | TCATTGCACTAATCTGCCATATTAG | 6 | |

Bayesian analysis was done with MrBayes 3.2.1 (Ronquist et al. 2012). We set up a partitioned model based on 3rd resp. 1st+2nd codon positions and applied a HKY+G+I model to each partitions, unlinking statefrequencies, t-ratio, shape and proportion of invariable sites. Partitions were allowed separate rates with a variable rate prior. All other prior and proposal settings were left as default. We ran two separate runs each with four chains (one cold and three incrementally heated) 3 million generations sampled every 1000th generation. First 25% was discarded as burn-in. For the first analysis we used a time-free model and rooted the tree with the outgroup *Hyphydrus aubei*. For the second analysis we excluded the outgroup and instead tested the placement of the root with a clockmodel. We used a Bayes Factor test to assess if the data was compatible with a strict molecular clock or if a relaxed clock should be used. A heuristic parsimony analysis was run in Nona (Goloboff 1999) (hold 10000, Mult*100, hold/10, mult*max*) spawned from Winclada (Nixon 1999-2002). The parsimony analysis was followed by optimising the characters on the most parsimonious tree. This was done to show discrete character support for the three species. We performed a species-delimitation analysis using the general mixed yule coalescence model (GMYC) as implemented in R (R Development Core team 2005) with the package Splits (Ezard et al. 2009; Fujisawa and Barraclough 2013). We tested the null-hypothesis that the *Hyphydrus ovatus*-complex is a single species versus the alternative hypothesis that it consists of more than one species with a likelihood ratio test under the GMYC model. The GMYC method optimizes the likelihood of a single threshold across an ultrametric gene-tree. The threshold defines speciation branches towards the root from the threshold and within-species coalescence branches towards the tips from the threshold. The older branches are modelled with a Yule (speciation) model while the younger branches are delimited into n-groups where each group is modelled with a separate coalescent process model. The maximum likelihood solution of the GMYC model (the likelihood is calculated placing the threshold at each node across the tree) is compared against a model treating the entire gene-tree as a single coalescence (i.e. as a single species) in the likelihood ratio test. We used the ultrametric clock-tree generated above as input to the species delimitation test.

Morphological observations

The specimens were examined using an Olympus SZX12 stereomicroscope. Measurements were taken with an ocular graticule. Habitus photographs were taken using a Canon MP-E 65mm f/2.8 macro lens with 5:1 optical magnification on bellows attached to a Canon EOS 550D camera. Drawings were made based on photographs taken using an Olympus SZX12 microscope equipped with a Canon EOS 1100D digital camera. Images of the same specimen/structure at different focal planes were combined using Helicon Focus 5.1.19 software. To avoid artefacts due to desiccation of poorly sclerotised parts, the genitalia were illustrated mounted in dimethyl hydantoin formaldehyde resin (DMHF) on the same card as the beetle.

Results

Molecular analyses

Amplification was highly successful with the short fragment PCRs of old dry-mounted material (Table 3). The full-length 825bp segment was achieved for the two *H. sanctus* specimens from Israel, 665bp for one of the Turkish specimens, and a 147bp segment of the second Turkish specimen, with three ambiguous base calls. The last specimen also gave a 175bp sequence from primer pair 1 (Table 2) that turned out to be contaminated DNA with closest BLAST hit on Genbank being saccharomycete fungi. This is always a risk when extracting DNA from the whole body of a specimen. All three dry-mounted *H. anatolicus* specimens yielded full-length CO1 sequences.

Genetic distances between the three presumed species in the *ovatus*-complex turned out to be large (Table 4). The distance between *H. ovatus* and *H. anatolicus* or *H. sanctus* was 9.4–11.4% (K2P-model). The distance between *H. sanctus* and *H. anatolicus* was slightly less, 6.7–7.1%. These genetic distances strongly indicate that we are dealing with three valid and separate species in the *ovatus*-complex. Within-species variation was less than 1.4%. The time-free bayesian analysis as well as the parsimony analysis, both rooted with *H. aubei* as outgroup, confirmed that the three presumed species are reciprocally monophyletic and separated from each other with long branches (Figs 1–2). Posterior probability support values were 1.0–0.98 for all three species. *H. sanctus* and *H. anatolicus* are sister species according to this single-gene phylogeny both in the outgroup-rooted trees (Figs 1–2), and in the clock-rooted tree (Fig. 3).

Table 3. Details on the older extracted specimens and the associated DNA data.

| Species | GUID NMPC: | Country | Specimen state | Age (years) | Bp | Ambiguous base calls |
|-----------------------------|---------------|----------|----------------|-------------|-----|----------------------|
| <i>Hyphydrus anatolicus</i> | JLKB000000518 | Turkey | Dry-mounted | 20 | 825 | 0 |
| <i>Hyphydrus anatolicus</i> | JLKB000000519 | Slovakia | Dry-mounted | 11 | 825 | 0 |
| <i>Hyphydrus anatolicus</i> | JLKB000000520 | Greece | Dry-mounted | 11 | 825 | 0 |
| <i>Hyphydrus sanctus</i> | JLKB000000244 | Turkey | Dry-mounted | 20 | 665 | 0 |
| <i>Hyphydrus sanctus</i> | JLKB000000241 | Israel | Dry-mounted | 25 | 825 | 0 |
| <i>Hyphydrus sanctus</i> | JLKB000000242 | Israel | Dry-mounted | 24 | 825 | 0 |
| <i>Hyphydrus sanctus</i> | JLKB000000243 | Turkey | Dry-mounted | 20 | 147 | 3 |

Table 4. Genetic distances between species calculated with Kimura 2-parameter model. Pairwise deletion of missing data was used, and the shortest fragment of *H. sanctus* (147bp) was deleted from comparison.

| | <i>H. ovatus</i> | <i>H. anatolicus</i> | <i>H. sanctus</i> | <i>H. aubei</i> |
|----------------------|------------------|----------------------|-------------------|-----------------|
| <i>H. ovatus</i> | 0.000–0.014 | / | / | / |
| <i>H. anatolicus</i> | 0.102–0.114 | 0.001–0.002 | / | / |
| <i>H. sanctus</i> | 0.094–0.107 | 0.067–0.071 | 0.001–0.008 | / |
| <i>H. aubei</i> | 0.119–0.126 | 0.125–0.128 | 0.132–0.138 | - |

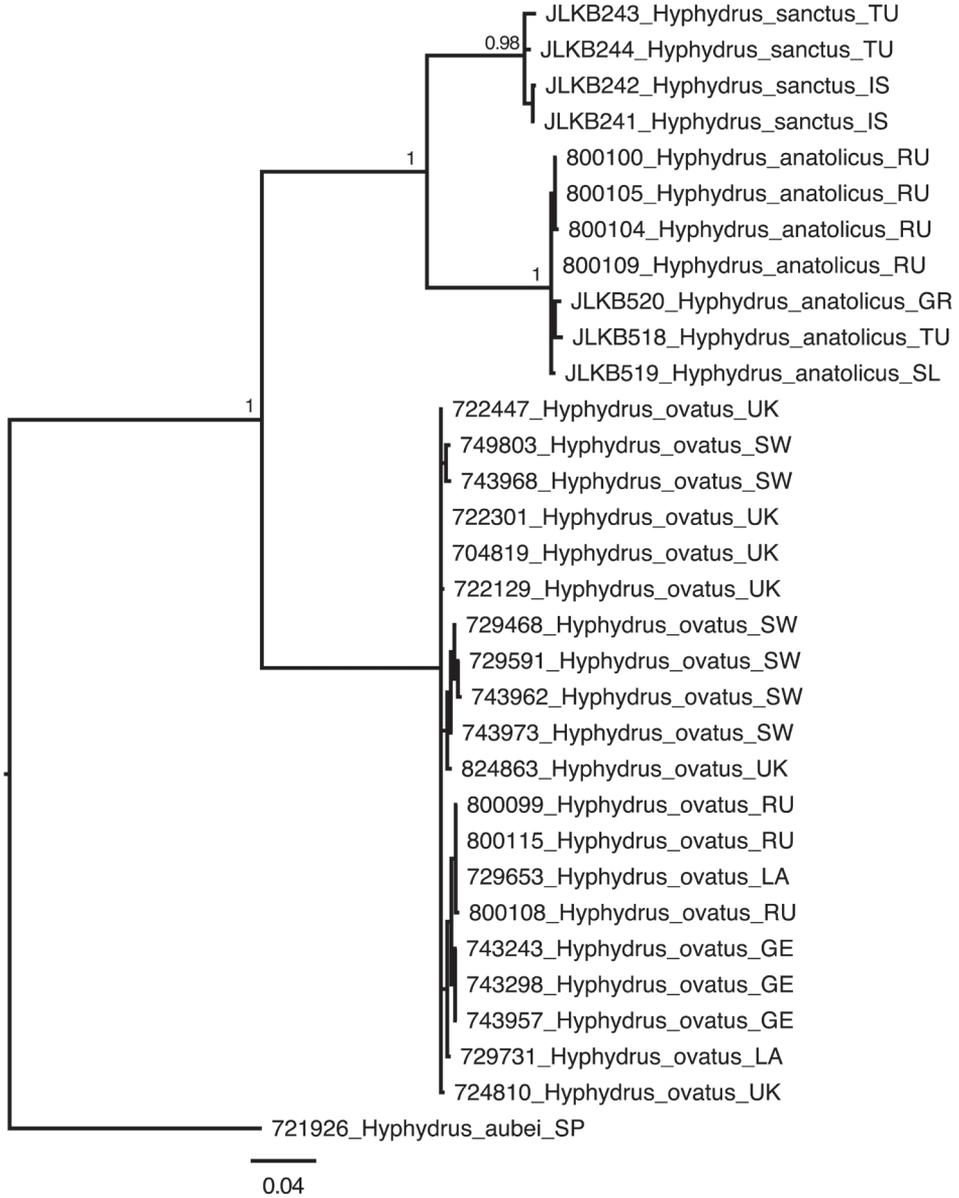


Figure 1. Majority-rule consensus tree from the non-clock Bayesian analysis. Posterior probability clade support values >0.9 shown. Country abbreviations: SW=Sweden, GE=Germany, UK=United Kingdom, La=Latvia, RU=Russia, TU=Turkey, IS=Israel, GR=Greece, SL=Slovakia. Rooted (midpoint) with *Hyphydrus aubei*.

Parsimony analysis and character optimization confirmed the *H. sanctus* + *H. anatolicus* sister group relationship with 17 supporting unambiguous and non-homoplasious substitutions (Fig. 2). Also all three presumed species were supported with between 16 and

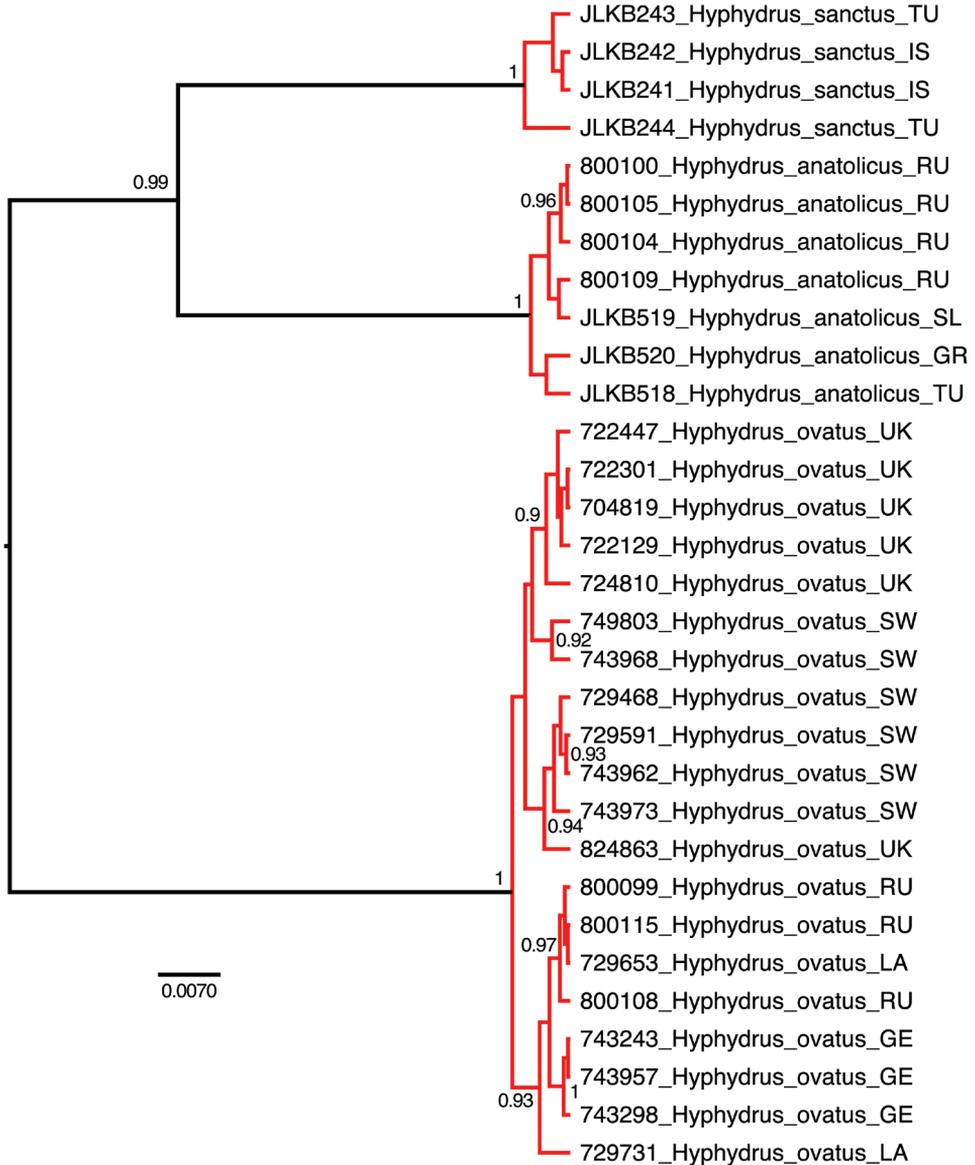


Figure 3. Clock-rooted ultrametric tree from Bayesian analysis with branches coloured according to the GMYC species delimitation analysis. Posterior probability clade support values >0.9 shown. Black branches=speciation events, red braches=within species coalescence events. Country abbreviations as in Figure 1.

24 unambiguous and non-homoplasious substitutions (Fig. 2). The Bayes factor test strongly favoured the strict clock ($\text{LnL}=-1701$) over a time-free model ($\text{LnL}=-1764$) ($2*\text{LnBF}=125$), hence a strict, as oppose to a relaxed, clock model was used to generate an ultrametric tree (Fig. 3). The GMYC model delimited three clusters congruent

with the three presumed species as the maximum likelihood solution (Fig. 3). An approximate confidence interval of 2log likelihood units from the maximum likelihood (3 clusters) did not include any other solution. The explicit likelihood ratio test of the null hypothesis of a single coalescing unit (species) was refuted in favour of the alternative hypothesis of three separately evolving and coalescing units ($-\text{Log } L_{\text{one species}} = 211.9965$, $-\text{Log } L_{\text{three species}} = 218.2261$, Likelihood ratio=12.4592, $p=0.00596$).

Systematics and distribution

All mentioned species belong to the *Hyphydrus ovatus* species group sensu Biström (1982). The group contains nine species occurring exclusively in the Palaearctic region. The members of the group are well characterised with the longer metatibial spur of males serrate (cf. Fig 7). The four western Palaearctic species share the similar shape of the median lobe of aedeagus which is rather poorly sclerotised, in ventral view nearly parallel-sided with sides straight, very slightly and continually narrowing from base to apex (cf. Fig 8). Finally, the three species of the *H. ovatus* complex (i.e. *H. anatolicus*, *H. ovatus* and *H. sanctus*) can be easily recognised by their more or less uniform dark ferruginous to ferruginous body colouration, rarely with minor pale markings.

Due to rather weak sclerotisation of external genitalia, the genital characters have only limited use for identification of species in this complex. Therefore, we focused more on habitus, punctuation and structure characters of the species. The most diagnostic character is probably the shape of the longer metatibial spur on males (see Fig. 7). A key to identification of all western Palaearctic species of the *H. ovatus* species group is presented at the end of the taxonomic section.

Hyphydrus anatolicus Guignot, 1957

Hyphydrus anatolicus Guignot, 1957: 91 (orig. descr.; type locality: “Angora” [Ankara, Turkey]).

Hyphydrus carrarai Sanfilippo, 1963: 77 (orig. descr.; type locality: “Macchia di Migliarino, Torre del Lago (Toscana)” [Italy]); synonymy by Pederzani 1976: 166.

Hyphydrus sanctus: Biström 1982: 39 (partim, misidentification).

Published records. Bosnia and Hercegovina: Biström (1982: 39 as *H. sanctus*). **Croatia:** Guéorguiev (1971: 8 as *H. carrarai*); Biström (1982: 39 as *H. sanctus*); Ádám (1992: 194 as *Hyphydrus sanctus*); Temunović et al. (2007: 17); Krčmar (2014: 20). **Greece:** Biström (1982: 39 as *H. sanctus*); Wewalka (1984: 131). **Hungary:** Ádám (1992: 194 as *H. sanctus*); Csabai et al. (1999: 148 as *H. sanctus*); Móra et al. (2004: 153); Csabai and Nosek (2006: 73); Kálmán et al. (2008: 76); Molnár (2008:110); Sóos et al. (2008: 223); Lökkös (2010:161). **Italy:** Sanfilippo (1963: 77 as *H. carrarai*); Angelini (1972: 182 as *H. carrarai*; 1984: 54); Pederzani (1976: 166); Biström (1982: 39 as *H. sanctus*);

Rocchi (1991: 68); Pederzani & Campadelli (1996: 21); Nardi (1997: 132); Bordoni et al. (2006: 87). **Macedonia:** Biström (1982: 39 as *H. sanctus*). **Montenegro:** Scheers (2016: 209). **Russia:** Biström (1982: 39 as *H. sanctus*). **Serbia:** Mesaroš (2015: 50). **Turkey:** Guignot (1957: 91).

Material examined. **Greece:** 2♂♂, Ionian Islands, Kerkyra, Chalikiopoulos [lagoon], 22.iv.1935 (NHMW); 1♂, Eastern Macedonia and Thrace, Évros Distr., plain of Évros river, 26.vii.1988, M. Jäch leg. (NHMW); 1♀, Central Macedonia, Khalkidhiki Distr., Sithonia, 2 km S of Kalamítsion, 12.viii.2000, J. Hotový leg. (NMPC); 5♂♂ 5♀♀, NW Peloponnese, 3 km S Kalogria, 38.1213N, 21.3810E, ca. 3 m, shallow seasonal swamp, 17.v.2010, H. Fery & L. Hendrich leg. (NMPC). **Hungary:** 1♂ 1♀, Hungary 46 36 (BMNH); 1♀, Bács-Kiskun, Kiskunmajsa env., 11.viii.1999, J. Hájek leg. (NMPC). **Montenegro:** 1♂, Vranjina env., Skadarsko jezero, 20.ix.2001, J. Hájek leg. (NMPC). **Russia:** 1♀, Orenburg reg., Totskoye, 1917, Š. Jureček leg. (NMPC); 2♂♂ 2♀♀, Samara, K. Fausta leg. (ZMAS); 1♀, Stavropol reg., Kuma river, 20.iv.1911 (ZMAS); 1♂ 2♀♀, Volgograd reg., 2 km south of Zryanin village, 48°36'60"N, 43°10'10"E, small lakes near Liska river, incl silty open bay with grasses, *Alisma* and *Juncus*, 29-30.iv.2002, J. Bergsten & A. Nilsson leg. (NHRS); 1♂ 1♀, Volgograd reg., Archeda-Don rivers alluvial sandy plain, 16 km ESE of Terkin village, 49.6861N, 43.3333E, different lakes, grassy ponds, fens and stream, 2-3.v.2002, J. Bergsten & A. Nilsson leg. (NHRS); 3♂♂ 2♀♀, Volgograd reg., Kretskiy, 48.6083N, 44.7061E, river-arm, newly flooded grassland, 5.v.2002, J. Bergsten & A. Nilsson leg. (NHRS). **Turkey:** 2 spec., Aydin vil. [= province], S of Aydin, ditch, 4.iv.14987, H. Fery leg. (HFCB); 4♂♂ 1♀, Muğla vil. [= province], Köyçeğiz, 27.v.1991, S. Schödl leg. (NHMW, NMPC). **Slovakia:** 1♂, 1 km N of Tvrdošovce, 24.iv.2000, T. Kopecký leg. (NMPC). **Ukraine:** 1♂, Kherson distr., monast. Korsunskij, cursus inf. fl. Dnjepr, 3.vi.1927, S. Medvedev leg. (ex coll. Zakharenko, ZMAS).

Diagnosis. Habitus as depicted in Figs 4c, 5c. Clypeus with anterior margin rounded (Fig. 6a). Reticulation of dorsal surface confined to head, more distinct and impressed anteriorly. Punctuation of head fine, visible on whole surface; punctures sparse, distance between them usually equal or bigger than their diameter (Fig. 6a). Punctuation of pronotum double, fine, distance between larger punctures bigger than their diameter. Punctuation of elytra double, diameter of small puncture less than half of diameter of large punctures; distance between large punctures bigger than their diameter. Epipleura smooth with fine punctures. Metatibia with sinuous outer margin.

Male. Longer metatibial spur long, nearly as long as metatarsomere I-II combined (Fig. 7a); spur bisinuate with only indistinct serration basally (Fig. 7a). Male genitalia as in Fig. 8a–d, median lobe in ventral view slightly narrowing from base to apex.

Female. Both shiny and matt forms known of females of *H. anatolicus*. Shiny form agreeing well with male; matt form with whole surface densely reticulated, meshes somewhat elongate on elytra. Large punctures well visible, small punctures indistinct among reticulation. Longer tibial spur shorter than in male; broad and with serration

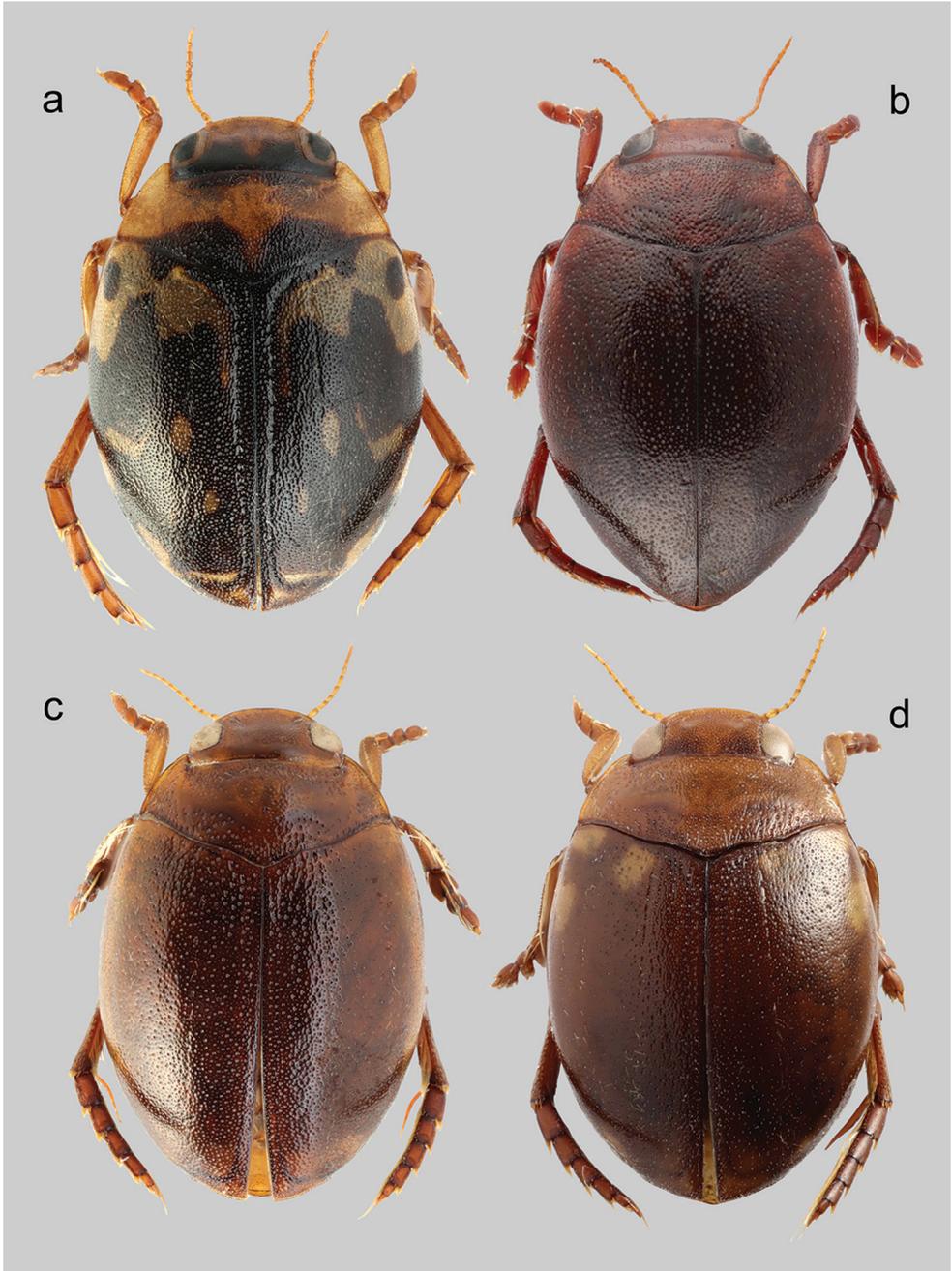


Figure 4. *Hyphydrus* male habitus. **a** *H. aubei* (Corsica; 4.9 mm) **b** *H. ovatus* (Sweden; 5.0 mm) **c** *H. anatolicus* (Slovakia, specimen post-extraction; 5.1 mm) **d** *H. sanctus* (Turkey; 5.2 mm).

