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Myobiid mites (Trombidiformes, Myobiidae) of the golden bat *Mimon cozumelae* from Mexico. Description of the male and tritonymph of *Ioanella mimon* and new records of *Eudusbabekia mimon*

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Abstract

The male and the tritonymph of *Ioanella mimon* are described for the first time parasitizing to *Mimon cozumelae* from Yucatan, Mexico. Male of *I. mimon* is characterized by the presence of legs I with the tibia and tarsus fused forming a small complex devoided of apical claws, legs II–IV with two claws, setae *vi* at level of anterior end of genital plate, genital plate rounded with an anterior projection, all intercoxal setae short; while the tritonymph is characterized by the presence of legs I unequal; legs II–IV with 2-1-1 claws, and posterior region of dorsal idiosoma with 3 pairs of cylindrical and toothed setae. Additionally, we include new locality and host records for *Eudusbabekia mimon* which was also found on *M. cozumelae*. Both species were described originally in association with *Mimon bennettii* at Bartica, Guyana.

Keywords

Myobiidae, *Ioanella*, *Eudusbabekia*, Phyllostomidae

Introduction

The genera *Eudusbabekia* Jameson, 1971 and *Ioanella* Dúsbabek & Lukoschus, 1973, include species associated with Phyllostomidae bats. The former is conformed by 32 species (Morales-Malacara et al. 2011) and the latter includes only five species (Bochkov 2009).

Particularly *Eudusbabekia mimon* Fain, 1973 and *Ioanella mimon* (Fain, 1973) were recorded parasitizing to *Mimon bennettii* Gray, 1938 from Bartica, Guyana (Fain 1973). Type material of both species is deposited in the Natural History Museum of London. The objective of this work is to provide the first morphological description of the male and tritonymph of *I. mimon*, and new host and locality records for both species associated with *Mimon cozumelae* Goldman, 1914 from Yucatan, Mexico.

Methods

A total of five bats were captured inside two hollowness located at carretera Santa Elena-Loltún Km 56, Yucatán, México (20°17'25.0"N, 89°38'43.3"W, 98 m) (Fig. 1). Bats were captured using mist nest and individually maintained until their posterior revision

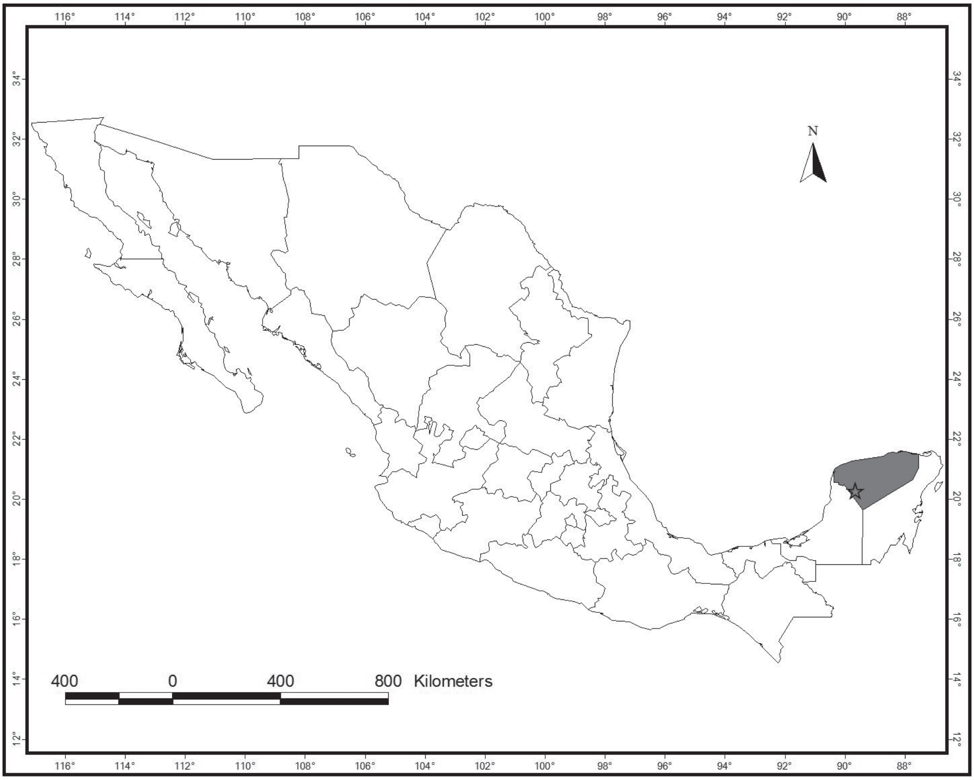

Figure 1. Map showing sampling site, carretera Santa Elena-Loltún, Km. 56, Yucatán, México.

with a dissecting microscope. The Myobiidae (adults and nymphs) were removed from bats using fine, sharp forces and fixed and preserved in vials with 96% ethanol. The specimens were cleared in lactophenol and mounted in Hoyer's medium. Mites were determined taxonomically. Descriptions and nomenclature for idiosomal setation follows Bochkov et al. (2008). Measures of body and setae are in micrometers and were made on a microscope Zeiss Axioscope 2 plus (Göttingen, Niedersachen, Germany), using the AXIOVISION 4 software; for measures we provide the average, followed by range in parenthesis. Drawings of specimens were made with a phase contrast microscope (Zeiss), equipped with a drawing tube. For the scanning electron microscopy (SEM), the specimens were dehydrated in 100% ethanol and dried to a critical point with liquid carbon dioxide. The dried specimens were mounted on aluminum specimen stubs, coated with a gold palladium alloy, and examined using a scanning electronic microscope Hitachi Stereoscan Model S–2469 N SEM (Hitachi Ltd., Tokyo, Japan). Mites were deposited at Colección del Laboratorio de Acarología, Facultad de Ciencias (LAFC), Universidad Nacional Autónoma de México (UNAM). Host were captured under the permission SGPA/DGVS/08257/13 and deposited at Colección de Mamíferos, Museo de Zoología "Alfonso L. Herrera", Facultad de Ciencias (MZFC), UNAM.