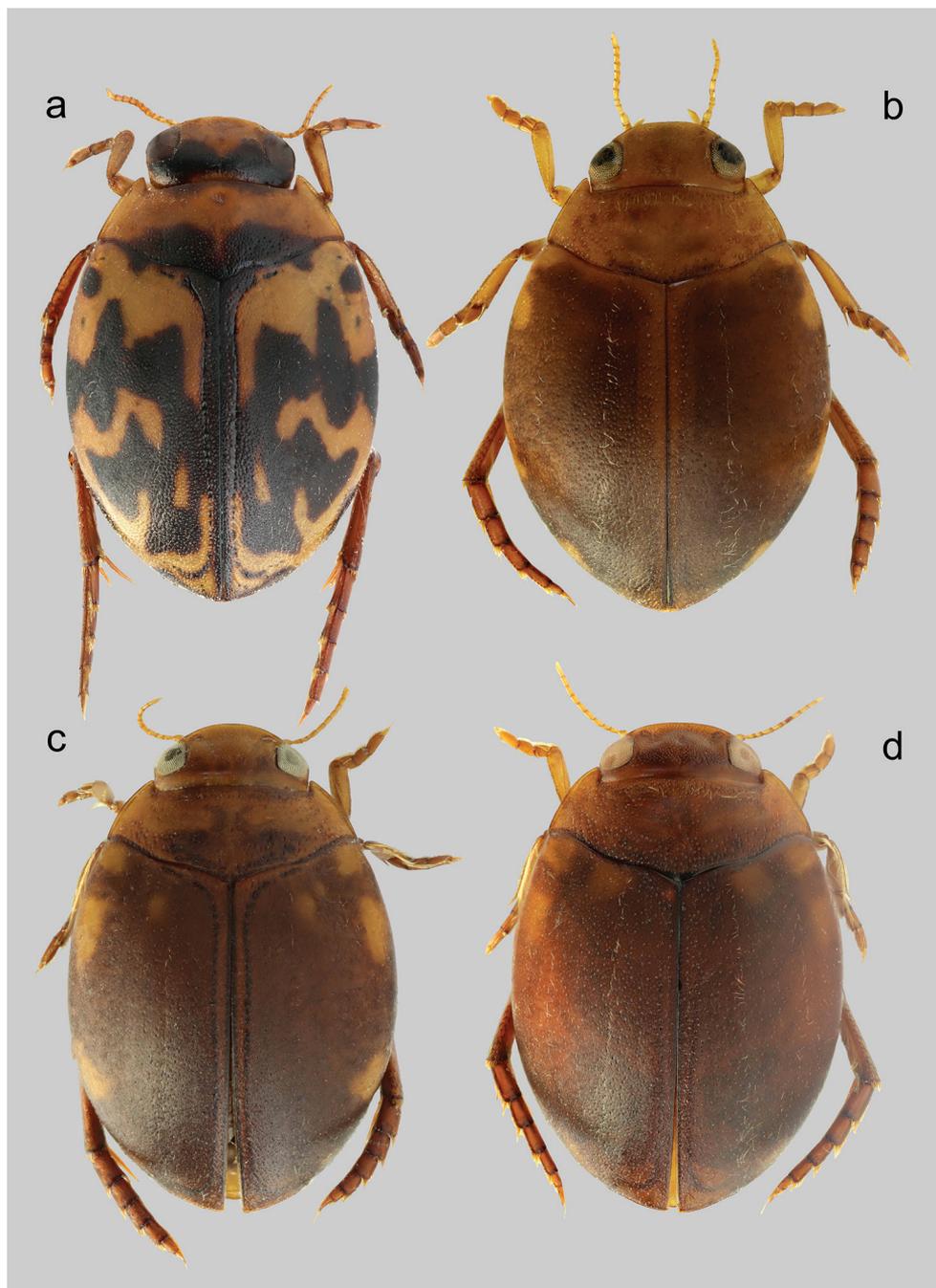


Figure 5. *Hyphydrus* female habitus. **a** *H. aubei* (Croatia; 4.7 mm) **b** *H. ovatus* (Bohemia; 4.6 mm) **c** *H. anatolicus* (Greece; 5.0 mm) **d** *H. sanctus* (Turkey; 4.9 mm).

in basal two thirds, narrowed, slightly curved and without serration in apical third. Female genitalia as in Fig. 8e–g.

Habitat. The species inhabits various types of standing water, predominantly densely vegetated pools, ditches and small ponds. *H. anatolicus* tolerates also saline habitats.

Distribution. The species is distributed in the Eastern Mediterranean and in south-eastern Europe. It occurs in Italy, southernmost Slovakia, Hungary, the Balkan Peninsula, Turkey, southern Ukraine and Russia up to latitude 55° and east to the Ural Mountains (Fig. 9). First record from Slovakia and Ukraine.

Hyphydrus ovatus (Linnaeus, 1760)

Dytiscus ovatus Linnaeus, 1760: 547 (type locality: Svecia [Sweden]).

For full list of synonymy, see Nilsson & Hájek (2017a: 199).

Material examined. We have examined more than 600 specimens from the Czech Republic, Finland, France, Germany, Great Britain, Russia, Slovakia, Sweden, and Ukraine, deposited in NHRS and NMPC.

Diagnosis. Habitus as depicted in Figs 4b, 5b. Clypeus with anterior margin medially nearly straight (Fig. 6b). Reticulation of dorsal surface confined to head, more distinct and impressed anteriorly (Fig. 6b). Punctuation of head fine, visible only in posterior half, punctures on clypeus imperceptible due to strong reticulation (Fig. 6b); punctures dense, distance between them smaller than their diameter (Fig. 6b). Punctuation of pronotum double, coarse, distance between larger punctures smaller than their diameter. Punctuation of elytra double, diameter of small puncture about half of diameter of large punctures; distance between large punctures, at least basally, smaller than their diameter. Epipleura smooth with fine punctures. Metatibia with outer margin nearly straight.

Male. Longer metatibial spur short, only slightly longer than metatarsomere I (Fig. 7b); spur nearly straight, broad with distinct serration (Fig. 7b). Male genitalia as in Fig. 8h–k, median lobe in ventral view parallel-sided in most of its length.

Female. Both shiny and matt forms are known for females of *H. ovatus*. Shiny form agreeing well with male; matt form with whole surface densely reticulated, meshes distinctly elongate on elytra. Large punctures well visible, small punctures indistinct among reticulation. Longer tibial spur similar to that of male. Female genitalia as in Fig. 8l–n.

Habitat. The species inhabits various types of standing and slowly flowing water bodies with at least some vegetation. The typical habitats represent (frequently eutrophic) ponds, densely vegetated pools, ditches, oxbows or open swamps.

Distribution. Widely distributed Palaearctic species. With the exception of the Iberian Peninsula, it occurs in most of territory of Europe and temperate Asia east to the Baikal Lake (east Siberia).

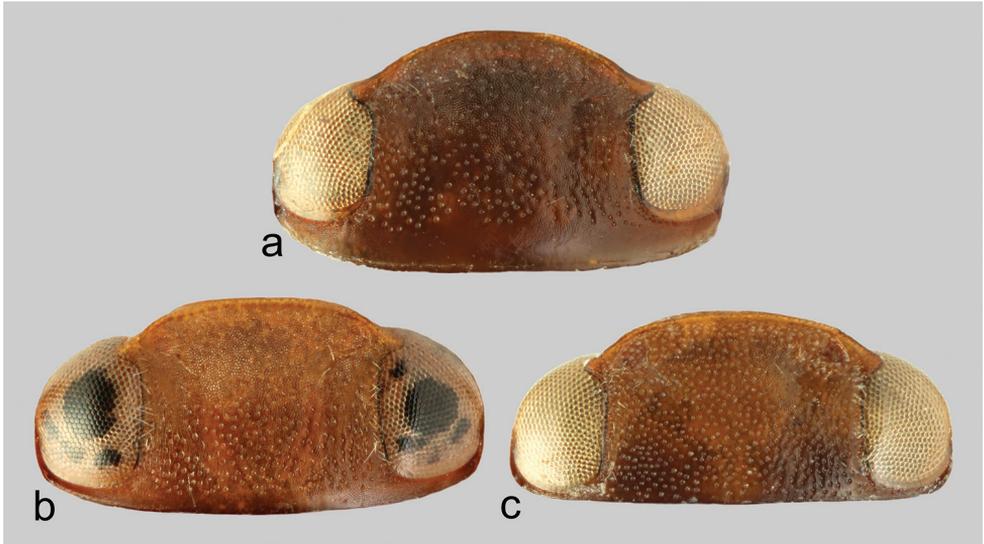


Figure 6. *Hyphydrus* head. **a** *H. anatolicus* **b** *H. ovatus* **c** *H. sanctus*. Not in scale.

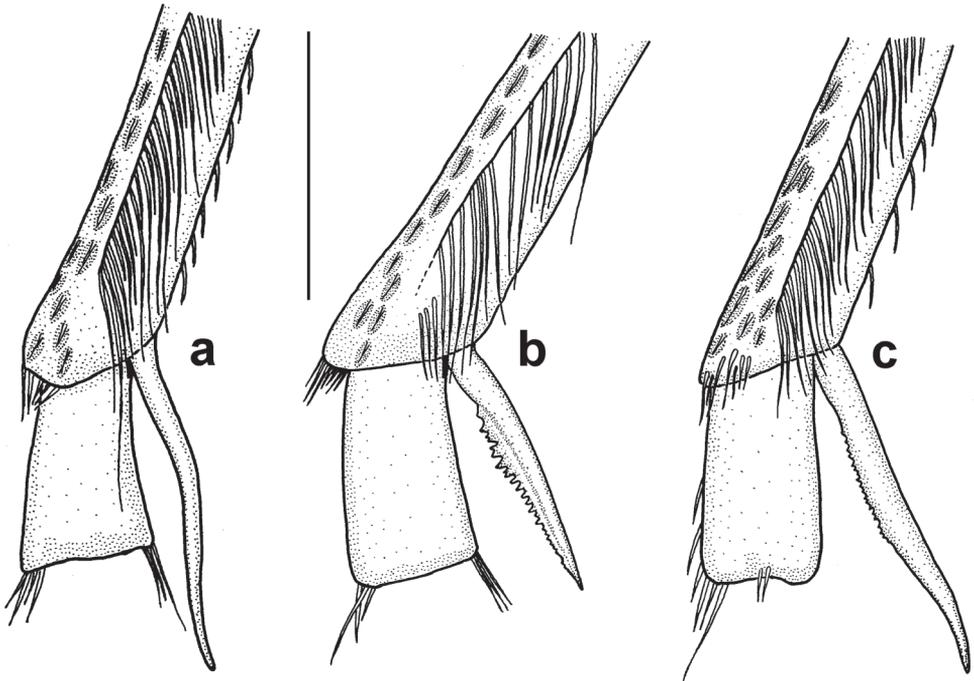


Figure 7. *Hyphydrus* male metatibia, longer metatibial spur and metatarsomere I. **a** *H. anatolicus* **b** *H. ovatus* **c** *H. sanctus*. Scale bar 0.5 mm.

Hyphydrus sanctus Sharp, 1882

Hyphydrus sanctus Sharp, 1882: 380.

Published records. Israel: Sharp (1882: 380); Biström (1982: 39); Wewalka (1984: 131). **Jordan:** Biström (1982: 39); Wewalka (1984: 131). **Syria:** Biström (1982: 39); Wewalka (1984: 131).

Material examined. Israel: 2♂♂, 1♀, Hula reserve, 21.iii.1985; 4♂♂, 8♀♀, same locality, but 13.iv.1986; 1♂, 3♀♀, Talme Elazar, 21.iv.1986; 1♂, 6♀♀, Magan Michael, 21.iv.1986, all M. Jäch leg. (NHMW, NMPC). **Turkey:** 3♂♂, 13♀♀, Muğla vil. [=province], Köyceğiz, 27.v.1991, S. Schödl leg. (NHMW, NMPC); 3♂♂, 2♀♀, same data, but M. Jäch leg. (NHMW, NMPC).

Diagnosis. Habitus as depicted in Figs 4d, 5d. Clypeus with anterior margin medially nearly straight (Fig. 6c). Reticulation of dorsal surface confined to head and more distinct and impressed anteriorly (Fig. 6c), and to sides of pronotum. Punctuation of head fine, visible on whole surface (Fig. 6c); punctures dense, distance between them smaller than their diameter (Fig. 6c). Punctuation of pronotum double, fine, distance between larger punctures bigger than their diameter. Punctuation of elytra double, diameter of small punctures less than half of diameter of large punctures; distance between large punctures bigger than their diameter. Epipleura reticulated with very fine punctures. Metatibia with outer margin nearly straight.

Male. Longer metatibial spur long, nearly as long as metatarsomere I-II combined (Fig. 7c); spur broad and straight in basal two thirds with small but distinct serration, attenuated and curved apically (Fig. 7c). Male genitalia as in Fig. 8o–r, median lobe in ventral view slightly narrowing from base to apex.

Female. Only matt females of *H. sanctus* are known so far. Whole surface densely reticulated, meshes on elytra somewhat elongate. Large punctures well visible, small punctures indistinct among reticulation. Longer tibial spur similar to that of male, but almost straight in apical third. Female genitalia as in Fig. 8s–u.

Habitat. Similarly to the other two species, *H. sanctus* inhabits various types of standing and slowly flowing water bodies with at least some vegetation. Wewalka (1984) reported several specimens from a densely vegetated pool and single occurrences from an artificial pool with clear water, an irrigation ditch and from a stream.

Distribution. A species distributed in the Levant region of the Near East. So far recorded from several localities in Israel, Jordan and Syria (Fig. 9). First record from Turkey.

Hyphydrus aubei Ganglbauer, 1891

Note. *Hyphydrus aubei* is the fourth European species in the *Hyphydrus ovatus* species group sensu Biström (1982). It does not belong to the *Hyphydrus ovatus* complex as here defined and it is easily separated from the preceding three species based on colouration (Figures 4–5).

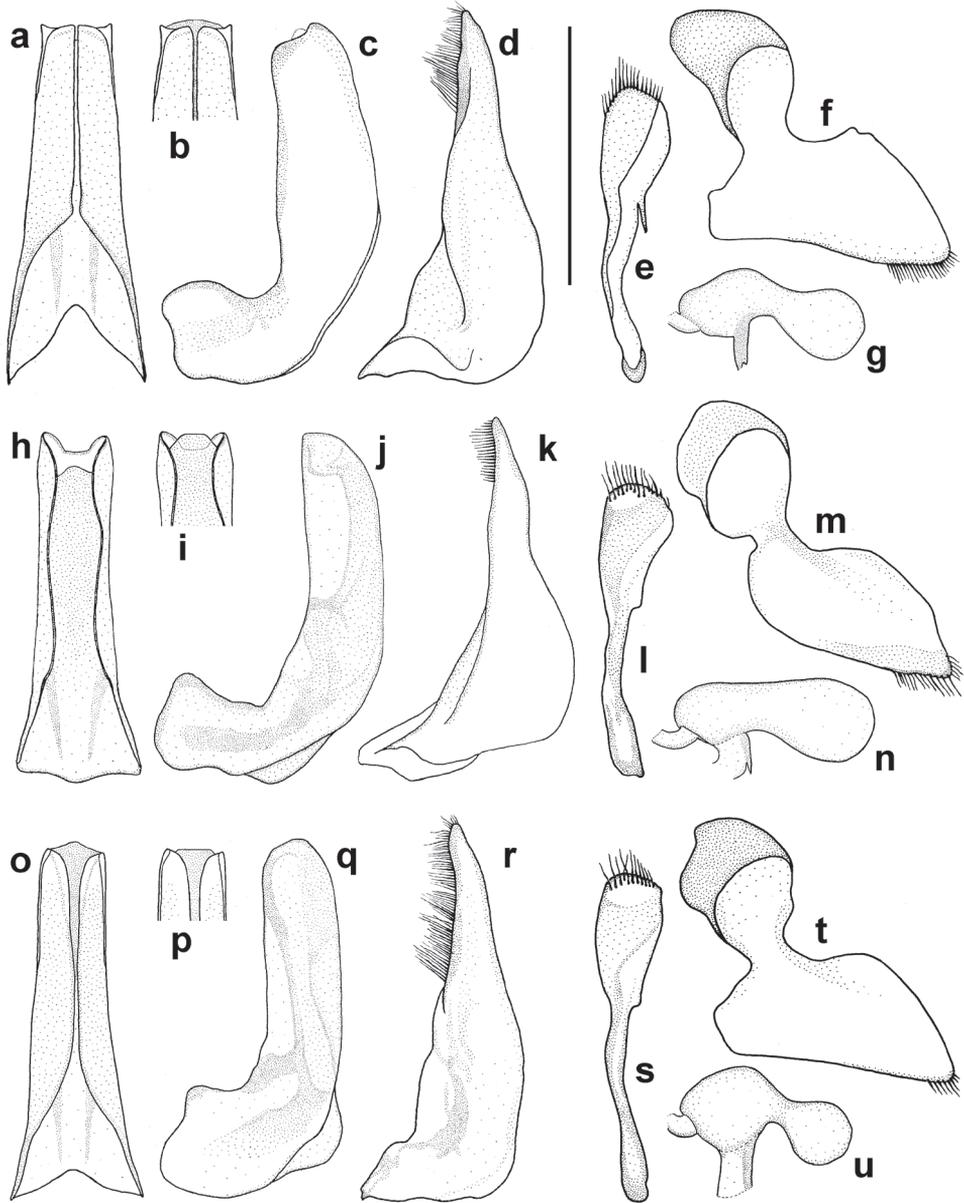


Figure 8. *Hyphydrus* male and female genitalia. **a, h, o** median lobe of aedeagus in ventral view **b, i, p** supplementary drawing of apex of median lobe **c, j, q** median lobe of aedeagus in lateral view **d, k, r** paramere **e, l, s** gonocoxa **f, m, t** gonocoxosternite **g, n, u** spermatheca. **a–g** *H. anatolicus* **h–n** *H. ovatus* **o–u** *H. sanctus*. Scale bar 0.5 mm.

Material examined. Turkey: 1♂, 2♀♀, Muğla vil. [=province], Köyceğiz, 27.v.1991, S. Schödl leg. (NHMW, NMPC).

Distribution. Predominantly a Mediterranean species. First record from Turkey.

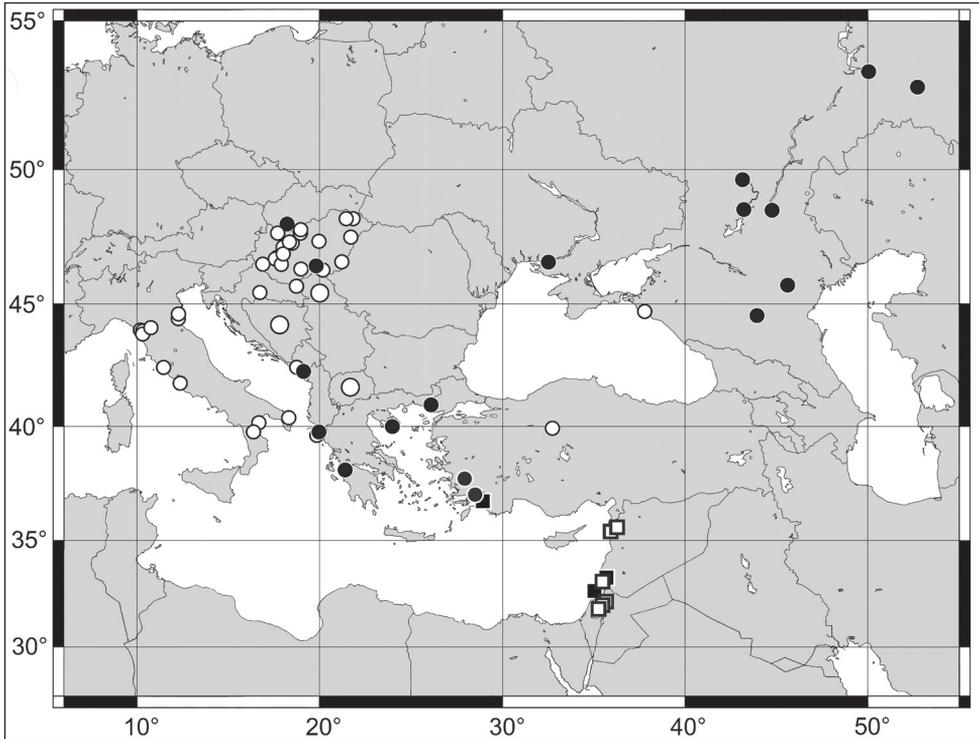


Figure 9. Map of distribution of *H. anatolicus* (circles, dots) and *H. sanctus* (squares). White symbols represent records from the literature, large circles represent imprecise data for a larger region (country); black symbols represent records of specimens examined by us.

Key to species

Key to western Palearctic species of the *Hyphyrus ovatus* species group

- 1 Elytra with distinct black maculate colour pattern on elytra; head bicoloured, testaceous anteriorly but distinct black areas posteriorly (Figs 4a, 5a) *Hyphyrus aubei*
- Elytra unicoloured, dark ferruginous to ferruginous, or with vaguely delimited lighter macula basally and laterally on elytra; head unicoloured, testaceous to dark ferruginous (Figs 4b–d, 5b–d) 2
- 2 Punctuation of pronotum and elytra (males and shiny females) very coarse; distance between larger punctures smaller than their diameter. Longer male metatibial spur only little longer than metatarsomere I; straight and with distinct serration (Fig. 7b)..... *Hyphyrus ovatus*
- Punctuation of pronotum and elytra (males and shiny females) finer; distance between larger punctures larger than their diameter. Longer male metatibial spur almost as long as metatarsomeres I-II combined; spur not straight, bisinuate or apically curved; serration of spur small to indistinct (Fig. 7a, c)..... 3

- 3 Clypeus with anterior margin medially nearly straight; exterior side of metatibia almost straight; longer male metatibial spur straight basally but curved apically and with serration small but visible (Fig. 7c)*Hyphydrus sanctus*
- Clypeus with anterior margin rounded; exterior side of metatibia somewhat sinuous; longer male metatibial spur bisinuate and with indistinct serration basally (Fig. 7a).....*Hyphydrus anatolicus*

Discussion

Our findings from molecular and morphological data unambiguously support the presence of three species of the *Hyphydrus ovatus* complex in the western Palaearctic and the names *H. ovatus*, *H. anatolicus* and *H. sanctus* are the oldest available names for these three species. The additional distributional findings of *H. anatolicus* and *H. sanctus* indicate, that the distribution of the *H. ovatus* complex is more complex in the eastern part of its range than previously thought. A revision of all previous records of *H. ovatus* from the Balkan Peninsula and further east is needed. It is highly probable that many records may refer to the other two species, but whether *H. ovatus* is replaced by, or sympatric with, these remain to be investigated for many areas.

Acknowledgements

We are obliged to all colleagues mentioned in the list of collections for putting specimens at our disposal. Special thanks goes to Hans Fery (Berlin, Germany) who provided us with the specimens of *H. anatolicus* from Peloponnesus and reviewed the manuscript. The work of J. Hájek was supported by the Ministry of Culture of the Czech Republic (DKRVO 2017/14, National Museum, 00023272) and by the SYNTHESIS project (SE-TAF 386).

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Review of the species of *Leptomias* Faust from Sichuan, China (Coleoptera, Curculionidae, Entiminae)

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Abstract

An account is given of the twelve species of *Leptomias* Faust, 1886 occurring in the Sichuan Province of China, including the description of a new species, *Leptomias verticalis* Ren, Zhang & Song, **sp. n.** from Jiulong County, Southwest Sichuan. New locality data and remarks for the other eleven species, a key to and distribution map of all twelve Sichuan species are provided. *Leptomias chenae* Alonso-Zarazaga & Ren is transferred to *Geotragus* Schoenherr, 1845, where its valid name is *G. granulatus* (Chao, 1980), **comb. n.** in application of Art. 59.4. Structural details of *Leptomias verticalis* and *Geotragus granulatus* are illustrated.

Keywords

Distribution, *Geotragus*, new species, Tanymericini, Weevils

Introduction

Leptomias Faust, 1886 is a diverse genus of flightless weevils (Coleoptera, Curculionidae) in the subfamily Entiminae, with a centre of distribution in China, India, Nepal, Afghanistan and Myanmar. It differs from related genera by having (i) the metanepisternum completely separated from the metaventricle and (ii) the upper edge of the scrobes directed towards the lower margin of the eye (Chao 1980).

Ninety per cent of the *Leptomias* species known from China occur in Xizang, Yunnan, Sichuan and Qinghai. During identification of specimens collected in Sichuan province, one new and one misplaced species were found. *Leptomias chenae* Alonso-Zarazaga & Ren, 2013 (renamed because of secondary homonymy of its original name, *Leptomias granulatus* Chao, 1980) does not belong in *Leptomias* but instead to the genus *Geotragus* Schoenherr, 1845. With the transfer of this species out of *Leptomias* effected and the new species described in this paper, the number of current species of *Leptomias* remains at 159 and that of species recorded from China at 89. The new species and the new combination are here documented and illustrated, along with a key to the species present in Sichuan. Moreover, species documented in Sichuan are usually described in Chinese and it might be difficult for most people to obtain information of their distribution.

Material and methods

All specimens, including types, examined for this study are located in the following collections: Institute of Zoology, Chinese Academy of Sciences, Beijing, China (IZCAS); Forschungsmuseum Alexander Koenig, Bonn, Germany; Natural History Museum, London, UK; Naturkundemuseum, Berlin, Germany; Senckenberg Naturforschendes Museum, Frankfurt am Main, Germany; Senckenberg Naturhistorische Sammlungen, Dresden, Germany. The types of the new species are deposited in IZCAS.

Specimens were dissected after soaking them in soapy water overnight, for cleaning and softening, and the dissected parts were placed in a cold 10 % NaOH solution for 20 hours to macerate the soft tissues. After dissection, all parts were photographed and stored in glycerine in microvials pinned beneath the specimen from which they were dissected.

The morphological terminology used in this study mainly follows Ren (2013). Measurements were made using an ocular micrometre as follows: standard length – in dorsal view from anterior margin of thorax to apex of elytra along midline; pronotal length – in dorsal view from anterior margin to base along midline; pronotal width – in dorsal view across widest part; elytral length – in dorsal view along suture of elytra from base to apex; elytral width – in dorsal view across widest part; rostral length – in lateral view in a straight line from apex to anterior margin of eye; rostral width – in dorsal view across base of rostrum. Measurements are made in millimetres.

All observations and dissections were performed using a Nikon SMZ1500 stereo microscope. The habitus photographs were taken with a MP-E 65 macro lens mounted on a CANON EOS700D digital camera. Other photographs were taken with a CCD Qimagine MicroPublisher 5.0 RTV camera mounted on a Zeiss SteREO Discovery V.12 microscope. Extended-focus images were generated with Auto-Montage Pro 5.03.0061 and edited with Adobe Photoshop CS 14.0 if required.

Label data are given *verbatim*, with pinyin romanisation and comments in square brackets if labels are in Chinese; labels are separated by semicolons and lines by slashes.

Taxonomic treatment

Leptomias verticalis Ren, Zhang & Song, sp. n.

<http://zoobank.org/02A25235-8C44-4C3D-9270-AAD7BB9E9EC6>

Figs 1–23

Diagnosis. This new species resembles *L. ochrolineatus* Chen, 1987 but differs by the following characters: elytra in lateral view abruptly sloping posteriorly, dorsal edge of slope of declivity straight, almost parallel to anterior margin; elytra in dorsal view at apical 1/3 with symmetrical crescent-shaped dark brown patches.

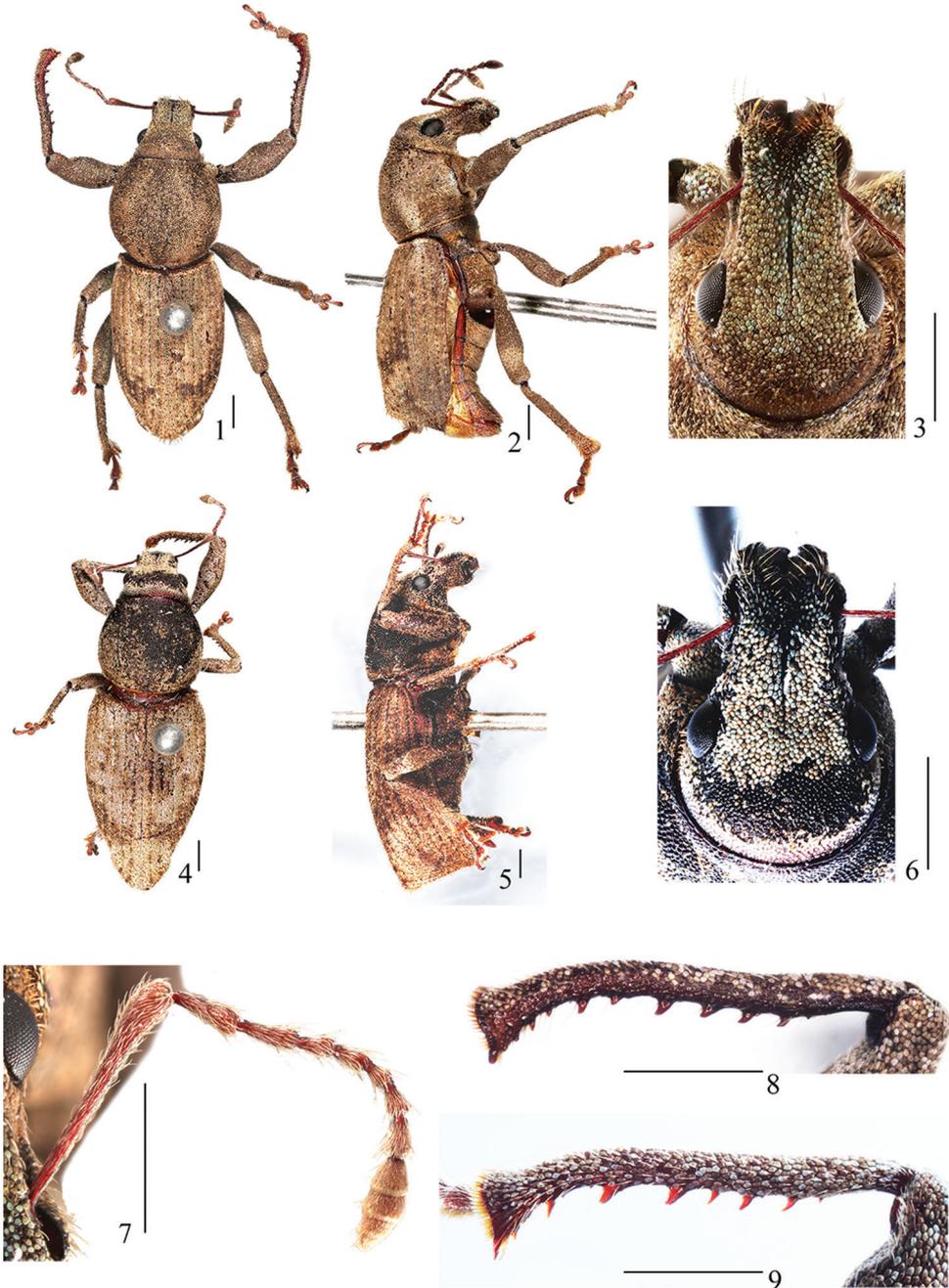
Description. Holotype, male. *Measurements* (mm): Standard length: 8.00; pronotal length: 3.00; pronotal width: 3.00; elytral length: 5.00; elytral width: 3.20; rostral length: 1.30; rostral width: 1.20.

Habitus and colour (Figs 1, 2): Body elongate-oval; integument dark reddish brown, antennae and legs reddish brown; with coppery to white to pale brown to brown scales, dorsal side of rostrum and apex of femora and tibiae with metallic turquoise scales; scales moderately dense, tessellate, contiguous but not overlapping, on dorsal side of rostrum moderately dense, oval to polygonal, behind epistome sparse, clearly different in colour from others, on lateral and ventral surfaces of rostrum moderately dense, around eyes penniform, elongate-oval, absent from anterior part of antennal scrobes but dense, penniform along posterior part, on pronotum dense, round to oval to polygonal, on elytra polygonal, moderately dense, at apical 1/3 forming symmetrical crescent-shaped dark brown patches, on ventrites dense, penniform, on legs dense, round to elongate-oval; body sparsely covered with recumbent to suberect, short and slightly fine, lanceolate setae, setae on rostrum subrecumbent, fine, lanceolate, sparse, on scapes and desmomes 1–7 long, recumbent, fine, dense, on pronotum subrecumbent to erect, curved, on interstriae subrecumbent to erect, moderately thick, sparse, on tibiae long, moderately dense, lanceolate, on femora recumbent, short, fine, moderately dense.

Head (Fig. 3): Moderately convex; with small, sparse punctures and dense, tiny granules, each granule covered by a scale; eyes convex, moderately oval, with deep and fine circumocular sulcus along dorsal and anterior edge; between eyes moderately convex, higher than dorsal surface of rostrum in lateral view.

Rostrum (Fig. 3): In dorsal view 1.13× longer than wide, apex narrower than base; base slightly narrower than distance at midpoint between eyes; dorsal surface with narrow and deep median sulcus extending from posterior margin of frons to midpoint between eyes; epistome V-shaped, posterior angle slightly less than 90°, posteriorly carinate; mandibular scars oval; ventral margin of scrobes visible in dorsal view from antennal insertion to base of rostrum; prementum with four setae.

Antennae (Fig. 7): Scapes slender, subclavate, extending to region between midpoint and posterior margin of eyes at rest, 0.85× as long as funicle; funicles with desmome 1 1.38× longer than 2, 1 and 2 elongate-clavate, 3.06× longer than all others (compared



Figures 1–9. Habitus of *Leptomias verticalis* sp. n.: **1** male paratype, dorsal view **2** male paratype, lateral view **3** male paratype, head and rostrum, anterior view **4** female paratype, dorsal view **5** female paratype, lateral view **6** female paratype, head and rostrum, anterior view **7** male paratype, antenna, anterior view **8** male paratype, right protibia, anterior view **9** female paratype, right protibia, anterior view. Scale bars 1 mm.

with the shortest desmomer 5), 3 and 4 equal in length, shortly clavate, $0.63\times$ as long as 2, 5 elongate moniliform, $0.72\times$ as long as 4, 6 $1.17\times$ longer than 5, shortly clavate, 7 as long as 3, shortly clavate; clubs with similar pubescence throughout, elongate-oval, $0.33\times$ as long as desmomer 3, 3-segmented, basal segment $1.33\times$ longer than segment 2, this $0.89\times$ as long as 3, 3 with a marked annulus at midpoint.

Pronotum: subquadratic in dorsal outline, strongly convex; anterior margin truncate, posterior margin medially slightly produced caudad; sides strongly rounded, greatest width at midpoint, gradually narrowing towards both ends, anterior margin slightly shorter than posterior one; disc smooth, median sulcus absent; posterior margin narrowly and slightly carinate; dorsal surface with dense, small and round tubercles, each tubercle with 1 scale on top; postocular lobes absent, vibrissae blond, moderately long.

Proventriculus (Fig. 17): Well developed, with eight sclerotized basal plates, each plate bearing two longitudinal rows of projecting setae, brush-like, apically ending with a trapezoidal zone covered with pointed inward denticles.

Scutellum: Not exposed.

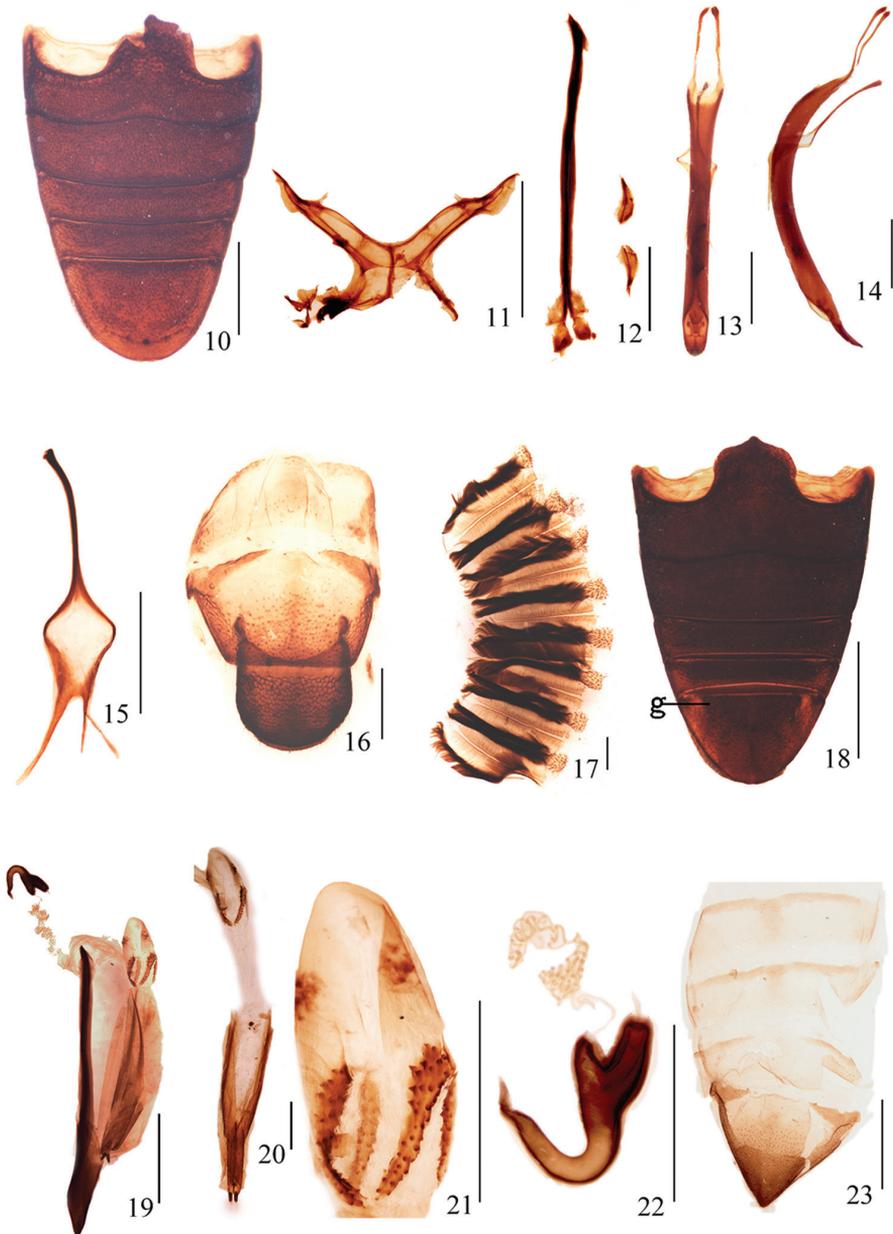
Elytra (Figs 4–5): In dorsal view elongate-ovate, anterior margin medially slightly produced and elevated as prominent flange, without humeral callus; lateral margins slightly diverging from base to basal $1/5$, there widest apart, then evenly converging towards narrowly rounded apex; in lateral view with posterior declivity straight and not overhanging elytral apex; with ten complete, distinct, narrow, moderately deep, punctate striae; punctures minute, moderately dense, intervals between punctures narrow; interstriae wide, slightly eminent.

Abdomen (Fig. 10): Ventrite 1 depressed in middle, slightly convex at sides, in middle longer than 2, suture between 1 and 2 slightly curved forward in middle; ventrite 2 moderately convex, as long as 3 and 4 combined; ventrite 5 as long as 1 in middle, moderately convex, broadly rounded at apex.

Metendosternite (Fig. 11): Stalk $0.39\times$ as long as furcal arms, trapezoidal and transverse, anterior part of longitudinal flange slightly shorter than posterior part; hemiductus inconspicuous; anterior tendons positioned almost at apical $1/3$ of furcal arms; furcal arms robust, apically not bifurcate, diverging at nearly 60° in relation to longitudinal flange.

Legs: Procoxae situated close to front margin of prothorax; contiguous, inner side flat. Protibiae (Fig. 8) subcylindrical, slightly sinuate, bent inwards at apical $1/3$; inner margin from basal $1/5$ to apex arcuate, with 10 large, slightly curved, sharp teeth, each tooth with spiniform seta just behind it; Mesotibiae similar but teeth slightly smaller; metatibiae with inner margin adentate, apical $1/3$ with much denser and longer setae. Tarsi slender, tarsomere 1 nearly $2\times$ longer than 2, much wider than 2, 3 wider than the others, deeply bilobed, 5 slender; claws connate in basal half.

Genitalia and terminalia: Sternite VIII (Fig. 12) divided into 2 transversely orientated, crescent-shaped hemisternites, each laterally acuminate, with anterior margin moderately sinuate and posterior margin arcuate. Sternite IX (Fig. 12) with basal plate bilobed, each lobe with inner margin almost straight and outer margin Σ -shaped; spiculum gastrale $0.90\times$ as long as aedeagus, almost straight, strongly sclerotized, ante-



Figures 10–23. Abdominal and genital structures of *Leptomias verticalis* sp. n.: **10** male paratype, ventrites, ventral view **11** male paratype, metendosternite, dorsal view **12** male paratype, sternites VIII and IX, dorsal view **13** male paratype, aedeagus, dorsal view **14** male paratype, aedeagus, lateral view **15** male paratype, tegmen, dorsal view **16** male paratype, pygidium, dorsal view **17** male paratype, proventriculus **18** female paratype, ventrites, ventral view (g - laterobasal groove) **19** female paratype, sternite VIII and genitalia, lateral view **20** female paratype, gonocoxites and styli, dorsal view **21** female paratype, bursal sclerites, dorsolateral view **22** female paratype, spermatheca, lateral view **23** female paratype, pygidium, dorsal view. Scale bars **10–19, 23**: 1 mm; **20–22**: 0.5 mm.

rior 1/5 slightly curved. Penis (Figs 13, 14) in dorsal view 3.90 mm long and 0.50 mm wide, remones 1.15 mm long; lateral margins subparallel in middle, minimally expanded at ostium level, thereafter slightly rounded and triangularly converging, though very narrowly rounded apex; in lateral view curved, caudally of ostium strongly constricted towards apex. Tegmen (Fig. 15) 0.46× as long as penis, ring narrow, parameroid lobes more sclerotized in basal half, separated from each other; tegminal apodeme slender, more sclerotized, Y-shaped with basal piece, slightly curved at apex.

Variation. Male paratype. Measurements (in mm): Standard length: 8.20; pronotal length: 3.20; pronotal width: 3.20; elytral length: 5.00; elytral width: 3.30; rostral length: 1.35; rostral width: 1.20; inner margin of protibiae with eleven blunt teeth (apex worn out), mesotibiae with ten small sharp teeth.

Female paratypes. Measurements (in mm): Standard length: 10.40–11.30; pronotal length: 3.00–3.20; pronotal width: 3.10–3.20; elytral length: 6.00–6.70; elytral width: 3.70–3.90; rostral length: 1.29–1.40; rostral width: 1.28–1.32. Pronotum with anterior and posterior margins not truncate, slightly curved; greatest width just behind midpoint. Elytra much longer and wider than in male; in lateral view with posterior declivity straight and overhanging elytral apex; ventrite 5 (Fig. 18) parabolic, apical 1/2 with median longitudinal ridge, slightly elevated, with basal longitudinal groove on each side close to lateral margins, extending from base to midpoint (Fig. 18, g). Inner margin of pro- and mesotibiae with 8–10 larger and sharper teeth than in male, inner margin of metatibiae with 10 small and sharp teeth. Sternite VIII (Fig. 19) with spiculum ventrale clavate, wide and straight; lamina tightly folded, in lateral view triangular, strongly sclerotized, ventral margin angular in middle. Ovipositor (Figs 19, 20) with gonocoxites shorter than sternite VIII, folded along middle, lateral margins strongly sclerotized, styli relatively small, cylindrical, with 2–3 long setae inserted apically, more strongly sclerotized than gonocoxites. Bursal sclerites (Fig. 21) near point of union of spermathecal duct and oviduct, with 1 V-shaped sclerite and 1 small sclerite on each side, dorsal surface of sclerites with small and sharp conical spines. Spermatheca (Fig. 22) with corpus short, trapezoidal; cornu elongate, strongly curved into a narrow U-shape, apically gradually narrowed, apex sinuate and acuminate; nodulus prominent, tube-like, apically gradually narrowed, subcontiguous with and angled at about 60° in relation to ramus; ramus prominent, elongate trapezoid, 2.0× length of nodulus.

Material examined. Holotype, ♂: (white, printed): 四川九龙县南 [Sichuān Jǐulóngxiàn nán] J08 / 2120m 核桃林 [Hétáolín] 杯诱 [bēiyòu] / 2001.VII.9–12 于晓东 [Yú Xiǎodōng] / 中科院动物所 [Zhōngkēyuàn Dòngwùsuǒ, printed]; (white, printed): IOZ(E) 1965001. Paratypes (1♂, 4♀): 1 ♂: (white, printed): same data as holotype except IOZ(E) 1965002; 2 ♀: (white, printed): same data as holotype except IOZ(E) 1965003, IOZ(E) 1965004; 2 ♀: (white, printed): same data as holotype except J09 / 2200m 青冈灌丛 [Qīnggāng Guàncóng] and IOZ(E) 1965005, IOZ(E) 1965006.

Remarks. The specific epithet refers to the straight declivity of the elytra in lateral view.

Distribution. Sichuan (China).

Other species of *Leptomias* from Sichuan

Leptomias elongitus Chao, 1981

Leptomias elongitus Chao, 1981. Insects of Xizang 1: 543, pl. III–19.

Type material examined. Holotype, ♂: (white): 西藏 [Xizàng, printed] 芒康 [Mángkāng, handwritten] / 3800 公尺 [Gōngchǐ, handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; (white): 1976.VI.9 [handwritten] / 采集者: 韩寅恒 [Cǎijízhě, Hán Yínhéng, printed]; (red, printed): HOLOTYPE; (white, printed): IOZ(E) 906241. Paratypes: 1 ♀: same data as holotype except ALLOTYPE printed on sea-green paper and IOZ(E) 906242. 1 ♀: same data as holotype except PARATYPE printed on yellow paper and IOZ(E) 906243. 4 ♀, 2 ♂: same data as holotype except locality 芒康盐井 [Mángkāng Yánjǐng, handwritten], 2700 公尺 [Gōngchǐ, handwritten], collecting date 1976.VI.3, PARATYPE printed on yellow paper and IOZ(E) 906244–IOZ(E) 906249. 1 ♀: (white): 西藏芒康什草 [Xizàng Mángkāng Shícǎo, handwritten] / 19 [printed] 76 [handwritten] 年 [nián, printed] 7 [handwritten] 月 [yuè, printed] 15 [handwritten] 日 [rì, printed] / 采集者 [Cǎijízhě, printed] 2600 米 [mǐ, handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; (yellow, printed): PARATYPE; (white, printed): IOZ(E) 906250. 2♀: ditto, IOZ(E) 906251, IOZ(E) 906252.

Additional material examined. 1 ♂: (white, handwritten): 3 / 得荣鱼根 [Déróng Yúgēn] / 高山新 [Gāoshānxīn] / 3700 公尺 [Gōngchǐ], 何多吉 [Hé Duōjǐ] 80.6.8; (white, printed): IOZ(E) 906253. 1♀: ditto, IOZ(E) 906254.

Remarks. *Leptomias elongitus* is known from the province of Sichuan (Derong) and Xizang (Mangkang). It is narrowly distributed in the southwest of Sichuan (Fig. 24). *Leptomias elongitus* resembles *L. nubilus* but differs by the following characters: antennae with scape extending beyond anterior margin of eye but not reaching middle when at rest; postocular lobes developed; prothorax broadest behind middle.

Leptomias foveicollis Voss, 1935

Leptomias foveicollis Voss, 1935. Entomologisches Nachrichtenblatt 9(2): 58.

Additional material examined. 1 ♂: (white): 四川 [Sìchuān, printed] 康定瓦新 [Kāngdìng Wǎxīn, handwritten] / 沟 [Gōu, handwritten] 1450m [handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; (white): 1983.VI–22 [handwritten] / 采集者 王书永 [Cǎijízhě, Wáng Shūyǒng, printed]; (white, printed): IOZ(E) 906879. 1 ♂: (white): 四川 [Sìchuān, printed] 康定 [Kāngdìng, handwritten] / 2600m [handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; (white): 1983.V–30 [handwritten] / 采集者 王书永 [Cǎijízhě, Wáng Shūyǒng, printed]; (white, printed): IOZ(E) 906854. 1 ♂: same data as 906854 except collecting date 1983.VI–25, 采集

者: 陈元清 [Cǎijízhě, Chén Yuánqīng, printed] and IOZ(E) 906860. 1 ♀: (white): 四川宝兴 [Sìchuān Bǎoxīng, printed] / 硃磬 [qiāoqì, printed] 2200–2700m [printed] / 1963.VI. [printed] 25 [handwritten] / 天津自然博物馆 [Tiānjīn Zìránbówùguǎn, printed]; (white): 采集者: 熊江 [Cǎijízhě, Xióngjiāng, printed]; (white, printed): IOZ(E) 906836. 2 ♀: ditto, IOZ(E) 906837, IOZ(E) 906830.

Remarks. *Leptomias foveicollis* is widely distributed in Sichuan (Baoxing, Kangding, Ganzi, Lixian), Liaoning (Changtu) and Heilongjiang (Haerbing). From southwest to northeast of China, this species has a wide distribution range. *Leptomias foveicollis* is widely distributed in the central-western region of Sichuan (Fig. 24). This species is similar to *L. moxiensis* but can be differed from the following characters: prothorax strongly convex, broadest behind middle, with fovea on either side of median longitudinal groove; elytra every interstriae with 1–2 column setae; procoxae contiguous, inner sides flat; penis long and robust, apex elongate and obliquely truncate. We could not locate type materials, all above are based on identified specimens.

Leptomias globosus Chen, 1987

Leptomias globosus Chen, 1987. Acta Zootaxonomica Sinica, 12(4): 409, fig. 7.

Type material examined. Holotype, ♂: (white): 四川 [Sìchuān, printed] 马尔康 [Mǎěrkāng, handwritten] / 2500m [handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; (white): 1983.VIII.17 [handwritten] / 采集者 王书永 [Cǎijízhě, Wáng Shūyǒng, printed]; (red, printed): HOLOTYPE; (white, printed): IOZ(E) 905588.

Remarks. *Leptomias globosus* is an endemic species of China which recorded from Maerkang, central region of Sichuan (Fig. 24). *Leptomias globosus* can be distinguished from other species by the following characters: disc of pronotum is strongly convex; prothorax broadest in middle; scrobes with dorsal margin not carinate; elytra posterior margin carinate, striae narrow, punctures small, every interstriae with 1–2 column setae, odd interstriae slightly raised than even ones; penis short and robust, apex short and truncate.

Leptomias moxiensis Chen, 1992

Leptomias moxiensis Chen, 1992. In Chen S (Ed) Insects of the Hengduan Mountains Region 2: 843, fig. 10.

Type material examined. Holotype, ♂: (white): 四川 [Sìchuān, printed] 泸定磨西 [Lúdìng Móxī, handwritten] / 1650m [handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; (white): 1983.VI.20 [handwritten] / 采集者: 陈元清 [Cǎijízhě, Chén Yuánqīng, printed]; (red, printed): HOLOTYPE; (white, printed): IOZ(E)



Figure 24. Distribution map of *Leptomias* species from Sichuan (all endemic species are marked by five-pointed stars).

905925. Paratypes: 1 ♀: same data as holotype except ALLOTYPE printed on sea-green paper and IOZ(E) 905926. 5 ♂, 3 ♀: same data as holotype except PARATYPE printed on yellow paper and IOZ(E) 905927–905934. 1 ♂: (white): 四川 [Sichuān, printed] 泸定磨西海 [Lúding Móxī, Hǎi handwritten] / 螺沟 1550m [Luógōu, handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; (white): 1982.IX.16 [handwritten] / 采集者 王書永 [Cǎijízhě, Wáng Shūyǒng, printed]; (yellow, printed): PARATYPE; (white, printed): IOZ(E) 905935. 1 ♀: ditto, IOZ(E) 905936. 1 ♀: same data as holotype except PARATYPE printed on yellow paper, 1500m, 采集者: 张学忠 [Cǎijízhě, Zhāng Xuézhōng, printed] and IOZ(E) 905937. 1 ♂: ditto, IOZ(E) 905938.

Remarks. *Leptomias moxiensis* is also an endemic species of China. It is recorded only from Luding, the central region of Sichuan (Fig. 24). *Leptomias moxiensis* can be identified by the following characters: prothorax broadest in middle, pronotum corrugated, with very fine, deep median longitudinal groove; antennae with scape reaching posterior margin of eye when at rest; elytra every interstriae with one column setae; prementum with two setae; procoxae separated from each other, inner sides flat; metatibiae with mucro.

Leptomias nubilus Chen, 1983

Leptomias nubilus Chen, 1983. Acta Zootaxonomica Sinica 8(4): 397–398, fig. 2.

Type material examined. Holotype, ♂: (white): 西藏芒康 [Xizàng Mángkāng, handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; (white): 1977.9.15 [handwritten] / 采集者 [Cǎijízhě, printed] 李继均 [Lǐjìjūn, handwritten]; (red, printed): HOLOTYPE; (white, printed): IOZ(E) 906290. Paratypes: 1 ♀: same data as holotype except PARATYPE printed on yellow paper and IOZ(E) 906291.

Additional material examined. 1 ♂: (white): 四川 [Sìchuān, printed] 乡城 [Xiāngchéng, handwritten] / 2900m [handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed, printed]; (white): 1983.VI.28 [handwritten] / 采集者: 张学忠 [Cǎijízhě, Zhāng Xuézhōng, printed]; (white, printed): IOZ(E) 906309. 2 ♂: ditto, IOZ(E) 906310, IOZ(E) 906311. 1 ♀: same data as 906309 except collecting date 1982.VI.17, 采集者: 王书永 [Cǎijízhě, Wáng Shūyǒng, printed] and IOZ(E) 906293. 2 ♀: ditto, IOZ(E) 906294, IOZ(E) 906296.

Remarks. *Leptomias nubilus* is recorded from Sichuan (Xiangcheng) and Xizang (Mangkang). Xiangcheng is located in the southwest region of Sichuan (Fig. 24). *Leptomias nubilus* can be distinguished from *L. elongitus* by antennae with scape reaching middle of eye when at rest; eyes large and slightly flat; postocular lobes not developed; with a depression positioned laterally between the upper margin of antennal scrobe and the front of eyes; prothorax rather smooth, without median longitudinal, broadest before middle.

Leptomias ochrolineatus Chen, 1987

Leptomias ochrolineatus Chen, 1987. Acta Zootaxonomica Sinica 12(4): 406–407, fig. 4.

Type material examined. Holotype, ♂: (white): 四川 [Sìchuān, printed] 德格 [Dégé, handwritten] / 3200m [handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; (white): 1983.VII.6 [handwritten] / 采集者: 陈元清 [Cǎijízhě, Chén Yuánqīng, printed]; (red, printed): HOLOTYPE; (white, printed): IOZ(E) 905520. Paratypes: 1 ♀: same data as holotype except ALLOTYPE printed on sea-green paper and IOZ(E)

905521. 8 ♀, 4 ♂: same data as holotype except PARATYPE printed on yellow paper and IOZ(E) 905522–905528, IOZ(E) 905531, IOZ(E) 905537, IOZ(E) 905540–905542. 3 ♀, 6 ♂: same data as holotype except PARATYPE printed on yellow paper, collecting date 1983.VII.4 and IOZ(E) 905529, IOZ(E) 905530, IOZ(E) 905532–905536, IOZ(E) 905538, IOZ(E) 905539.

Remarks. *Leptomias ochrolineatus* is endemic to China and collected only from Sichuan (Dege). It is narrowly distributed in the northwest region of Sichuan (Fig. 24). *Leptomias sublongicollis* and *L. varians* are also recorded from the same locality, Dege; however, *L. ochrolineatus* is very different from *L. varians*: elytra in lateral view moderately flat, intervals convex, with odd intervals more raised than even ones; prothorax broadest in middle; pronotum without median longitudinal groove; penis bent downwards at apex. *L. ochrolineatus* is similar to *L. verticalis* except the following characters: prementum with two setae; antennae with scape extending beyond middle of eye when at rest; elytra in lateral view with posterior declivity not straight; scutellum large, ligulate.

Leptomias sublongicollis Chen, 1987

Leptomias sublongicollis Chen, 1987. Acta Zootaxonomica Sinica 12 (4): 404–405, fig. 1.

Type material examined. Holotype, ♂: (white): 云南 [Yúnnán, printed] 维西攀天 [Wéixī Pāntiān, handwritten] / 阁 [Gé, handwritten] 2500m [handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; (white): 1981.VII.24 [handwritten] / 采集者: [Cǎijízhě, printed] 廖素柏 [Liào Sùbó, handwritten] / (red, printed): HOLOTYPE; (white, printed): IOZ(E) 905433. Paratypes: 1 ♀: same data as holotype except ALLOTYPE printed on sea-green paper and IOZ(E) 905434. 14 ♂, 5 ♀: same data as holotype except PARATYPE printed on yellow paper and IOZ(E) 905435–905437, IOZ(E) 905448, IOZ(E) 905473, IOZ(E) 905482, IOZ(E) 905483, IOZ(E) 905485, IOZ(E) 905488, IOZ(E) 905489, IOZ(E) 905491–905493, IOZ(E) 905495, IOZ(E) 905497–905500, IOZ(E) 905503. 7 ♂, 4 ♀: same data as holotype except PARATYPE printed on yellow paper, (white, printed) 采集者 张学忠 [Cǎijízhě, Zhāng Xuézhōng] and IOZ(E) 905438, IOZ(E) 905442, IOZ(E) 905447, IOZ(E) 905452, IOZ(E) 905472, IOZ(E) 905477, IOZ(E) 905478, IOZ(E) 905481, IOZ(E) 905494, IOZ(E) 905501, IOZ(E) 905502. 12 ♂, 5 ♀: same data as holotype except PARATYPE printed on yellow paper, collecting date 1981.VII.26, IOZ(E) 905439–905441, IOZ(E) 905443, IOZ(E) 905446, IOZ(E) 905449, IOZ(E) 905454, IOZ(E) 905458, IOZ(E) 905462, IOZ(E) 905463, IOZ(E) 905465–905468, IOZ(E) 905471, IOZ(E) 905474, IOZ(E) 905496 and with 寄主: 黑桃 [Jīzhǔ, Hēitáo, handwritten]. 1 ♂, 2 ♀: same data as holotype except PARATYPE printed on yellow paper, collecting date 1981.VII.26, IOZ(E) 905444, IOZ(E) 905445, IOZ(E) 905461 and with (white, printed) 采集者 王书永 [Cǎijízhě, Wáng Shūyǒng]. 4 ♂, 4 ♀: same data as holotype except PARATYPE

printed on yellow paper, collecting date 1981.VII.28 and IOZ(E) 905450, IOZ(E) 905456, IOZ(E) 905459, IOZ(E) 905460, IOZ(E) 905464, IOZ(E) 905475, IOZ(E) 905479, IOZ(E) 905484. 1 ♂, 2 ♀: same data as holotype except PARATYPE printed on yellow paper, collecting date 1981.VII.27 and IOZ(E) 905451, IOZ(E) 905469, IOZ(E) 905470. 1 ♂, 1 ♀: same data as holotype except PARATYPE printed on yellow paper, collecting date 1981.VII.27, IOZ(E) 905453, IOZ(E) 905455 and with (white, printed) 采集者 王书永 [Cǎijízhě, Wáng Shūyǒng]. 1 ♂, 1 ♀: same data as 905455 except collecting date 1981.VII.28 and IOZ(E) 905457, IOZ(E) 905480. 1 ♂, 1 ♀: same data as holotype except PARATYPE printed on yellow paper, collecting date 1981.VII.27, IOZ(E) 905476, IOZ(E) 905487 and with (white, printed) 采集者 张学忠 [Cǎijízhě, Zhāng Xuézhōng]. 1 ♂, 1 ♀: same data as holotype except PARATYPE printed on yellow paper, IOZ(E) 905486, IOZ(E) 905490 and with (white, printed) 采集者 王书永 [Cǎijízhě, Wáng Shūyǒng]. 1 ♀: (white): 云南 [Yúnnán, printed] 维西白济汎 [Wéixī Báijìfān, handwritten] / 1780m [handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; (white): 1981.VII.12 [handwritten] / 采集者: [Cǎijízhě, printed] 廖素柏 [Liào Sùbó, handwritten] / (yellow, printed): PARATYPE; (white, printed): IOZ(E) 905504. 1 ♀: (white): 云南 [Yúnnán, printed] 维西白济汎 [Wéixī Báijìfān, handwritten] / 1780m [handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; (white): 1981.VII.10 [handwritten] / 19号 [Hào, handwritten] / 采集者 王书永 [Cǎijízhě, Wáng Shūyǒng, printed] / (yellow, printed): PARATYPE; (white, printed): IOZ(E) 905505. 1 ♀: (white): 四川 [Sìchuān, printed] 德格 [Dégé, handwritten] / 3200m [handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; 1983.VII.4 [handwritten] / 采集者: 陈元清 [Cǎijízhě, Chén Yuánqīng, printed]; (yellow, printed): PARATYPE; (white, printed): IOZ(E) 905506.

Remarks. *Leptomias sublongicollis* is recorded from Sichuan (Dege) (Fig. 24) and Yunnan (Weixi). It is distributed in the Hengduan Mountains. *L. sublongicollis* resembles *L. varians*, but they are different in the following characters: scrobes with dorsal margin carinate; eyes large and convex; postocular lobes not developed; penis bent upwards at apex; rostrum dorsal surface corrugated; protibiae apex not projecting outwards.

Leptomias thibetanus (Faust, 1888)

Heteromias thibetanus Faust, 1888. Stett. Entomol. Zeit, 49(7–9): 285–286.

Leptomias thibetanus (Faust): Marshall (1916), In: Shipley AE (Ed) The Fauna of British India, including Ceylon and Burma, pp 172.

Type material examined. 1 ♂: Thibet / Oayrollv (white, handwritten); Coll J. Faust / Ankauf 1900 (yellow, printed); Type (red, printed); Staatl. Museum für / Tierkunde Dresden (white, printed).

Additional material examined. 1 ♀: (white): 四川 [Sìchuān, printed] 贡嘎山 [Gònggāshān, handwritten] / 燕子沟 2500m [Yànzǐgōu, handwritten] / 中国科学

院 [Zhōngguó Kēxuéyuàn, printed]; 1983.VI.10 [handwritten] / 采集者: 陈元清 [Cǎijízhě, Chén Yuánqīng, printed]; (white, printed): IOZ(E) 906817. 1 ♀: (white): 四川 [Sichuān, printed] 红原 [Hóngyuán, handwritten] / 3500m [handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; 1983.VIII.27 [handwritten] / 采集者: [Cǎijízhě, printed] 牛春来 [Niú Chūnlái, handwritten]; (white, printed): IOZ(E) 906819. 1 ♂: (white): 四川 [Sichuān, printed] 贡嘎山 [Gònggāshān, handwritten] / 燕子沟 2500m [Yànzǐgōu, handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; 1983.VI.8 [handwritten] / 采集者: 陈元清 [Cǎijízhě, Chén Yuánqīng, printed]; (white, printed): IOZ(E) 906823. 1 ♂: (white): 四川 [Sichuān, printed] 泸定新兴 [Lúding Xīnxīng, handwritten] / 1900m [handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; 1983.VI.12 [handwritten] / 采集者: 陈元清 [Cǎijízhě, Chén Yuánqīng, printed]; (white, printed): IOZ(E) 906825.

Remarks. *Leptomias tibetanus* is known from Sichuan (Ganzi, Hongyuan, Kangding, Luding) and Xizang. It is widely distributed from the central to northwest region of Sichuan (Fig. 24). *L. tibetanus* is similar to *L. zheduoshanensis*, but can be recognized by the following characters: rostrum dorsal surface with a median sulcus, extending longitudinally from antennal insertion to the vertex; elytra every interstriae with 1–2 column setae; prothorax broadest behind middle, pronotum corrugated; striae with moderately large punctures; penis slender, moderately long and straight, outline gradually converging after ostium region, apex narrowly rounded projected.

Leptomias varians Chen, 1987

Leptomias varians Chen, 1987. Acta Zootaxonomica Sinica, 12(4): 405, fig. 2.

Type material examined. Holotype, ♂: (white): 四川 [Sichuān, printed] 德格 [Dégé, handwritten] / 3200m [handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; 1983.VII.4 [handwritten] / 采集者: 陈元清 [Cǎijízhě, Chén Yuánqīng, printed]; (red, printed): HOLOTYPE; (white, printed): IOZ(E) 905414. Paratypes: 1 ♀: same data as holotype except ALLOTYPE printed on sea-green paper and IOZ(E) 905415. 6 ♂, 3 ♀: same data as holotype except PARATYPE printed on yellow paper and IOZ(E) 905416–905424.

Remarks. *Leptomias varians* is an endemic species of China, collecting from Sichuan (Dege) (Fig. 24). *L. varians*, *L. ochrolineatus* and *L. sublongicollis* are all recorded from the same county. It is close to but can be differed from *L. ochrolineatus* by these characters: elytra in dorsal view broadly ovate; prothorax broadest behind middle, with very fine and shallow median longitudinal groove; elytral intervals flat; the metatibial apex with mucro; penis bent upwards at apex. *Leptomias varians* resembles *L. sublongicollis*, but can be identified by the following characters: elytra every interstriae with 1–2 column setae; scrobes with dorsal margin not carinate; postocular lobes developed; eyes large and slightly flat; penis not bent at apex.

***Leptomias wenchuanensis* Chen, 1992**

Leptomias wenchuanensis Chen, 1992. In Chen S (Ed) *Insects of the Hengduan Mountains Region 2*: 843, fig. 11.

Type material examined. Holotype, ♂: (white): 四川 [Sìchuān, printed] 汶川卧龙 [Wèncuān Wòlóng, handwritten] / 1920m [handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; (white): 1983.VII.24 [handwritten] / 采集者 王书永 [Cǎijízhě, Wáng Shūyǒng, printed]; (red, printed): HOLOTYPE; (white, printed): IOZ(E) 905907. Paratypes: 1 ♀: (white): 四川 [Sìchuān, printed] 汶川 [Wèncuān, handwritten] / 卧龙 [Wòlóng, handwritten] 1920m [handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; (white): 1983.VII.24 [handwritten] / 采集者 王书永 [Cǎijízhě, Wáng Shūyǒng, printed]; (sea-green, printed): ALLOTYPE; (white, printed): IOZ(E) 905908. 2 ♂: same data as allotype except PARATYPE printed on yellow paper and IOZ(E) 905909, IOZ(E) 905910. 3 ♀: same data as holotype except PARATYPE printed on yellow paper, collecting date 1983.VII.25, 1780m and IOZ(E) 905411, IOZ(E) 905413, IOZ(E) 905414. 1 ♂: (white): 四川 [Sìchuān, printed] 汶川 [Wèncuān, handwritten] / 卧龙 [Wòlóng, handwritten] 1780m [handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; (white): 1983.VII.25 [handwritten] / 采集者 王书永 [Cǎijízhě, Wáng Shūyǒng, printed]; (yellow, printed): PARATYPE; (white, printed): IOZ(E) 905912. 1 ♀: ditto, IOZ(E) 905415. 1 ♂: same data as 905912 except 1800m, 采集者 张学忠 [Cǎijízhě, Zhāng Xuézhōng, printed] and IOZ(E) 905416. 1 ♀: (white): 四川 [Sìchuān, printed] 卧龙 [Wòlóng, handwritten] / 2700m [handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; (white): 1983.VIII.9 [handwritten] / 采集者 [Cǎijízhě, printed] 牛春来 [Niú Chūnlái, handwritten]; (yellow, printed): PARATYPE; (white, printed): IOZ(E) 905917. 1 ♀: (white): 四川 [Sìchuān, printed] 汶川 [Wèncuān, handwritten] / 1300m [handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; (white): 1983.IX.13 [handwritten] / 采集者: 张学忠 [Cǎijízhě, Zhāng Xuézhōng, printed]; (yellow, printed): PARATYPE; (white, printed): IOZ(E) 905918. 1 ♀: (white): 四川 [Sìchuān, printed] 汶川 [Wèncuān, handwritten] / 三圣沟 2500m [Sānshènggōu, handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; (white): 1983.VIII.6 [handwritten] / 采集者: 柴怀成 [Cǎijízhě, Chái Huáichéng, printed]; (yellow, printed): PARATYPE; (white, printed): IOZ(E) 905919. 1 ♀: (white): 四川 [Sìchuān, printed] 汶川木江坪 [Wèncuān Mùjiāngpíng handwritten] / 1200m [handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; (white): 1983.VIII.8 [handwritten] / 采集者: 柴怀成 [Cǎijízhě, Chái Huáichéng, printed]; (yellow, printed): PARATYPE; (white, printed): IOZ(E) 905920. 1 ♀: (white): 四川 [Sìchuān, printed] 汶川映秀 [Wèncuān Yǐngxiù handwritten] / 900–1000m [handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; (white): 1983.VIII.1 [handwritten] / 采集者: 张学忠 [Cǎijízhě, Zhāng Xuézhōng, printed]; (yellow, printed): PARATYPE; (white, printed): IOZ(E) 905921. 1 ♀: (white): 1983.VIII.3 [handwritten] / 采集者 [Cǎijízhě,

printed] 柴怀成 [Chái Huáichéng, handwritten]; (white): 四川 [Sichuān, printed] 汶川 [Wēnchuān, handwritten] / 映秀 [Yìngxiù, handwritten] / 900m [handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed, printed]; (yellow, printed): PARATYPE; (white, printed): IOZ(E) 905922. 1 ♀: (white): 四川 [Sichuān, printed] 马尔康 [Mǎěrkāng, handwritten] / 2900m [handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; (white): 1983.VIII.18 [handwritten] / 采集者: [Cǎijízhě, printed] 张学忠 [Zhāng Xuézhōng, handwritten]; (yellow, printed): PARATYPE; (white, printed): IOZ(E) 905923. 1 ♀: (white): 四川 [Sichuān, printed] 马尔康 [Mǎěrkāng, handwritten] / 梦笔山 [Mèngbǐshān, handwritten] / 4000m [handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; (white): 1983.VIII.19 [handwritten] / 采集者: 王书永 [Wáng Shūyǒng, printed]; (yellow, printed): PARATYPE; (white, printed): IOZ(E) 905924.

Remarks. *Leptomias wenchuanensis* is an endemic species of China and recorded from Sichuan (Wenchuan, Maerkang). It is narrowly distributed in the North Central region of Sichuan (Fig. 24). *L. wenchuanensis* and *L. globosus* are both distributed in Maerkang County, north central Sichuan. *L. wenchuanensis* is different from *L. globosus* by the following characters: protibiae strongly bent inwards at apical; inner margin of pro-, meso- and metatibiae with large teeth; prementum with two setae; pronotum strongly convex, with two foveae on either side of median longitudinal groove.

Leptomias zheduoshanensis Chen, 1992

Leptomias zheduoshanensis Chen, 1992. In: Chen S (Ed) Insects of the Hengduan Mountains region 2: 842–843.

Type material examined. Holotype, ♂: (white): 四川 [Sichuān, printed] 康定 [Kāngdìng, handwritten] / 4200m [handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; (white): 1983.VII.13 [handwritten] / 采集者: 陈元清 [Chén Yuánqīng, printed]; (red, printed): HOLOTYPE; (white, printed): IOZ(E) 905953. Paratypes: 1 ♀: same data as holotype except ALLOTYPE printed on sea-green paper and IOZ(E) 905954. 2 ♂, 2 ♀: same data as holotype except PARATYPE printed on yellow paper and IOZ(E) 905955, IOZ(E) 905957, IOZ(E) 905959, IOZ(E) 905961. 1 ♂: (white): 四川 [Sichuān, printed] 康定折多 [Kāngdìng Zhédūo, handwritten] / 山 垭口 4200m [Shān Yàkǒu, handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; (white): 1983.VII.13 [handwritten] / 采集者 王书永 [Wáng Shūyǒng, printed]; (yellow, printed): PARATYPE; (white, printed): IOZ(E) 905956. 1 ♂: ditto, IOZ(E) 905960. 1 ♂: (white): 四川 [Sichuān, printed] 康定 [Kāngdìng, handwritten] / 3100m [handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; (white): 1983.VI.24 [handwritten] / 采集者 [Cǎijízhě, printed] 陈元清 [Chén Yuánqīng, handwritten]; (yellow, printed): PARATYPE; (white, printed): IOZ(E) 905962. 1 ♀: ditto, IOZ(E) 905963. 1 ♀: (white): 四川 [Sichuān, printed]

康定 [Kāngdìng, handwritten] / 4200m [handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; (white): 1983.VII.13 [handwritten] / 采集者: [Cǎijízhě, printed] 牛春来 [Niú Chūnlái, handwritten]; (yellow, printed): PARATYPE; (white, printed): IOZ(E) 905958.

Remarks. *Leptomias zheduoshanensis* is another endemic species of China which recorded from Sichuan (Kangding). It is narrowly distributed in the central region of Sichuan (Fig. 24). *Leptomias zheduoshanensis*, *L. foveicollis* and *L. tibetanus* are all distributed in Kangding County. *Leptomias zheduoshanensis* differs from *L. tibetanus* by the following characters: prothorax broadest in middle; striae with small punctures; rostrum dorsal surface with a narrow and deep median sulcus, not reach the vertex; elytra every interstriae with one column setae; penis bent upwards at apex.

Key to species of *Leptomias* occurring in Sichuan

- 1 Antennae with scape extending beyond anterior margin of eye but not reaching middle when at rest.....2
- Antennae with scape reaching or extending beyond middle of eye when at rest.....6
- 2 Pronotum rather corrugated; scutellum invisible; procoxae separate, inner sides flat.....*L. wenchuanensis*
- Pronotum rather smooth, not corrugated; scutellum ligulate; procoxae contiguous, inner sides convex.....3
- 3 Prementum with 4 setae; elytral striae broad with large punctures; mesotibiae without mucro; metatibiae without corbel *L. elongitus*
- Prementum with 2 setae; elytral striae narrow with small punctures; mesotibiae with mucro; metatibiae with narrow corbel4
- 4 Prothorax broadest in middle, pronotum without median longitudinal groove; penis bent downwards at apex *L. ochrolineatus*
- Prothorax broadest behind middle, pronotum with very fine and shallow median longitudinal groove; penis bent upwards at apex5
- 5 Scrobes with dorsal margin not carinate; eyes large and slightly flat; postocular lobes obvious; elytral interstriae flat..... *L. varians*
- Scrobes with dorsal margin carinate; eyes large and convex; postocular lobes absent; elytral interstriae convex..... *L. sublongicollis*
- 6 Scrobes with dorsal margin carinate.....7
- Scrobes with dorsal margin not carinate.....10
- 7 Antennae with scape reaching middle of eye when at rest; eyes large and slightly flat; prothorax broadest before middle; scutellum ligulate and covered with scales; procoxae contiguous, inner sides convex..... *L. nubilus*
- Antennae with scape extending beyond middle of eye when at rest; eyes larger or small, convex; prothorax broadest in middle or behind it; scutellum invisible; procoxae contiguous or separated, inner sides flat.....8

- 8 Prothorax broadest behind middle, pronotum with fovea on either side of median longitudinal groove; penis long and robust, apex elongate and obliquely truncate *L. foveicollis*
- Prothorax broadest in middle, pronotum without fovea on either side of median longitudinal groove; penis slender, apex ogival **9**
- 9 Pronotum corrugated, with very fine, deep median longitudinal groove; inner margin of metatibiae with teeth; procoxae separated from each other, inner sides flat; prementum with 2 setae *L. moxiensis*
- Pronotum smooth, without median longitudinal groove; inner margin of metatibiae without teeth; procoxae contiguous, inner sides flat; prementum with 4 setae *L. verticalis*
- 10 Antennae with scape reaching posterior margin of eye when at rest; pronotum without median longitudinal groove, with fovea on each side of disc; scutellum invisible; procoxae separate, inner sides flat; penis short and robust, apex short and truncate *L. globosus*
- Antennae with scape extending to region between middle and posterior margin of eye when at rest; pronotum with median longitudinal groove, with fovea on either side of groove; scutellum triangular; procoxae contiguous, inner sides flat; penis short or slender, apex moderately long, ogival or round **11**
- 11 Antennae with scape reaching middle of eye when at rest; prothorax broadest behind middle, pronotum corrugated; striae with moderately large punctures; penis slender, apex moderately long and straight, ogival *L. tibetanus*
- Antennae with scape extending beyond middle of eye but not reaching posterior margin when at rest; prothorax broadest at midpoint, pronotum smooth; striae with small punctures; penis shorter and robust, diverging at ostium level, thereafter roundly converging, then slightly diverging again and then converging to narrowly rounded, thickened apex *L. zheduoshanensis*

***Geotragus granulatus* (Chao, 1980), comb. n.**

Figs: 25–46

Leptomias granulatus Chao, 1980. Entomotaxonomia 2(1): 29.

Leptomias chenaе Alonso-Zarazaga & Ren, 2013. Catalogue of Palearctic Coleoptera 8: 89, 396 (replacement name for secondary homonymy).

Comments. The correct name for this species under *Geotragus* is *G. granulatus*, not *G. chenaе*, because of Art. 59.4 of the Code: “59.4. Reinstatement of junior secondary homonyms rejected after 1960. A species-group name rejected after 1960 on grounds of secondary homonymy is to be reinstated as valid by an author who considers that the two species-group taxa in question are not congeneric, unless it is invalid for some other reason.”

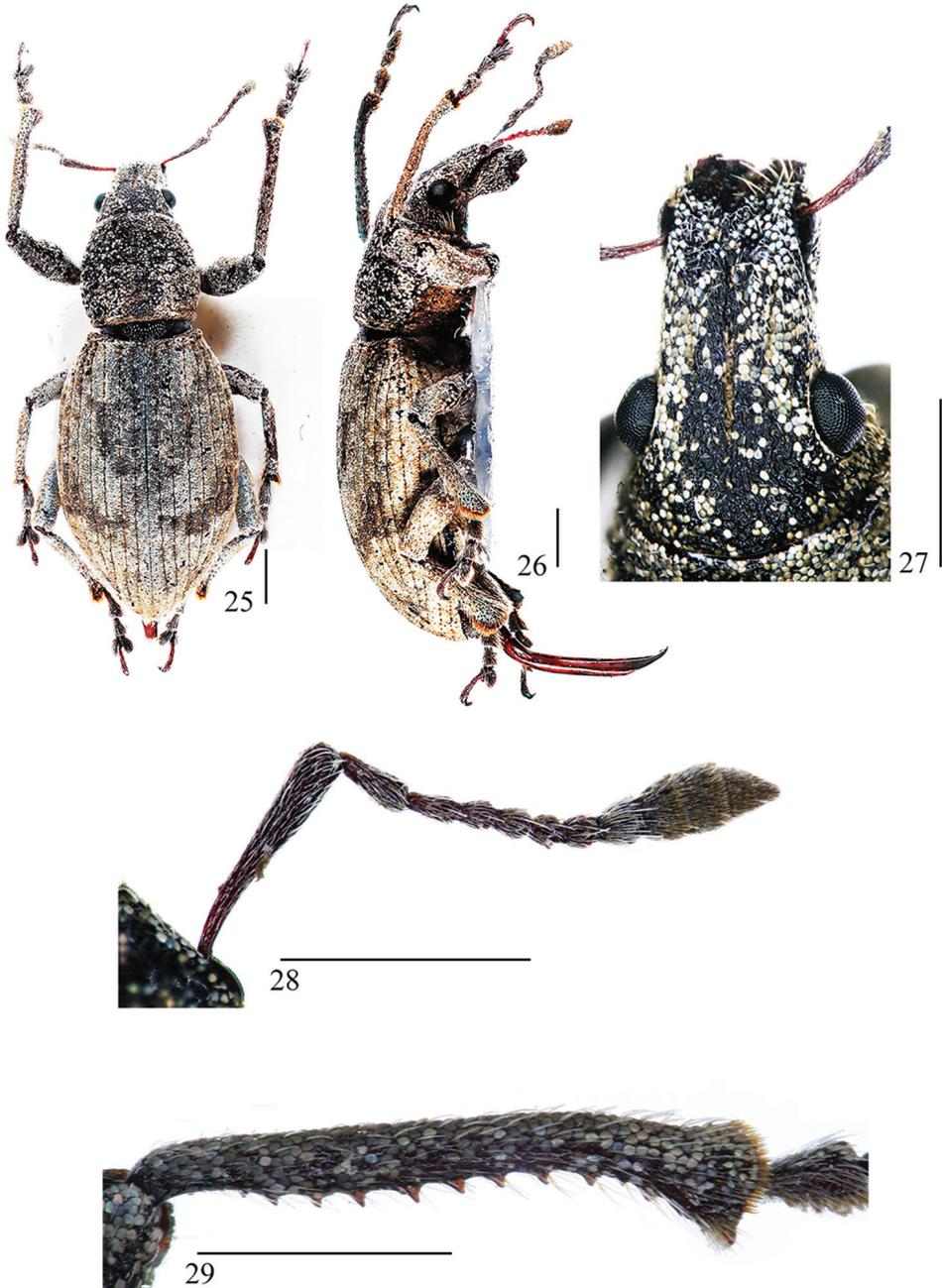
Redescription. Body medium-sized, black to reddish brown. Eyes lateral, oval, convex, with deep and fine circumferential stria. Rostrum 1.14× longer than wide, base narrower than frons, with slightly broad, deep median sulcus, reaching vertex. Scapes

short and stout, exceeding anterior margin of eyes but not surpassing middle of eyes. Funicles with desmomere 1 elongate clavate, apical stout, 1.70× longer than desmomere 2, distinctly wider than 2. Prementum with four setae. Prothorax transverse, sides evenly rounded, broadest behind middle, pronotum with extremely shallow, fine, incomplete, median longitudinal groove. Elytral interstriae slightly elevated, unequal in width, without tubercles. Proventriculus (Fig. 30): well developed, with sclerotized basal plates, each plate brush-like, apically ending with a trapezoidal zone covered with pointed inward denticles. Metendosternite (Figs 36, 39): stalk 0.23× as long as furcal arms, anterior tendons positioned almost at apical 1/2 of furcal arms; furcal arms robust, apically not bifurcate, diverging at nearly 60° in relation to longitudinal flange. Male genitalia and terminalia: sternite VIII (Fig. 31) divided into two transversely orientated, crescent-shaped hemisternites; spiculum gastrale 0.26× as long as aedeagus, almost straight, strongly sclerotized; penis (Figs 32, 33) in dorsal view 3.36 mm long and 0.36 mm wide, aedeagal apodemes 0.69 mm long, lateral margins subparallel in middle; tegmen (Fig. 34) 0.31× as long as penis, ring narrow; endophallus (Fig. 35) strongly ossification at end. Pygidium (Figs 37, 42) in dorsal view male apex broadly rounded and female apex acuminate. Hindwing (Fig. 38): generally do not possess complete venation; oblong-ovate; gradually narrowing towards end and strongly narrowing towards base; radial field, apical, medial and anal field not apparent; at the middle part of anterior margin strongly ossified; with a setae at the end. Female sternite VIII and genitalia (Fig. 40) in lateral view coxites and styli 0.55× as long as sternum VIII. Spermatheca (Fig. 41) with corpus short, trapezoidal; cornu elongate, strongly curved into a narrow U-shape, apically gradually narrowed; nodulus and ramus not developed; spermathecal duct strongly sclerotized and curved.

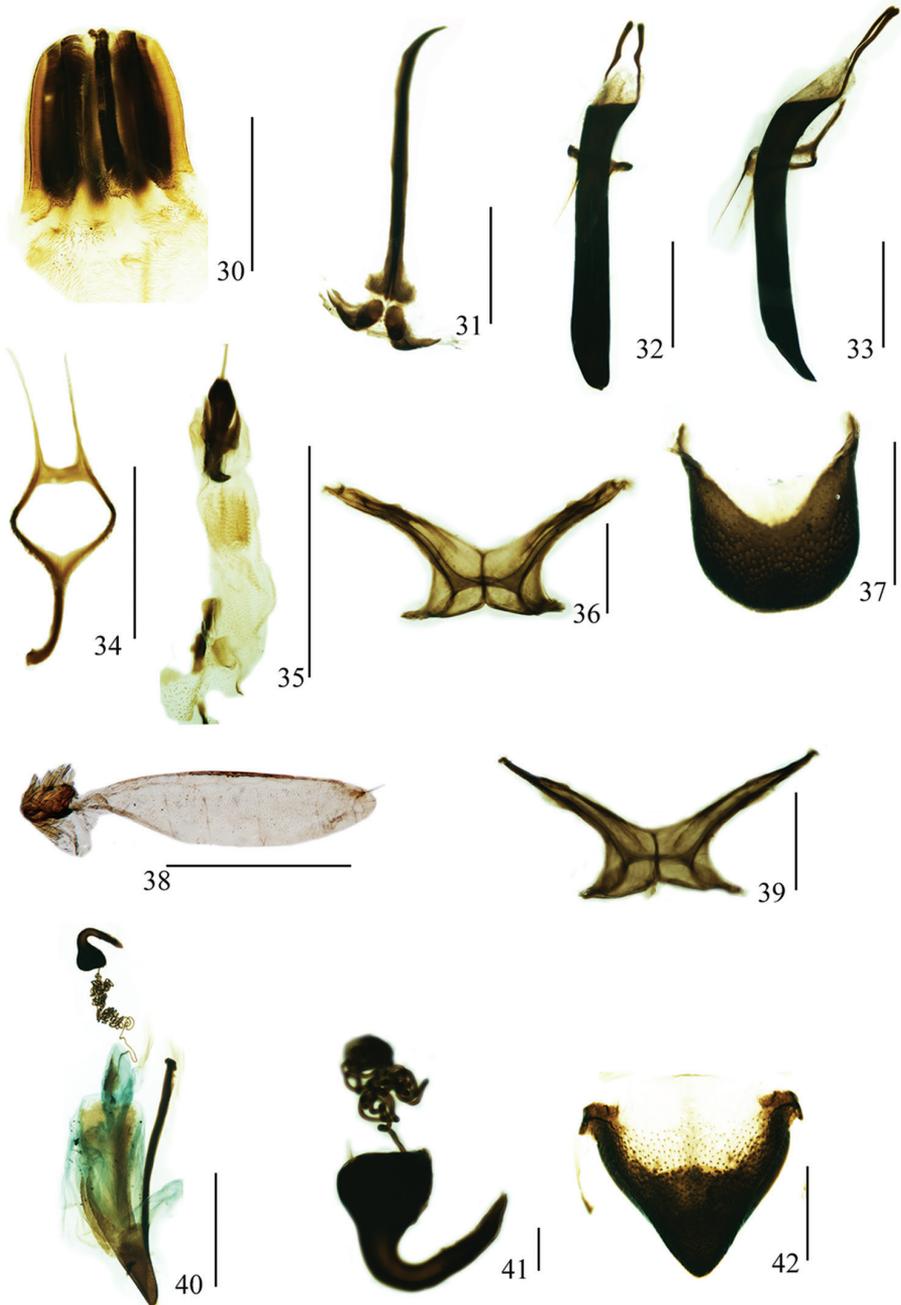
Remarks. Its metanepisterna are posteriorly fused with the metaventrite and its scrobes are narrow, well defined and with the upper edge directed towards the lower end of eye, features well agreeing with the key characters of *Geotragus*. Chao (1980) described this species from a single male specimen. We later found additional specimens during several field trips, which allowed us to dissect 10 males and 10 females and illustrate the reduced hind wings and other important structures of the species (Figs 25–42). This species resembles *Geotragus declivis* Ren, Alonso-Zarazaga & Zhang, 2013 but differs by the following characters: prementum with 4 setae; elytral interstriae slightly elevated, unequal in width, without tubercles. It is similar to *Geotragus shanensis* Kumar, Mahendiran, Ayri & Ramamurthy, 2016, from which it can be distinguished by the following characters: pronotum with fine, incomplete, median longitudinal groove; protibiae only slightly bent inward at apical 1/4; bursal sclerite situated near junction of spermathecal duct and oviduct, ventral side of bursa copulatrix tile-like, in lateral view triangular, with several sharp tubercles ventrally, strongly sclerotized in middle.

Type material examined. Holotype, ♂: (white, printed): 四川康定 [Sichuān Kāngdìng] / 2400–2700 公尺 [Gōngchǐ, printed] / 中国科学院 [Zhōngguó Kēxuéyuàn]; (white): 1963.VII.28 [handwritten] / 采集者 张学忠 [Cǎijízhě Zhāng Xuézhōng, printed]; (red, printed): HOLOTYPE; (white, printed): IOZ(E) 906893.

Additional material examined. 8 ♂, 9 ♀: (white, printed): 四川甘孜州泸定县 [Sichuān Gānzī Zhōu Lú dì Xiàn] / 折田坝 [Zhétiánbà] 2110m / 2011.VII.03 / 中国科学院 [Zhōngguó Kēxuéyuàn]; (white, printed): leg. 张华康 [Zhāng Huákāng] / N



Figures 25–29. Habitus of *Geotragus granulatus* (Chao, 1980): **25** male, dorsal view **26** male, lateral view **27** male, head and rostrum, anterior view **28** male, antenna, anterior view **29** male, left protibia, anterior view. Scale bars 1 mm.



Figures 30–42. *Geotragus granulatus* (Chao, 1980): **30** male, proventriculus **31** male, sternites VIII and IX, dorsal view **32** aedeagus, dorsal view **33** aedeagus, lateral view **34** tegmen, dorsal view **35** endophallus, dorsal view **36** male, metendosternite, dorsal view **37** male, pygidium, dorsal view **38** male, hind wing, dorsal view **39** female, metendosternite, dorsal view **40** female, sternite VIII and genitalia, lateral view **41** spermatheca, lateral view **42** female, pygidium, dorsal view. Scale bars: **31–35, 37, 38, 40**: 1 mm; **30, 36, 39, 42**: 0.5 mm; **41**: 0.1 mm.

29.68912 / E 102.06859 / 中国科学院 [Zhōngguó Kēxuéyuàn]; (white, printed): IOZ(E) 1506001–1506006, IOZ(E) 1506022, IOZ(E) 1506032, IOZ(E) 1506033, IOZ(E) 1506052–1506057, IOZ(E) 1506063, IOZ(E) 1506064. 1 ♂, 2 ♀: same data as 1506064 except 和平组 [Hépíngzǔ], 1845m, 2011.VI.15, N 29.64937, E 102.09164, IOZ(E) 1506027, IOZ(E) 1506031 and IOZ(E) 1506062. 3 ♂, 5 ♀: same data as 1506064 except 火草坪 [Huǒcǎopíng], 2116m, 2011.VI.30, N 29.512675, E 102.133512, IOZ(E) 1506035, IOZ(E) 1506040–1506045 and IOZ(E) 1506061. 1 ♂: (white): 四川 [Sichuān, printed] 泸定磨西 [Lúdìng Móxī, handwritten] / 1650m [handwritten] / 中国科学院 [Zhōngguó Kēxuéyuàn, printed]; (white): 1983.VI.20 [handwritten] / 采集者: 陈元清 [Cǎijízhě, Chén Yuánqīng, printed]; (white, printed): IOZ(E) 907104. 1 ♂: same data as 907104 except 采集者 王书永 [Cǎijízhě, Wáng Shūyǒng] and IOZ(E) 907106. 1 ♀: same data as 907104 except 1500m, 采集者: [Cǎijízhě] 张学忠 [Zhāng Xuézhōng, handwritten] and IOZ(E) 907009. 1 ♀: (white): same data as 907104 except collecting date 1983.VI.17, and IOZ(E) 907010. 6 ♂, 7 ♀: same data as 907104 except 四川泸定 [Sichuān Lúdì, printed], 1800m, 1983.VI.14 and IOZ(E) 906944–906956.

Distribution. *Geotragus granulatus* mainly occurs northeast and east of Gongga Mountain, which is the highest mountain in Sichuan province, China.

Discussion

There are 12 species of *Leptomias* occurring in Sichuan Province, accounting for 14 % of the species presently known from China. Seven of them appear to be endemic to an area that stretches from Dege County to Wenchuan County (Fig. 24). Seven endemic species are all marked on the map by five-pointed star. The other five species also occur in Xizang (Mangkang, Nielamu), Yunnan (Weixi), Liaoning (Changtu), and Heilongjiang (Haerbin) provinces. The 12 species in the centre are more widely distributed than those in the south and along the western border. Dege and Kangding all have three species. Ganzi, Maerkang, and Luding have two species. This places Sichuan third in terms of *Leptomias* diversity in China. The species occur in Sichuan at elevations between 900 and 4200 m, in a geographical rectangle delimited by 31°48.600'N 98°34.120'W and 31°27.600'N 103°36.600'W. *Geotragus* is recorded for the first time from Sichuan, which also presents a new northern-most record for the genus. *Geotragus* currently comprises 13 species, six of which occur in China.

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Renius cornutus, a new genus and species of Chilocorini from Tibet, China (Coleoptera, Coccinellidae)

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Abstract

A new monotypic genus of Chilocorini, *Renius* Li & Wang, **gen. n.**, with a new species *R. cornutus* Li et Wang, **sp. n.** is described from Tibet, China. All diagnostic features are illustrated. The relationships with other genera of Chilocorini are discussed and a key to Chinese genera of Chilocorini is provided.

Keywords

China, Coccinelloidea, Coleoptera, new genus, new species, Tibet

Introduction

Ladybirds belonging to tribe Chilocorini, well-known primary predators of coccids, with known instances of aphidophagy (Giorgi et al. 2009), are distributed worldwide. Chilocorini consists of 26 genera and 280 species (Łącznyński and Tomaszewska 2012), classified under the subfamily Chilocorinae with Platynaspidini and Telsimini (Sasaji 1968). However, recent molecular phylogenetic analyses reveal that Chilocorinae does not represent a monophyletic group (Giorgi et al. 2009; Margo et al. 2010; Seago et al. 2011; Robertson et al. 2015), and Chilocorini should be classified in the subfamily Coccinellinae (Ślipiński 2007 and Seago et al. 2011).

The tribe is also diverse in China being represented with nine genera and 39 species (Pang et al. 2004; Ren et al. 2009; Hu et al. 2013; Li et al. 2015a; 2015b). During our study of the Chinese Chilacorini, a particular species from Tibet was found, recorded twice during collecting trips in 2009 and 2011, respectively. This new species is similar to members of *Orcus* Mulsant, 1850 in body shape and coloration. However, some characters make it hard to group it to any extant genus of Chilacorini.

Therefore, a new genus, *Renius* gen. n. is established for the only so far known species, *Renius cornutus* Li et Wang sp. n., which is also described here. Additionally, a key is provided to the genera of Chilacorini known in China and the diagnostic features of the new genus and species are illustrated. Lastly, the relationships between *Renius* and the other genera of Chilacorini are discussed.

Materials and methods

Specimens examined in this study were collected in Tibet, China. Type specimens designated in the present paper are deposited at the Department of Entomology, South China Agriculture University (SCAU), Guangzhou.

All the morphological photographs were taken by Zeiss AxioCam HRc digital camera mounted on a Zeiss Stereo Discovery V20 stereomicroscope or Zeiss Imager Z2m microscope. A number of serial images were combined in Zerene Stacker in order to obtain an entirely focused image, and photographs were cleaned up and laid out in plates in Adobe Photoshop CS 8.0. Morphological terms of Coccinellidae follow Ślipiński (2007) and Ślipiński and Tomaszewska (2010). The following measurements were made with an ocular micrometer:

- TL** total length, length from apical margin of clypeus to apex of elytra;
- TW** total width, width across both elytra at widest point;
- TH** height measured across the highest point of the elytra;
- HW** head width in frontal view, including eyes;
- PL** pronotal length, from middle of anterior margin to base of pronotum;
- PW** pronotal width at widest point;
- EL** elytral length, from the apex of the elytra to the base including the scutellum;
- EW** elytral width, equal TW.

Results

Renius Li & Wang, gen. n.

<http://zoobank.org/FA483030-8C57-40AC-B403-06301177A11A>

Type species. *Renius cornutus* Li & Wang, sp. n.

Diagnosis. The genus *Renius* can be distinguished from other genera of the tribe Chilacorini by the following combination of characters: clypeus distinctly projecting medially in male (Fig. 1c–d), slightly projecting medially in female (Fig. 1e); antenna composed of 10 antennomeres (Fig. 1f); basal margin of pronotum with distinct border line; prosternal process long, narrow, parallel sided, without carina (Fig. 1j); outer elytral margin strongly reflexed without distinct bead; epipleuron without foveae for the reception of mid and hind legs; abdominal postcoxal lines complete or almost complete, arcuate (Fig. 2a–b); legs with stout femora, tibiae slender without apical spurs (Fig. 1m–o); between the coxites with large, subtriangular sclerite (Fig. 2h).

Description. Body broadly rounded, moderately convex, dorsum and underside glabrous (Fig. 1a). Head large, 0.54–0.56 times pronotal width, covered with short, yellow pubescence. Eyes large, approximately oval, densely faceted, with inner sides subparallel. Clypeus with distinct horn-like projection, both sides of projection with a small subquadrate gap in male (Fig. 1c–d), in female clypeus with weak projection medially, without any gap (Fig. 1e). Antenna 10-segmented, scape asymmetrical, narrow at basal 1/3, distinctly expand to apical 2/3, pedicel subquadrate, with the same width as scape anteriorly, antennomeres 3–5 gradually broadening and shortening, 5–8 gradually broadening with the same length, antennomere 9 distinctly longer and wider than antennomere 8, terminal antennomere slightly narrower and shorter than antennomere 9, truncate and oblique at apex (Fig. 1f). Mandible unidentate, protheca distinct, outer margin of mandible slightly curved (Fig. 1h). Terminal maxillary palpomere elongate with sides slightly expanded, apex obliquely truncate (Fig. 1g). Penultimate labial palpomere stout, 1.5 times as wide as and longer than terminal labial palpomere; terminal labial palpomere subconical (Fig. 1i).

Prothorax descending anteriorly (Fig. 1b–c). Basal margin of pronotum with visible border line. Prosternum T-shaped, in front of coxae distinctly longer than basal width of prosternal process; prosternal process long, narrow, parallel sided, without carina (Fig. 1j). Mesoventrite approximately trapezoidal, with anterior margin straight. Meso and metaventral process narrow, junction straight, with visible suture (Fig. 1k). Postcoxal lines on metaventrite descending laterally. Tendons of metendosternite separated by much less than width of stalk and placed close to middle (Fig. 1l). Scutellum small and triangular. Elytra distinctly wider than pronotum at base; outer elytral margin strongly reflexed without distinct bead; elytral epipleuron distinctly broaden with descending outer portion, without grooves. Abdomen with six ventrites in both sexes; abdominal postcoxal lines complete or almost complete, arcuate (Fig. 2a–b). Legs with stout femora, tibiae slender, without tibial spurs (Fig. 1m–o); tarsal claws stout, with trapezoidal basal tooth, about 1/2 length of claw (Fig. 1p).

Etymology. The generic name is dedicated to the memory of the well-known Chinese entomologist, Ren Shunxiang, who devoted most of his life to the study of Coccinellidae and biological control. Gender masculine.

***Renius cornutus* Li & Wang, sp. n.**

<http://zoobank.org/BE549488-ED63-44FE-9BB6-26BBD7782787>

Figs 1, 2

Type material. Holotype. male, CHINA: Tibet: Gedang, Motuo County, [29°27.49'N; 95°32.57'E], ca. 1600m, 11.v.2011, Huo LZ leg (SCAU). Paratypes. The same information as the holotype; 1 female, Tibet: Beibeng to Hanmi, Motuo County, [29°19.23'N; 95°07.21'E], 800–2100m, 5–8.v.2011, Huo LZ leg (SCAU); 1 female, Tibet: No. 1 Bridge, Hanmi, Motuo County, [29°21.06'N; 95°04.53'E], ca. 2000m, 14.v.2009, Wang XM leg (SCAU).

Diagnosis. *Renius cornutus* can be easily distinguished from other species of the tribe Chilicorini by the roundish body with bluish black pronotum and elytra; medially projecting clypeus and subtriangular sclerite between coxites.

Description. TL: 4.43–5.00 mm, TW: 4.56–5.00 mm, TH: 1.94–2.31 mm, TL/TW: 0.97–1.00, PL/PW: 0.46–0.47, EL/EW: 0.77–0.81.

Body roundish, moderately convex. Head bluish black, mouthparts yellow, only clypeal portion covered with short, greyish pubescence. Pronotum, scutellum and elytra bluish black (Fig. 1a–d). Underside bluish black except legs yellow, abdomen brownish black, sparsely covered with short, grayish pubescence.

Head relatively large, 0.54–0.56 times pronotal width, punctures on frons large and moderately densely distributed, 0.5–2.0 diameters apart, surface polished between punctures. Eyes approximately oval, densely faceted, widest interocular distance about 0.46 times head width (Fig. 1c–d). Pronotum 0.49–0.50 times elytral width, pronotal punctures large and unevenly distributed, similar to those on head, 1.0–3.5 diameters apart, lateral punctures sparser than those on disc, surface polished between punctures. Punctures on elytra large and densely distributed, 1.0–2.0 diameters apart, similar to those on pronotum. Elytral epipleura very wide, descending without groove. Abdominal postcoxal lines complete or almost complete, arcuate; posterior margin of male abdominal ventrite 5 weakly emarginate and ventrite 6 rounded; posterior margin of female abdominal ventrite 5 straight and ventrite 6 rounded (Fig. 2a–c).

Male genitalia: penis slender, penis capsule with long outer arm and short inner one, apex of penis acute, screw-shaped from apical 1/11 to apical 2/11 (Fig. 2d–e). Tegmen stout, penis guide narrow at base, widest at basal 1/3 then gradually converging to blunt tip, symmetrical in ventral view; widest at base gradually converging to blunt apex in lateral view. Parameres stout, slightly shorter than penis guide, densely covered with short setae at inner surfaces and a distal end in lateral view (Fig. 2f–g).

Female genitalia: ovipositor with coxites elongate, approximately triangular, with large, subtriangular sclerite between coxites, 2/3 time as long as coxites (Fig. 2h); styli absent. Spermatheca oblong-oval, stout, with long and slender appendage at apex (Fig. 2i).

Distribution. Motuo County, Tibet, China.

Etymology. The species name is derived from Latin *cornutus* and refers to middle of clypeus with a horn-like projection in the male.

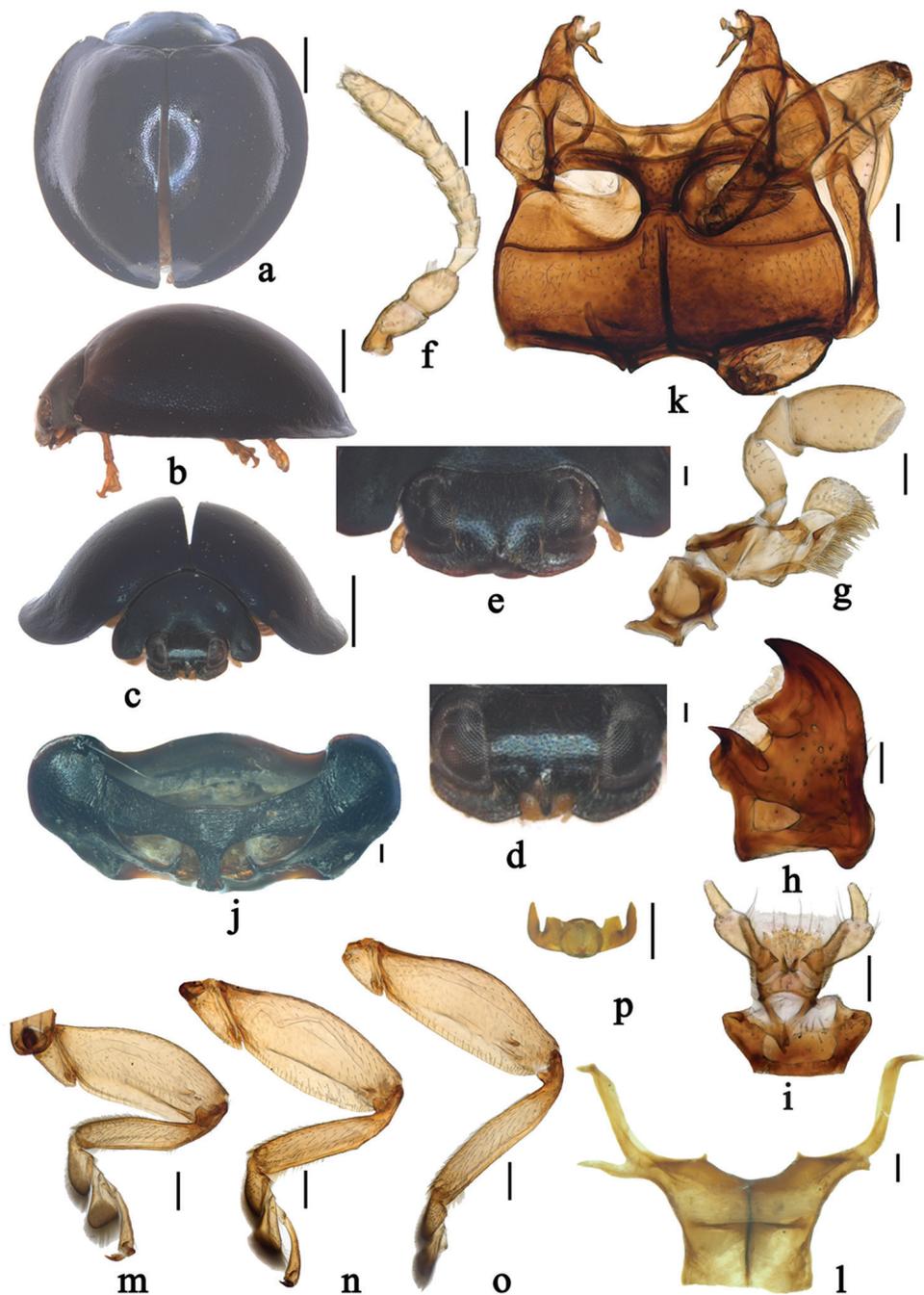


Figure 1. *Renius cornutus* Li et Wang, sp. n. **a** dorsal view **b** lateral view **c–d** frontal view, male **e** frontal view, female **f** antenna **g** maxilla **h** mandible **i** labium **j** prothorax, ventral view **k** meso- and metaventrite **l** metendosternite **m** front leg **n** mid leg **o** hind leg **p** tarsal claws. Scale bars 1.0mm **a–c**, 0.1 mm **d–p**.

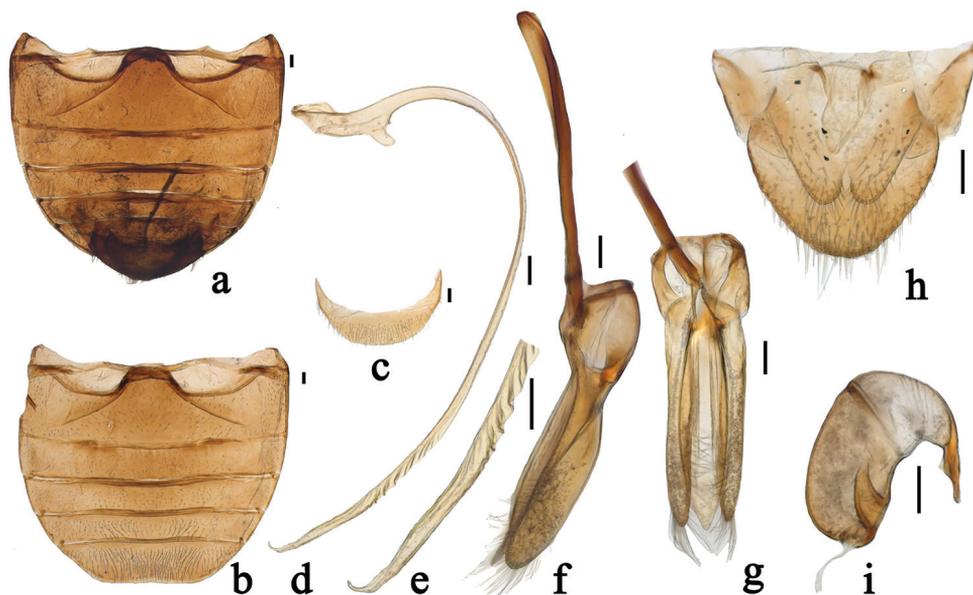


Figure 2. *Renius cornutus* Li et Wang, sp. n. **a** abdomen (male) **b** abdomen (female) **c** abdominal ventrite 6, female **d** penis **e** apex of penis **f** tegmen, lateral view **g** tegmen, ventral view **h–i** female genitalia: **h** ovipositor **i** spermatheca. Scale bars 0.1 mm.

Key to the Chinese genera of Chilocorini

- | | | |
|---|--|-----------------------------------|
| 1 | Meso- and metatibia with apical spurs | 2 |
| – | Meso- and metatibia without apical spurs | 8 |
| 2 | Antenna composed of less than 10 antennomeres | 3 |
| – | Antenna composed of 10 antennomeres | 4 |
| 3 | Antenna with 8 antennomeres | <i>Brumoides</i> Chapin |
| – | Antenna with 9 antennomeres | <i>Chujochilus</i> Sasaji |
| 4 | Pronotal basal margin with bordering line | 5 |
| – | Pronotal basal margin without bordering line | <i>Xanthocorus</i> Miyatake |
| 5 | Base of pronotum and elytra not contiguous all along their length..... | 6 |
| – | Base of pronotum and elytra contiguous all along their length..... | |
| | | <i>Priscibrumus</i> Kovář |
| 6 | Tarsal claw with distinct subquadrate or triangulate basal tooth..... | 7 |
| – | Tarsal claw simple, sometimes thickened at base..... | <i>Brumus</i> Mulsant |
| 7 | Prosternal process rounded at apex; abdominal postcoxal lines narrowly open laterally..... | <i>Parexochomus</i> Barovsky |
| – | Prosternal process truncate at apex; abdominal postcoxal lines closed laterally..... | <i>Exochomus</i> Redtenbacher |
| 8 | Antenna with 8 antennomeres | 9 |
| – | Antenna with 10 antennomeres | <i>Renius</i> Li et Wang, gen. n. |

- 9 Terminal maxillary palpomere slender and elongate, approximately 3 times as long as basal width.....*Phaenochilus* **Weise**
- Terminal maxillary palpomere stout, from 1 to 2 times as long as basal width.....*Chilocorus* **Leach**

Discussion

Although *Renius* share ten antennomeres of the antenna and similar shapes of the tibiae with *Exochomus*, it does not have the terminal antennomere embedded in the penultimate one, and it lacks apical spurs on mid and hind tibiae.

Initially, *the specimens* were thought as a member of *Orcus* Mulsant. Both genera share many characters, like: roundish body; basal margin of pronotum with border line; elytral margin strongly reflexed; elytral epipleuron broadened; penultimate labial palpomere stout; shape of abdominal postcoxal lines etc. (Łącznyński and Tomaszewska 2009). Therefore, it appears likely having a close relationship with *Orcus* Mulsant. However, the shape of spermatheca, mesoventrite, and meso-metaventral junction of *Renius* resemble those of *Chilocorus* Leach. According to morphology, *Renius* should have a closer relationship with *Orcus* rather than with *Chilocorus*. However, the molecular phylogenetic analysis of Chilicorini reveal *Renius* and (*Chilocorus* + *Phaenochilus* + *Anisorcus*) to be a sister group (Li et al., in prep.).

Renius differs from all other genera of Chilicorini in having unique characters, such as clypeus with median projection and subtriangular large sclerite between coxites of female ovipositor. These characters, together with an antenna composed of ten antennomeres with antennomeres 3–5 gradually shortening, define this new genus.

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Discovery of the genus *Glyphicnemis* Förster in the Oriental Region (Hymenoptera, Ichneumonidae, Cryptinae)

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Abstract

The genus *Glyphicnemis* Förster, 1869 is newly recorded from the Oriental Region based on a new species, *Glyphicnemis ganica* Sheng & Li, **sp. n.**, collected from Jiangxi Province, in the oriental part of China. This species resembles *G. watanabei* (Uchida, 1930) from Japan in the coloration of flagellum and the structure and colouration of metasomal tergites, but it can be distinguished by the density and length of clypeal setae, the large propodeal spiracle, and the sculpture of area superomedia. Illustrations of *G. ganica* and *G. watanabei* are provided. A key to the Asian species of this genus is also given.

Keywords

Glyphicnemis, key, new species, Phygadeuontini, taxonomy

Introduction

Glyphicnemis Förster, 1869, belonging to the tribe Phygadeuontini of the subfamily Cryptinae (Hymenoptera: Ichneumonidae), comprises 12 species (Yu et al. 2016), of which six are from the Eastern Palearctic Region (Ghahari and Jussila 2014, Jonaitis 1981, Uchida 1930, 1952) (three of them are found across the Palearctic), five from the Western Palearctic Region (Ciochia 1973, Jonaitis 1981, Sawoniewicz 1985,

Schwarz and Shaw 2010, Yu et al. 2016) and four from the Nearctic Region (Luhman 1986). One species of *Glyphicnemis* Förster was known from China (Uchida 1930). The diagnostic characters of the genus were most recently revised by Townes (1970).

Jonaitis (1981) provided a key to the species of the European part of USSR. Sawoniewicz (1985) revised the European species of the subtribe Endaseina with keys to the genera and the species of *Glyphicnemis*. Most Eastern Palaearctic species were described by Uchida (1930, 1952, 1955). A single species, *G. satoi* (Uchida, 1930), is previously recorded from Heilongjiang Province, Northeastern China.

In this article a new species of *Glyphicnemis* from Jiangxi, China, is described. This species is the first record of this genus from the Oriental Region.

Materials and methods

Specimens were collected with interception traps (IT) (Li et al. 2012) in Wugongshan National Natural Reserve, Pingxiang, Jiangxi Province, P.R. China. Type specimens are deposited in the Insect Museum, General Station of Forest Pest Management (GS-FPM), State Forestry Administration, People's Republic of China.

The type specimens of *Stylocryptus osakensis* Uchida, 1930 (Holotype), *S. satoi* Uchida, 1930 (Lectotype), *S. watanabei* Uchida, 1930 (Lectotype), deposited in Hokkaido University, Japan, were examined and compared to the new species. *Glyphicnemis atrata* (Strobl, 1901), *G. vagabunda* (Gravenhorst, 1829) and *G. profligator* (Fabricius, 1775), deposited in Zoologische Staatssammlung München, München, Germany and identified by Sawoniewicz, were also compared to the new species.

Images were taken using a Stereomicroscope (Leica M205A) with a LAS Montage MultiFocus. Morphological terminology is mostly based on Gauld (1991).

Taxonomy

Glyphicnemis Förster, 1869

Glyphicnemis Förster, 1869: 181, figs 2,3,6,9,10.

Diagnosis. Eye surface usually with sparse, short hairs (Fig. 3). Clypeus very wide, apical margin thick. Lower tooth of mandible much longer than upper tooth (Fig. 2). Upper end of epicnemial carina reaching to subalar prominence. Scutoscuteellar groove with strong median longitudinal carina (Fig. 6). Outer side and apex of tibiae with strong spines (Figs 9, 10). Apical truncation of hind tibia very oblique (Fig. 9). Spurs of hind tibia inserted distinctly before apex (Fig. 10). Median dorsal carina of first tergite strong.

Key to species of *Glyphicnemis* recorded from Asia (Oriental and Eastern Palearctic Regions) (Female only)

- 1 Propodeal spiracle small, semicircular, 1.3–1.5 × as long as wide. Costula connecting area superomedia approximately at its middle. Tergites 2 and 3 usually reddish brown. ***G. atrata* (Strobl)**
- Propodeal spiracle large, elongate, 1.5–2.1 × as long as wide. Costula connecting area superomedia at its posterior portion (in *G. profligator* and *G. vagabunda* at midlength), or tergites 2 and 3 black **2**
- 2 Flagellum red, apical portion brown-black, without white ring. Tergites (except base of first tergite which is black) and hind femur red-brown..... ***G. vagabunda* (Gravenhorst)**
- Flagellum with white ring (Fig. 4), at least dorsal median portion white. Anterior and posterior extremities of tergites black or brownish black (except *G. profligator*). Hind femur black, brown-black, red-brown, or light colored ... **3**
- 3 Hypostomal carina distinctly higher than genal carina. Area superomedia distinctly wider than its length ***G. profligator* (Fabricius)**
- Hypostomal carina almost as high as genal carina. Area superomedia almost as wide as long **4**
- 4 Tergites 2 and 3 smooth, shiny, without punctures, or almost impunctate; black or brownish black **5**
- Tergites 2 and 3 more or less granulate, with fine punctures; red or darkish red-brown **6**
- 5 Apical margin of clypeus with dense long hairs (Fig. 12). Propodeal spiracle large, elliptic. Area superomedia smooth (Fig. 13). Tergites darkish red-black. Median portion of hind tibia yellow ***G. watanabei* (Uchida)**
- Apical margin of clypeus without exceptional long hairs (Fig. 2). Propodeal spiracle elongate, 2 × as long as wide (Figs 7, 8). Area superomedia (Fig. 11) with dense irregular transverse rugae. Second and subsequent tergites black (Fig. 1). Dorsal side of hind tibia darkish brown, ventral side yellow-brown (Figs 1, 9) ***G. ganica* Sheng & Li, sp.n.**
- 6 Anterior portion of postpetiole with transverse rugae, posterior portion with longitudinal rugae. Lateral carinae of area superomedia very weak, costula connecting approximately at its posterior 0.25. Tergites 2 and 3 darkish red-brown ***G. satoi* (Uchida)**
- Median portion of postpetiole smooth, almost unpunctate, lateral portion with sparse fine punctures. Lateral carinae of area superomedia strong, costula connecting almost at its middle. Tergites 2 and 3 red..... ***G. osakensis* (Uchida)**

***Glyphicnemis ganica* Sheng & Li, sp. n.**

<http://zoobank.org/EEA5AC71-4536-40C1-961B-8D00C25F0124>

Figs 1–11

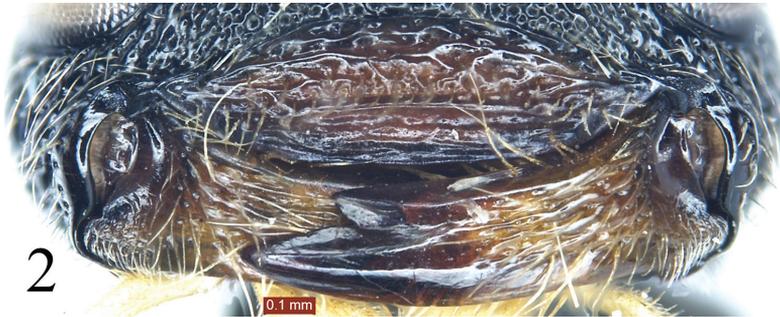
Type material. Holotype, female, Hongyangu, Wugongshan Natural Reserve, 530m, 24 May 2016, collected with IT by Yu Yao (GSFPM).

Diagnosis. Subapical portion of clypeus strongly convex, forming a transverse ridge, apical margin without exceptional long hairs (Fig. 2). Area superomedia with dense, irregular transverse rugae (Fig. 11). Propodeal spiracle large, elongate, approximately $2 \times$ as long as wide (Figs 7, 8). Second and subsequent tergites black (Fig. 1). Dorsal side of hind tibia darkish brown, ventral side yellow-brown (Fig. 9). First tergite dark brown, posterior portion of postpetiole red-brown. Second and subsequent tergites black.

Description. Female. Body length approximately 8.5 mm. Forewing length approximately 6.0 mm. Ovipositor sheath length 1.2 mm. Head, mesosoma, and apical portion of metasoma with dense short yellowish brown hairs.

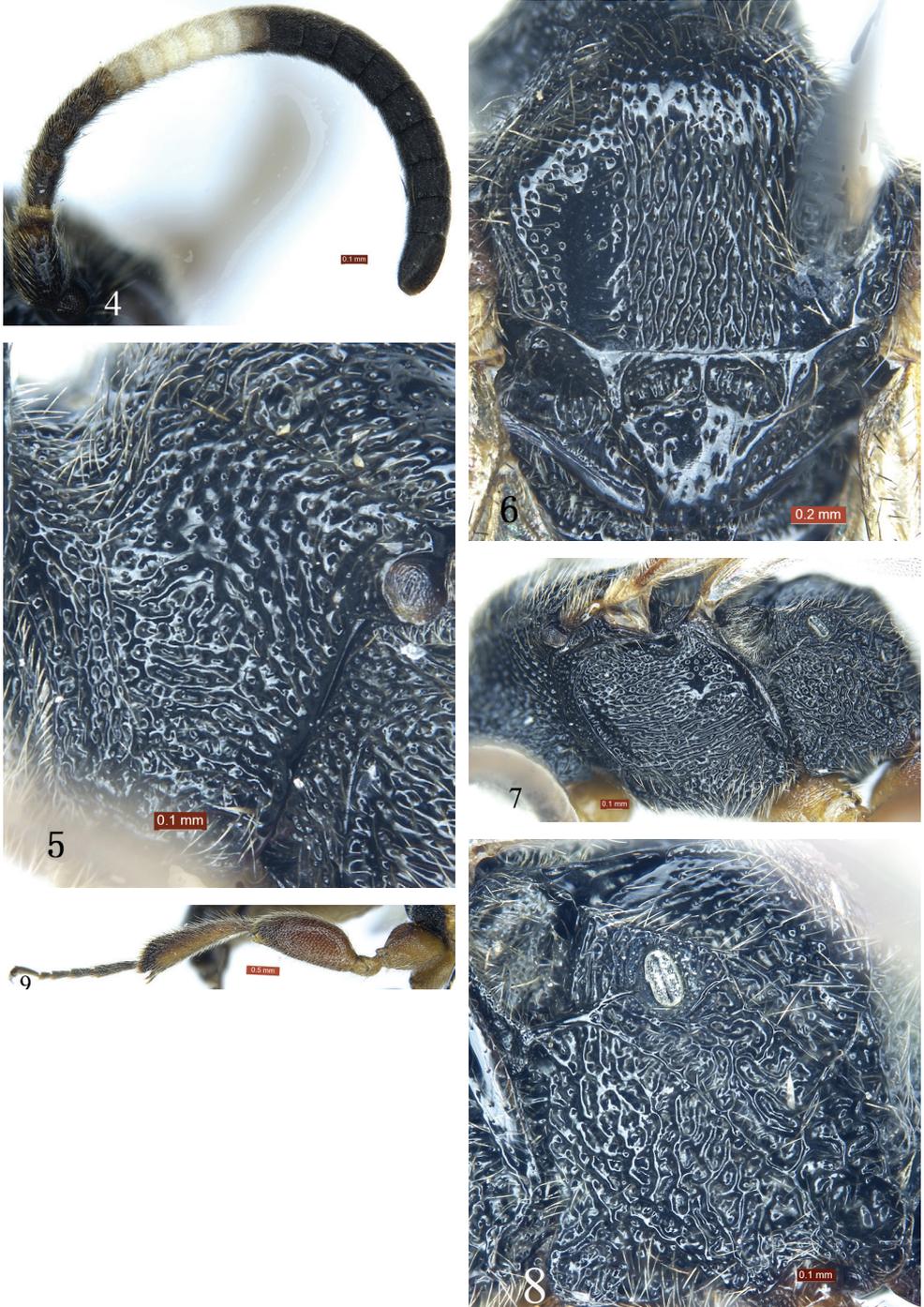
Head. With dense large punctures. Face $2.8 \times$ as wide as long, strongly convex. Clypeus $4.0 \times$ as wide as long (Fig. 2); basal portion with transverse rugae; subapical portion strongly convex, forming a transverse ridge. Basal portion of mandibles with longitudinal rugae and fine punctures; lower tooth $3.7 \times$ as long as upper tooth. Eye particularly small, with sparse short hairs. Malar space $0.4 \times$ as long as basal width of mandible. Gena in lateral view $1.4 \times$ as long as width of eye, with punctures larger than those of face. Vertex (Fig. 3) with dense uneven punctures. Postocellar line $1.2 \times$ as long as ocular-ocellar line. Antenna (Fig. 4) short, with 19 flagellomeres. Second flagellomere $1.25 \times$ as long as maximum width. Ratio of length from first to fifth flagellomeres: 1.4:1.0:0.9:0.8:0.7. Occipital carina complete.

Mesosoma. Anterior portion of pronotum laterally (Fig. 5) with dense irregular rugae and punctures; lateral concavity with uneven transverse rugae; upper posterior portion with large punctures. Epomia distinct. Mesoscutum (Fig. 6) shiny, with irregular punctures, postero-median portion with longitudinal rugae. Scutellum (Fig. 6) slightly convex, smooth, shiny, with sparse punctures. Upper portion of mesopleuron (Fig. 7) with dense, irregular punctures, lower portion with transverse rugae and irregular, indistinct punctures; lower posterior portion with oblique rugae. Speculum small, smooth, shiny. Metapleuron (Fig. 8) with strong, irregular reticulate rugae. Wings gray, hyaline. Fore wing with vein $1cu-a$ distinctly distal of $1-M$. Areolet pentagonal. Distance from vein $2rs-m$ to $2m-cu$ slightly longer than distance from $2m-cu$ to $3rs-m$. Vein $2-Cu$ approximately $2 \times$ as long as $2cu-a$. Hind wing vein $1-cu$ about $3 \times$ as long as $cu-a$; $1-cu$ strongly inclivous. Hind leg (Figs 9, 10) exceptionally stout. Hind femur $2.5 \times$ as long as its maximum width. Ratio of length of one to fifth hind tarsomeres 2.0:1.0:0.7:0.4:1.0. Propodeum (Fig. 11) with complete carinae. Area basalis shiny, with sparse fine punctures, strongly convergent posteriorly. Area superomedia hexagonal, with strong irregular transverse rugae, costula connecting approximately at its posterior 0.3. Area petiolaris strongly slant, with irregular transverse rugae. Area



Figures 1–3. *Glyphicnemis ganica* sp. n. Holotype. Female. **1** Habitus, lateral view **2** Clypeus and mandibles **3** Head, dorsal view.

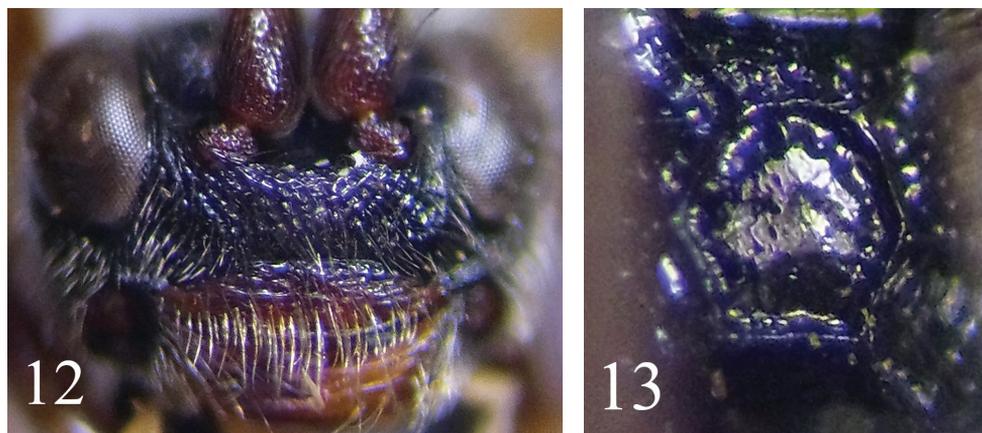
externa shiny, with distinct, uneven punctures. Area dentipara and area lateralis with irregular reticulate rugae. Propodeal spiracle (Fig. 8) elongate, approximately twice as long as wide.



Figures 4–9. *Glyphicnemis ganica* sp. n. Holotype. Female. **4** Antenna **5** Pronotum, lateral view **6** Mesoscutum and scutellum **7** Mesosoma, lateral view **8** Metapleuron **9** Hind leg.



Figures 10–11. *Glyphicnemis ganica* sp. n. Holotype. Female. **10** Apical portion of hind tibia **11** Propodeum.



Figures 12–13. *Glyphicnemis watanabei* (Uchida, 1930). Holotype. Female. **12** Head, anterior view **13** Propodeum.

Metasoma. Tergites smooth, shiny. First tergite $1.7 \times$ as long as posterior width, median dorsal carinae reaching about 0.6 of first tergite; posterolateral parts with sparse fine punctures. Dorsolateral and ventrolateral carinae complete. Spiracle circular, small, located at posterior 0.3 of first tergite. Second tergite $0.56 \times$ as long as its posterior width, with a few indistinct fine punctures. Third tergite $0.7 \times$ as long as its posterior width, $0.8 \times$ as long as its posterior width. Fourth and subsequent tergites with short brown pubescence. Ovipositor sheath $0.9 \times$ as long as hind tibia.

Coloration (Fig. 1). Black, except for the following. Clypeus, mandibles except teeth, reddish brown. Maxillary and labial palpi fawn. Ventral side of scape and pedicel reddish brown. Ventral side of flagellum slightly brownish. Flagellomeres 5 to 9 white,

ventral side narrowly slightly blackish. Dorsal sides of legs red-brown, ventral sides yellow-brown; apical portion of hind tibia and tarsi more or less brownish black. Tegulae and posterior portion of postpetiole red-brown. First tergite dark brown. Pterostigma and veins brownish black.

Remarks. This new species is similar to *G. watanabei* (Uchida, 1930) but can be distinguished from the latter by the following combination of characters: apical margin of clypeus without unusual long hairs (vs. with dense, long hairs; see Fig. 12). Area superomedia with strong irregular transverse rugae, costula connecting at its posterior 0.3 (vs. smooth, shiny, without rugae, costula connecting slightly beyond its middle; see Fig. 13). Ovipositor sheath $0.9 \times$ as long as hind tibia (vs. 0.75). Clypeus entirely reddish brown (vs. basally black, apically brown). First tergite dark brown (vs. black). All coxae and hind femur yellow brown (vs. black). It can also be distinguished from the known species of the Oriental and Eastern Palaearctic Regions by the preceding key.

Etymology. The specific name is derived from the type locality.

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An update on the distribution and nomenclature of fleas (Order Siphonaptera) of bats (Order Chiroptera) and rodents (Order Rodentia) from La Rioja Province, Argentina

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Abstract

The mammalian and flea fauna of La Rioja Province is one of the least known from northwestern Argentina. In this study, the distribution and nomenclature of 13 species of fleas of bats and rodents from La Rioja Province are updated. Four species of fleas are recorded for the first time in La Rioja Province including a new record for northwestern Argentina, and two new flea-host associations. An identification key and distribution map are included for all known species of Siphonaptera of bats and rodents from La Rioja Province, Argentina.

Keywords

Distribution map, mammals, new records, northwestern Argentina, Siphonaptera

Introduction

The flea fauna of the northern province of La Rioja (Argentina) has received little attention historically and accounts for the least number of documented flea records of any province in Argentina. Four different ecoregions are represented in La Rioja: High Andes, Puna, Dry Chaco, and Monte Desert of Mountains and Isolated Valleys (Burkart et al. 1999), all belonging to the arid and semi-arid environments of Argentina, containing a number of little known mammal species (Ojeda et al. 1998, Barquez et al. 2006). Ectoparasites, including fleas, display different degrees of host specificity from generalists to specialists (Lareschi et al. 2004; Poulin et al. 2006). It is important to note that unexplored geographic areas, containing species of little known small mammals, represent an interesting source for the discovery of new parasites for the study area, extensions of their distributions, and even the discovery of forms new to science.

In this study, an update on the distribution and nomenclature of the fleas of bats and rodents from La Rioja Province is offered, including new records of fleas for the province, a new record for northwestern Argentina, and additional new flea-host associations.

Materials and methods

Fleas were collected from several sites in different ecoregions: Puna, Dry Chaco, and Monte Desert of Mountains and Isolated Valleys of La Rioja Province. Surface-dwelling mammals were captured with Sherman live traps baited with oats and set in transects; fossorial mammals were collected with traps designed for the live capture of subterranean rodents, modified from the model of Baker and Williams (1972), placed early in the morning at the entrance of active burrows, and checked every two hours. Mist nets were employed from sunset until midnight to capture bats. Fleas were removed from each mammal specimen with forceps and placed in vials filled with ethanol 70%. Fleas were mounted on microscope slides in accordance with conventional procedures that included puncturing the area between abdominal sterna II and III with a minute pin, soaking for 24 h in potassium hydroxide (10%), transferring to distilled water and gently compressing the flea's abdomen to expel macerated soft tissues, dehydration in a series of ethanol solutions (70%, 80%, 95%, absolute) for 30 minutes each, clarifying the exoskeleton for 15–20 minutes in methyl salicylate, transferring to xylene for a minimum of 1 h, and mounting in Canada balsam (see Hastriter and Whiting 2003).

The images were prepared using a Leica M205A stereo microscope with a Leica DFC295 camera supported by Leica Application Suite Version 4.8.0. The distribution map was designed with an ArcGIS 10.1 program (ESRI, 2011). ArcGIS Desktop: Release 10. Redlands, California: Environmental Systems Research Institute. The map (Fig. 1) shows the localities mentioned in the text; the numbers are indicated in brackets in front of each locality in Material Examined and Additional Records.

Mammalian nomenclature follows that of Wilson and Reeder (2005), Gardner (2008), Coyner et al. (2013), and Patton et al. (2015). Some mammals not yet identi-

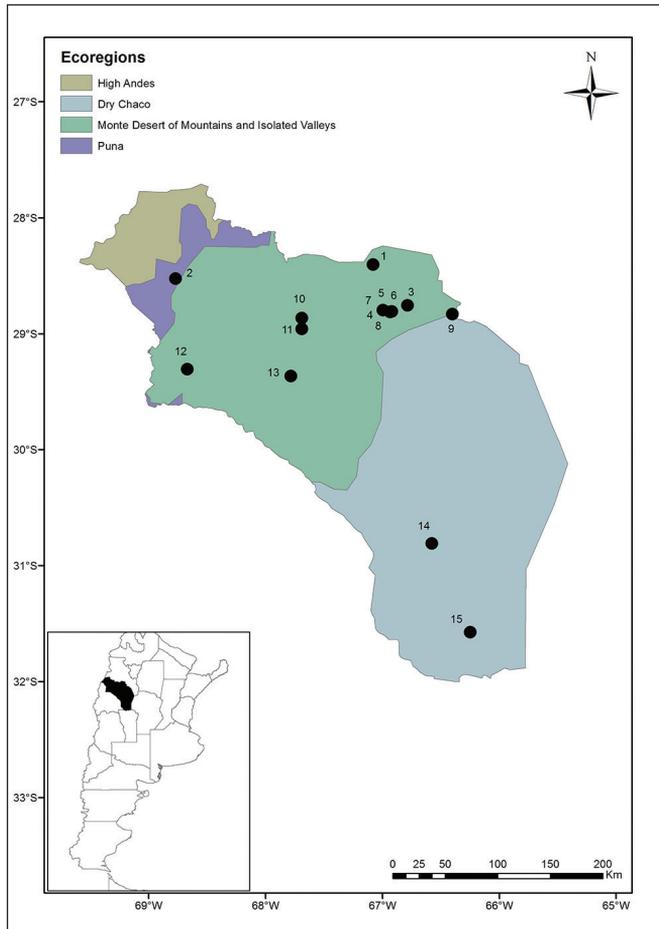


Figure 1. Map illustrating the localities of fleas of bats and rodents from La Rioja Province, Argentina. The symbol with associated locality number are listed on map by latitude from north to south. The localities include specific locality, coordinates, department, and altitudes as follow: **1** 700 m E of National Route 40 (28°24'17.4"S, 67°04'48.4"W), San Blas Department, 1123 m **2** Quebrada de Santo Domingo 30 km SW of Jagüé (28°31'34.7"S, 68°46'13.8"W), Vinchina Department, 3131 m **3** 2 km S Río de La Punta on provincial road 7 (28°45'28.8"S; 66°47'09.3"W), Arauco Department, 996 m **4** Reserva Aguada de las Alturas, 4 km W Anillaco (28°47.942'S, 66°59.749'W), Castro Barros Department, 1188 m **5** Anillaco, 500 m W of plaza de Anillaco (28°48'40.30"S, 66°55'55.55"W), Castro Barros Department, 500 m **6** Anillaco 1.7 m E of CRILAR (28°48'46.00"S, 66°55'50.44"W), Castro Barros Department, 1357 m **7** Anillaco, behind cemetery (28°48'49.04"S, 66°56'0.75"W), Castro Barros Department, 1365 m **8** 800 m E Anillaco (28°48.572' S; 66°55.193' W), Castro Barros Department, 780 m **9** Cuesta La Cébila, 22 km NW of Chumbicha, by route 60 (28°50'S, 66°24'W), Capital Department: 1066 m **10** 5 km S of Cañón del Ocre (28°51'55.9"S, 67°41'26.3"W), Famatina Department, 2495 m **11** 8 km NE of Cañón del Ocre, (28°57'37.3"S, 67°41'26.3"W), Famatina Department, 3127 m **12** Zapallar, (29°18'24.74"S, 68°40'9.2"W), Coronel Felipe Varela Department, 1634 m **13** 1 km N Los Tambillos (29°22'S, 67°47'W), Coronel Felipe Varela Department, 1951 m **14** 2 km E of Malanzán, camping El Descanso (30°48'37.7"S, 66°34'40.3"W), General Facundo J. Quiroga Department, 957 m **15** Ulapes, 1 km W of plaza principal de Ulapes (31°34'35"S, 66°14'55"W), San Martín Department, 493 m.

fied at the species level are cited as sp. since they are under study. Fleas were identified using keys and descriptions by Hopkins and Rothschild (1953, 1956), Johnson (1957), Smit (1987), Hastriter and Mendez (2000), Lareschi and Linardi (2009), Sanchez et al. (2012) and López Berrizbeitia et al. (2015). The classification of Siphonaptera is based on Whiting et al. (2008). Voucher specimens of hosts are deposited in the Colección Mamíferos Lillo (CML), Universidad Nacional de Tucumán, Argentina. Some of the host specimens are still being catalogued for the CML Collection; for this reason, the acronym used in the text corresponds to the initials of the collector, Rocío Tatiana Sánchez (RTS). Fleas are deposited in the Colección Mamíferos Lillo “Anexos” (CMLA), Universidad Nacional de Tucumán, Argentina.

Results

Family Tungidae

Subfamily Tunginae

Hectopsylla (Hectopsylla) cypha Jordan

Distribution in Argentina. La Rioja, Mendoza, Río Negro, and Tucumán (Lareschi et al. 2016).

Material examined. None.

Additional records. Coronel Felipe Varela Department: (12) Zapallar (29°18'24.74"S, 68°40'9.2"W), 1634 m, *Lagostomus* sp., 1 ♂ (Hastriter and Mendez 2000).

Remarks. According to the revision of the genus *Hectopsylla* by Hastriter and Mendez (2000), *H. (H.) cypha* can be distinguished from all other species of the genus by the following characters: in males the median lobe presents a lateral patch of long thin setae; in females the dorsal margin of metepimeron is heavily sclerotized and usually with three setae. The host species surely corresponds to *Lagostomus maximus* (Desmarest), because this is the only extant genus. Zapallar is in the Monte Desert of Mountains and Isolated Valleys eco-region.

Hectopsylla (Hectopsylla) gracilis Mahnert

Distribution in Argentina. Chubut, Jujuy, La Rioja, Mendoza, Neuquén, Río Negro, and Salta (López Berrizbeitia et al. 2013; Lareschi et al. 2016).

Material examined. Arauco Department: (3) 2 km S Río de La Punta on provincial road 7 (28°45'28.8"S; 66°47'09.3"W), 996 m, *G. chacoensis*, 1.IX.2014, RTS (75), 1 ♂ CMLA (600). Castro Barros Department: (7) Anillaco, behind cemetery (28°48'49.04"S, 66°56'0.75"W), 1365 m *Eligmodontia moreni* (Thomas), 10.IX.2014, RTS (77), 2 ♀ CMLA (601, 602); (8) 800 m E Anillaco (28°48.572' S; 66°55.193' W), 780 m, *Andalgalomys ologi* Williams and Mares, 17.IV.2012, CML (9747), 4 ♀

CMLA (594, 595, 596, 597); *G. chacoensis*, 17.IV.2012, CML (9748), 1 ♀ CMLA (593); *Eligmodontia typus* F. Cuvier, 18.IV.2012, CML (9751), 2 ♀ CMLA (598, 599) (López Berrizbeitia et al. 2013).

Remarks. This species can be distinguished from all other species of the genus by the following characters: in males, the median lobe of distal portion of sternum IX is enlarged with a concavity at the ventral margin, the apical margin of process of clasper is straight; in females the hilla is much narrower than width of bulga, the duct of spermatheca is connecting at cribriform area of bulga on ventral apical margin and the base of metatarsal claw do not present a sinus (see Hastriter and Mendez 2000). *Hectopsylla* (*Hectopsylla*) *gracilis* infesting *E. moreni* constitutes a new flea-host association; this result was expected since *H. (H) gracilis* has been collected on *Eligmodontia hirtipes* and *E. typus* (Lareschi et al. 2016). All localities correspond to the Monte Desert of Mountains and Isolated Valleys eco-region.

Familia Stephanocircidae Subfamily Craneopsyllinae

Craneopsylla minerva (Rothschild)

Fig. 2a

Distribution in Argentina. Buenos Aires, Catamarca, Chubut, Córdoba, Jujuy, La Pampa, Mendoza, Neuquén, Río Negro, Salta, Santa Fe, Santiago del Estero, Tierra del Fuego, and Tucumán (Lareschi et al. 2016).

Material examined. Famatina Department: (10) 5 km S of Cañón del Ocre (28°51'55.9"S, 67°41'26.3"W), 2495 m, *Phyllotis xanthopygus*, 6.XI.2013, RTS (40), 1 ♀ CMLA (608). General Facundo J. Quiroga Department: (14) 2 km E of Malanzán, camping El Descanso (30°48'37.7"S, 66°34'40.3"W), 957 m, *G. chacoensis*, 10.XI.2014, RTS (129), 1 ♀ CMLA (611). San Martín Department: (15) Ulapes, 1 km W of plaza principal de Ulapes (31°34'35"S, 66°14'55"W), 493 m, *G. chacoensis*, 4.X.2014, RTS (84), 2 ♀ CMLA (609, 610).

Additional records. Capital Department: (9) Cuesta La Cébila, 22 km NW of Chumbicha, by route 60 (28°50'S, 66°24'W), 1066 m *Akodon simulator* Thomas, CML (3752), 1 ♀ (Lareschi et al. 2003).

Remarks. The genus *Craneopsylla* is monotypic, and *C. minerva* is distinguished mainly by the genal bristles on the level of the proximal portion of the mouthparts and adjacent structures (Hopkins and Rothschild 1956). Although some authors (Hopkins 1951; Lareschi et al. 2016) consider there are two subspecies, *C. m. minerva* (Rothschild) and *C. m. wolffhuegeli* (Rothschild), Del Ponte (1977) considered *C. minerva* and *C. wolffhuegeli* to be valid species. We believe more detailed morphological and molecular studies are needed to resolve this taxonomic issue. Here we accept these taxa at the species level. Lareschi et al. (2003) cited as *Akodon simulator* Thomas the name of the host species, but we use *A. glaucinus* following Coyner et al. (2013). The

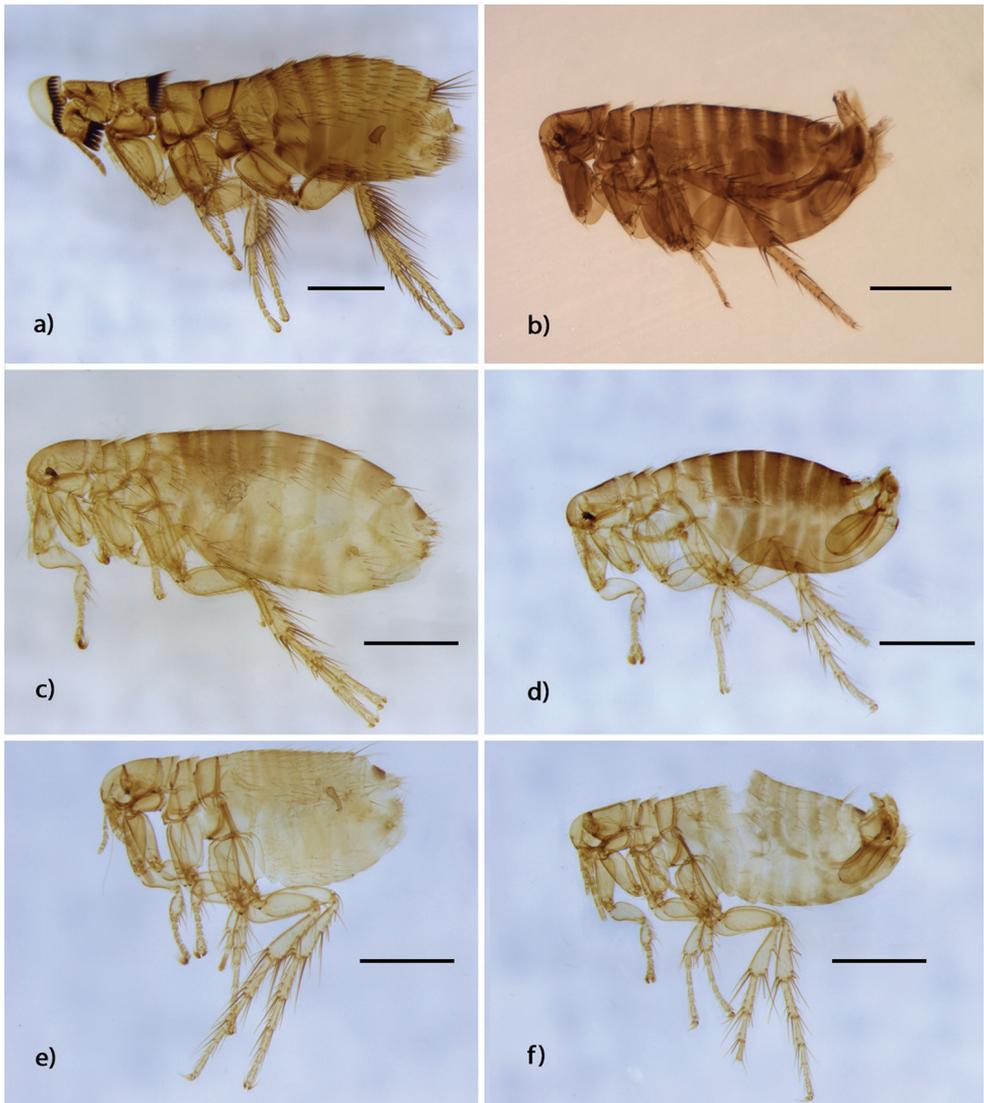


Figure 2. Species of fleas representing the first record for La Rioja Province, Argentina. **a** *Craneopsylla minerva*, ♀ CMLA (608) (Stephanocircidae **b** *Polygenis (Polygenis) acodontis*, ♂ CMLA (674) (Rhopalopsyllidae) **c** *Delostichus talis*, ♀ CMLA (616) (Rhopalopsyllidae) **d** *Delostichus talis*, ♂ CMLA (619) (Rhopalopsyllidae) **e** *Tiamastus palpalis*, ♀ CMLA (631) (Rhopalopsyllidae) **f** *Tiamastus palpalis*, ♂ CMLA (629) (Rhopalopsyllidae). Scale=500 um.

authors cited the collecting locality as belonging to Catamarca Province but, in effect, it is placed within La Rioja Province. Moreover, in the same study, a specimen cited as *C. minerva*, was reidentified by us as *Polygenis acodontis*, a member of another family,

Rhopalopsyllidae (see below). All localities cited in Material Examined and Additional Records correspond to the Dry Chaco and Monte Desert of Mountains and Isolated Valleys eco-regions.

Family Rhopalopsyllidae
Subfamily Parapsyllinae

***Delostichus talis* (Jordan)**

Fig. 2c, d

Distribution in Argentina. Buenos Aires, Chubut, La Pampa, Mendoza, Río Negro, and San Juan (Lareschi et al. 2016).

Material examined. Vinchina Department: (2) Quebrada de Santo Domingo 30 km SW of Jagüé (28°31'34.7"S, 68°46'13.8"W), 3131 m *Microcavia* sp., 6.III.2015, RTS (212), 3 ♂ CMLA (619, 620, 621), 6 ♀ CMLA (613, 614, 615, 616, 617, 618).

Remarks. *Delostichus talis* differs from the other species of the genus by the distal arm of sternum IX which is widest at the middle and have a pointed apex in males; and the posterior margin of sternum VII presents a broad lobe in females (Smit 1987). This is the first record of the genus *Delostichus* for La Rioja Province and the first record of the species *D. talis* for northwestern Argentina. The geographical distribution of the species is extended ~ 400 km north of the northernmost available record, cited by Lareschi et al. (2016) (Las Casuarinas, San Juan Province). The locality of the Material Examined corresponds to the Puna eco-region.

Subfamily Rhopalopsyllinae

***Polygenis (Polygenis) acodontis* (Jordan & Rothschild)**

Fig. 2b

Distribution in Argentina. Buenos Aires, Catamarca, Córdoba, Jujuy, La Pampa, Salta, and Tucumán (Lareschi et al. 2016).

Material examined. Capital Department: (9) Cuesta La Cébila, 22 km NW of Chumbicha, by route 60 (28°50'S, 66°24'W), 1066 m *Akodon glaucinus*, 25.IX.1993, CML (3751), 1 ♀ CMLA (674).

Remarks. The main morphological characters that distinguish *P. acodontis* from the other known species of genus are: in males, the distal arm of sternum IX with a dense fringe of setae along its ventral margin and sternum VIII is strongly emarginated ventro-apically; in females the posterior margin of sternum VII presents a drawn-out median

lobe (Smit, 1987). This is the first record of this species for La Rioja Province. The locality of the Material Examined corresponds to the Monte Desert of Mountains and Isolated Valleys eco-region.

***Polygenis (Polygenis) platensis* (Jordan & Rothschild)**

Distribution in Argentina. Buenos Aires, Córdoba, Chubut, Entre Ríos, Jujuy, La Pampa, La Rioja, Mendoza, Río Negro, Salta, San Luis, San Juan, Santa Cruz, and Santiago del Estero (Lareschi et al. 2016).

Material examined. Castro Barros Department: (4) Reserva Aguada de las Alturas, 4 km W of Anillaco (28°47.942'S, 66°59.749'W), 1188 m, *A. glaucinus*, 19.IV.2012, RTS (19), 1 ♂ CMLA (605) (López Berrizbeitia et al. 2013). San Martín Department: (15) Ulapes, 1 W of plaza principal de Ulapes (31°34'35"S, 66°14'55"W), 493 m, *G. chacoensis*, 4.X.2014, RTS (84), 2 ♀ CMLA (622, 623); RTS (85), 1 ♀ CMLA (624); RTS (93), 2 ♂ CMLA (625,626), 2 ♀ CMLA (627, 628).

Additional records. “Guayapa 30.59”S, 65.59 W”, Order Rodentia (unknown species) (Smit 1987).

Remarks. Males of *P. platensis* are distinguished by the narrow distal arm of sternum IX with scattered lateral setae and by the posterior margin of sternum VIII which presents a right angle. Females have the ventral margin of bulga of spermatheca markedly indented (Smit 1987); however, Lareschi and Linardi (2009) observed a variation on this character and they reported that spermatheca can be indented or not. With respect to the record from “Guayapa”, we found that the coordinates given by Smit (1987) place the collecting locality at “app. 3 km N of El Milagro, General Ocampo Department”. The locality “Guayapa” in La Rioja Province is located at 29°51'41.18"S, 67°14'22.99"W, which is about 180 km SE of the previous coordinates. López Berrizbeitia et al. (2013) cited the host as *Akodon simulator*, but we now use the name *A. glaucinus* following Coyner et al. (2013). The collection from Ulapes from *G. chacoensis* constitutes a new flea-host association, this result was expected, because *P. (P.) platensis* has been recorded on *Graomys griseoflavus* (Lareschi et al. 2016). The localities recorded are from the Dry Chaco and Monte Desert of Mountains and Isolated Valleys eco-regions.

***Polygenis (Polygenis) rimatus* (Jordan)**

Distribution in Argentina. Buenos Aires, Chubut, Formosa, La Rioja, Misiones, Neuquén, San Juan, and Santiago del Estero (Lareschi et al. 2016).

Material examined. None.

Additional records. No specific locality, *Cavia aperea* Erxleben, 1 ♀ (Smit 1987).

Remarks. This species can be distinguished from the other species of *Polygenis* by the labial palp reaching the apex of fore coxa, the acetabular seta is below level of the upper margin of acetabulum in males; the posterior margin of sternum VII in females

with a smaller lobe (Smit 1987). The host was probably erroneously identified because *C. aperea*, a member of the family Caviidae, is not known to occur in La Rioja Province (Patton et al. 2015). The only members of this family known to be present in La Rioja are *Galea leucoblephara* and *Microcavia australis*.

Tiamastus palpalis (Rothschild)

Fig. 2e, f

Distribution in Argentina. Catamarca, Jujuy, La Pampa, Mendoza, Santa Fe, Santiago del Estero, and Tucumán (Lareschi et al. 2016).

Material examined. San Blas Department: (1) 700 m E of National Route 40 (28°24'17.4"S, 67°04'48.4"W), 1123 m, *Ctenomys* sp., 29.II.2016, RTS (300), 1 ♀ CMLA (631). Castro Barros Department: (5) Anillaco, 500 m W of plaza de Anillaco (28°48'40.30"S, 66°55'55.55"W), 500 m, *Ctenomys* sp., IX.2015, released, ♂ CMLA (629), 5 ♀ CMLA (630, 632, 633, 634, 635).

Remarks. This species can be distinguished from all other species of the genus by the following characters: apical half of telomere narrowing to a sharp apex in males; in females, the posterior margin of sternum VII with a narrow sinus and spermatheca with bulga as long as hilla (Smit 1987). These are the first records of the species for La Rioja Province. The localities correspond to the Monte Desert of Mountains and Isolated Valleys eco-region.

Family Ctenophthalmidae

Subfamily Ctenophthalminae

Neotyphloceras crassispina Rothschild

Neotyphloceras crassispina hemisus Jordan

Distribution in Argentina. Catamarca, Jujuy, La Rioja, Mendoza, Neuquén, Río Negro, and Salta (López Berrizbeitia et al. 2013; Lareschi et al. 2016).

Material examined. Castro Barros Department: (4) Reserva Aguada de las Alturas, 4 km W Anillaco (28°47.942'S, 66°59.749'W), 1188 m, *Phyllotis xanthopygus* (Waterhouse), 18.IV.2012, CML (9753), 2 ♂ CMLA (603, 604) (López Berrizbeitia et al. 2013). Famatina Department: (11) 8 km NE of Cañón del Ocre, (28°57'37.3"S, 67°41'26.3"W), 3127 m, *P. xanthopygus*, 6.XI.2013, RTS (39), 2 ♀ CMLA (606, 607).

Additional records. Coronel Felipe Varela Department: (13) 1 km N Los Tambillos (29°22'S, 67°47'W), 1951 m, *Graomys griseoflavus* (J. A. Allen), 30.IX.1993, CML (9400), 1 ♂, 1 ♀ (Lareschi et al. 2003).

Remarks. *Neotyphloceras crassispina hemisus* differs from all other species and subspecies of the genus by the presence of abdominal spinelets; females are unique by the apical margin of sternum VII wide, and the contour of the distal margin rounded or slightly convex in the lower portion; males differ by a combination of characters

in the genitalia (López Berrizbeitia et al. 2015). Lareschi et al. (2003) cited *G. grieseoflavus* as the name of the host for this species, but now it should be treated as *G. chacoensis*, following Braun and Patton (2015); it is also important to note that the correct name for the locality is “Los Tambillos,” and not “Los Tombillos,” as cited by these authors. All localities correspond to the Monte Desert of Mountains and Isolated Valleys eco-region.

Family Pulicidae

Subfamily Pulicinae

Pulex irritans Linnaeus

Distribution in Argentina. Buenos Aires, Catamarca, Córdoba, Chubut, Formosa, La Rioja, Mendoza, Neuquén, Río Negro, Salta, San Luis, Santiago del Estero, and Tucumán (Lareschi et al. 2016).

Material examined. None.

Additional records. “Between Olta and Santa Rita de Catuna” *Dolichotis patagonica* (Zimmermann), 1 ♀; *Lepus* sp., 1 ♀ (Hopkins and Rothschild 1953).

Remarks. *Pulex irritans* is distinguished by the disposition of the internal incrasation of frons, which is hardly projected inwards from margin of frons (Hopkins and Rothschild 1953). Hopkins and Rothschild (1953) cited *Dolichotis patagonica* as the host species, but the correct spelling is *D. patagonum*. They also cited *Lepus* sp. as a host, which corresponds to *Lepus europaeus* Pallas, because this is the only *Lepus* sp. found in Argentina. Because the authors did not cite an exact locality, we only indicate the coordinates for the two main localities cited by them: Olta 30°37'53.26"S, 66°15'48.87"W; Santa Rita de Catuna 30°57'03.87"S, 66°13'02.48"W.

Subfamily Xenopsyllinae

Xenopsylla cheopis (Rothschild)

Distribution in Argentina. Buenos Aires and La Rioja (Lareschi et al. 2016).

Material examined. None.

Additional records. No specific locality, *Epimys decumanus* Pallas, 1 ♂; *Epimys* sp., 4 ♂, many ♀ (Hopkins and Rothschild 1953).

Remarks. *Xenopsylla cheopis* differs from all other species of the genus by the following characters: in males, sternum IX with distal arm equally sclerotized throughout; in females, the tail of spermatheca is not strongly swollen (Johnson 1957). Hopkins and Rothschild (1953) cited *Epimys decumanus* Pallas and *Epimys* sp. as hosts which, follow the nomenclature of Wilson and Reeder (2005), but are synonymous with *R. norvegicus* Berkenhout and *Rattus* sp., respectively. *Xenopsylla cheopis* is the most ef-

ficient vector of *Yersinia pestis* (Lehmann and Neumann), responsible for the bubonic plague (Boyer et al. 2014). Although only old records of this species are cited from La Rioja Province, it is important to mention that this is the only record for northwestern Argentina. The absence of more and newer records of this species is probably a reflection of mammalogists exerting little effort in the study of domestic rats.

Family Ischnopsyllidae

Myodopsylla isidori (Weyenbergh)

Distribution in Argentina. Buenos Aires, Catamarca, Córdoba, Corrientes, Entre Ríos, Jujuy, La Rioja, Neuquén, Río Negro, San Luis, Salta, Santiago del Estero, and Tucumán (Lareschi et al. 2016).

Material examined. None.

Additional records. No specific locality, Order Chiroptera (unknown species), 1 ♂, 1 ♀ (Hopkins and Rothschild 1956).

Remarks. This species is distinguishable from the other known species of *Myodopsylla* by the movable process with a proximal apical angle of about 60°; females with the frons oblique (Hopkins and Rothschild 1956). *Myodopsylla isidori* is restricted to South America (Hopkins and Rothschild 1956) and parasitizes bats of the families Molossidae and Vespertilionidae (Autino et al. 2009). Collection of bats and their ectoparasites, particularly in shelters, is needed in the province of La Rioja to elucidate the bat species diversity and their associated fleas.

Myodopsylla sp.

Material examined. Castro Barros Department: (6) Anillaco 1.7 m E of CRILAR (28°48'46.00"S, 66°55'50.44"W), 1357 m *Myotis dinellii*, 12.XI.2015, released specimen, 1 ♀ CMLA (612).

Remarks. This is the second record for this undetermined species of *Myodopsylla* for La Rioja Province. More specimens, males and females, and comparisons with material deposited in collections are necessary to identify the species with confidence. The collecting locality corresponds to the Monte Desert of Mountains and Isolated Valleys eco-region.

Key to identification of fleas from La Rioja Province, modified from Hopkins and Rothschild (1953, 1956), Smit (1987), and Hastriter and Mendez (2000)

- 1 Genal comb present 2
- Genal comb absent 5

- 2 Anterior helmet-comb present; five to eight spines in the genal comb
 ...Family Stephanocircidae; Subfamily Craneopsyllinae; ***Craneopsylla minerva***
- Anterior helmet-comb absent; two or four spines in the genal comb **3**
- 3 Genal comb composed of four spines.....Family Ctenophthalmidae; Subfamily Ctenophthalminae; ***Neotyphloceras crassispina hemisus***
- Genal comb composed of two spines Family Ischnopsyllidae, Subfamily Ischnopsyllinae; Genus *Myodopsylla* **4**
- 4 Males with proximal apical angle of movable process about 60°; females with frons markedly oblique ***Myodopsylla isidori***
- Males unknown; females with frons much more convex ***Myodopsylla* sp.**
- 5 Frontal tubercle present and well developed..... Family Rhopalopsyllidae...**6**
- Frontal tubercle absent..... **10**
- 6 Postantennal region of head mostly with one row of setae.....
 Subfamily Parapsyllinae; ***Delostichus talis***
- Postantennal region of head with three rows of setae (rarely two).....
 Subfamily Rhopalopsyllinae...**7**
- 7 Labial palp extending to or beyond apex of fore trochanter.....
 ***Tiamastus palpalis***
- Labial palp not extending beyond base of fore trochanter
 Genus *Polygenis* (*P.*)...**8**
- 9 Males with posterior margin of sternum VIII forming a right angle; females with ventral margin of bulga of spermatheca markedly indented.....
 ***Polygenis* (*P.*) *platensis***
- Males with posterior margin of sternum VIII not forming a right angle; females with ventral margin of bulga of spermatheca without distinct indentation..... **9**
- 9 Males with sternum VIII ventro-apically strongly emarginate; females with sternum VII with a protruding median lobe ***Polygenis* (*P.*) *acodontis***
- Males with sternum VIII not emarginate; females with sternum VII with a not protruding median lobe..... ***Polygenis* (*P.*) *rimatus***
- 10 Inner side of hind coxa with spiniform bristles..... Family Pulicidae **11**
- Inner side of hind coxa without spiniform bristles
 Family Tungidae, Subfamily Tunginae; Genus *Hectopsylla* (*H.*)...**12**
- 11 Pleural rod of mesothorax absent Subfamily Pulicinae; ***Pulex irritans***
- Pleural rod of mesothorax present.....
 Subfamily Xenopsyllinae; ***Xenopsylla cheopis***
- 12 Males with median dorsal lobe of aedeagus well developed; females with dorsal margin of metepimeron heavily sclerotized, usually with three setae.....
 ***Hectopsylla* (*H.*) *cypha***
- Males with median dorsal lobe of aedeagus poorly developed; females with dorsal margin of metepimeron not noticeably sclerotized, usually four setae
 ***Hectopsylla* (*H.*) *gracilis***

Discussion

These results are a contribution to the knowledge of the flea fauna of La Rioja, a neglected province regarding the study of mammals and their parasites; the last study about ectoparasites from La Rioja Province was published by López Berrizbeitia et al. (2013), reporting new records of fleas and mites for the province; therefore, here, the number of hosts and fleas is increased, allowing us to have a better representation of the flea-host associations. Thirteen species, nine genera, and six families of fleas are recorded for La Rioja Province. *Craneopsylla minerva*, *Delostichus talis*, *Polygenis acodontis*, and *Tiamastus palpalis* represent the first records for these species for La Rioja Province.

The occurrence of *C. minerva* was expected because it is distributed in some neighboring provinces of La Rioja (Lareschi et al. 2016). The distribution of *D. talis* is extended approximately 400 km to the north. *Delostichus* is recorded for the first time for northwestern Argentina, infesting *Microcavia*. Smit (1987) considered the caviids, *Galea leucoblephara* and *Microcavia australis*, to be the primary hosts of *D. talis*. *Tiamastus palpalis* is also associated mainly with caviid rodents (Smit 1987); we found it infesting *Ctenomys* spp., coincident with previous reports. This species of the flea was recorded on *Ctenomys haigi* and *Ctenomys juris* from Jujuy Province (Johnson 1957; Smit 1987) and *Ctenomys andersoni* from Bolivia (Pucu et al. 2014). Out of 13 species recorded, two are endemic to Argentina: *D. talis* and *H. (H.) gracilis* (Lareschi et al. 2016).

Most species of fleas reported in the current study inhabit the Monte Desert of Mountains and Isolated Valleys ecoregion, and two are also found in the Dry Chaco eco-region, *Craneopsylla minerva* and *Polygenis platensis*. These two species showed the highest prevalence and mean abundance on small mammals in a study carried out in the Monte Desert biome (Lareschi et al. 2004). *Delostichus talis* was recorded exclusively in the Puna eco-region, where the vegetation is dominated by shrub steppe, characterized by scattered shrubs and stony or saline soils covered by sparse vegetation. In Argentina, the Puna is located in the north and extends from Jujuy Province to north of San Juan Province (Burkart et al. 1999). This is the first record of *D. talis* for Puna eco-region. The previous northernmost known record in the San Juan Province (Las Casuarinas) (Lareschi et al. 2016) corresponds to Monte Desert of Mountains and Isolated Valleys eco-region.

Knowledge of the distribution and hosts of *Delostichus* spp. is important because they are potential vectors of the agent of bubonic plague in the Chile-Andean subregion (Macchiavello 1948; Gimenez et al. 1964; Beaucournu et al. 2013). Likewise, *Xenopsylla cheopis* is a competent vector of *Yersinia pestis*, but unlike *D. talis*, this species infests introduced rodents (*Rattus* spp.). *Craneopsylla minerva* was recorded harboring this pathogen in Ayabaca Province, Piura, Perú (Pozo et al., 2005). Additional research is needed to determine whether these species are vectors in Argentina.

The nomenclature of the hosts was updated according to the current taxonomy and distribution, although identifications of some species are in process. The correct identification of hosts is fundamental to avoid misinterpretations about parasite-host associations (Robles 2010). Research on identity of host species has long been neglected by par-

asitologists. We emphasize the importance of joint research between parasitologists and mammalogists to insure proper identification of both parasites and their hosts. Because these parasites are potentially important as vectors of infectious agents causing human and animal disease (Hastriter and Whiting 2003), knowledge of their hosts is of fundamental zoological and epidemiological importance, especially in matters of public health.

Some regions as the Puna and High Andes ecoregions in the Province La Rioja have not yet been adequately sampled for ectoparasites, particularly those areas where some species are potentially present, and where specimens are needed to resolve taxonomic conflicts.

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Ogeramua, a new name for the land snail genus *Papuanella* Clench & Turner, 1959 (Mollusca, Gastropoda, Camaenidae), preoccupied by *Papuanella* Distant, 1914 (Insecta)

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Camaenidae, zoological nomenclature, homonymy, Papua New Guinea, *Papuanella*, *Ogeramua*

Results

The genus *Papuanella* (type species *Geotrochus ogeramuensis* Kobelt, 1914, by original designation) was established by Clench and Turner (1959: 5) for two species of land snails inhabiting the Central Highlands of Papua New Guinea. *Papuanella* is currently recognized as a valid genus within the subfamily Papuininae of the family Camaenidae (Schileyko 2003).

Distant (1914: 352) established *Papuanella* for a genus of fulgorid homopterans also inhabiting the island of New Guinea, and thus Clench and Turner's taxon is a junior homonym in need of replacement. Accordingly, pursuant to Article 60 of the International Code of Zoological Nomenclature (International Commission on Zoological Nomenclature 1999), the name *Ogeramua*, nom. n., is here proposed as a replacement

name for *Papuanella* Clench & Turner, 1959 (non *Papuanella* Distant, 1914). Species included in the genus as defined by Clench and Turner (1959) are *O. ogeramuensis* (Kobelt, 1914), comb. n., and *O. finisterrensis* (Kobelt, 1914), comb. n.

The epithet *Ogeramua* is named for Ogeramua, Papua New Guinea, the type locality of its type species, and is to be treated as feminine in gender.

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