Taxonomy

Family Myobiidae Mégnin, 1877
Eudusbabekia Jameson, 1971

Eudusbabekia mimon Fain, 1973

Material examined. 1♂ ex *Mimon cozumelae*, Oquedad 1, carretera Santa Elena-Loltún Km. 56, Yucatán, México (LAFC-A01); 1♀, 1 PN same data, except Oquedad 2 (LAFC-A02).

Ioanella Dúsbabek & Lukoschus, 1973

Ioanella mimon (Fain, 1973)

Figs 2–4

Material examined. 7 TN, 3 ♀, ex *Mimon cozumelae*, Oquedad 1, carretera Santa Elena-Loltún Km 56, Yucatán, México (LAFC-A03); 4 TN, 3 ♀, 2♂, same data, except Oquedad 2 (LAFC-A04).

Description. Male (Based on 2 males). Body length 225 (223–228); wide 139 (125–152). Body 1.6 larger than wide. Dorsal idiosoma (Fig. 2A). With a reduce number of setae. All dorsal setae slightly toothed except setae *vi*; *vi* at level of anterior end of genital plate; setae *sci* cylindrical, and situated close to the genital aperture.

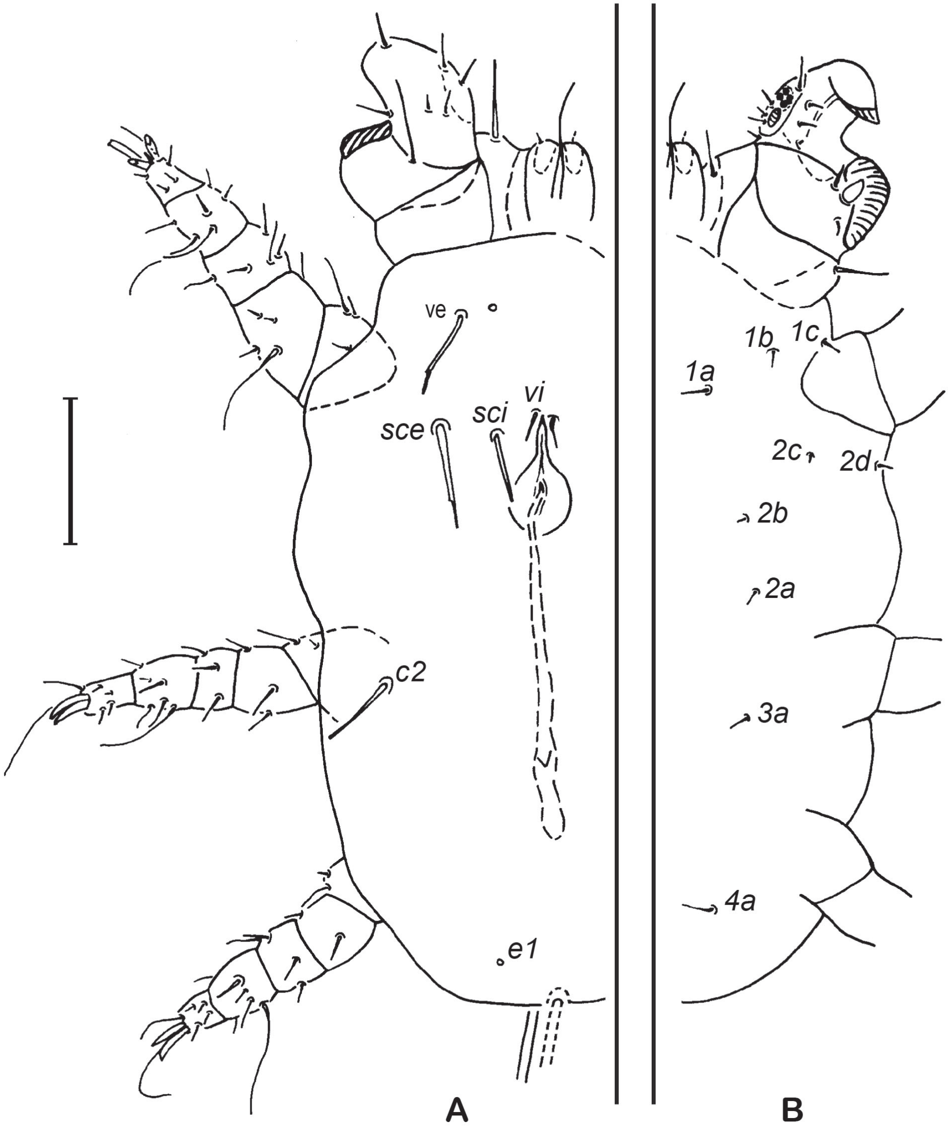

Figure 2. *Ioanella mimon*, male. **A** Dorsal view **B** Ventral view. Scale bar: 50 µm.

Setae *sce* cylindrical, with the base broad and becoming narrower to the tip and with the tip flat. Setae *c2* not distinctly inflated basally; *sci* situated at 15–16 behind the *sce*; setae *f2* absent as female; setae *e1* minute. Length of setae: *ve* 21 (18–25), *sce* 28 (26–31), *sci* 17 (14–17), *c2* 20 (17–22). Distances between bases of setae: *vi-vi:* 30 (29–31), *ve-ve:* 46 (45–47), *sce-sce:* 53 (52–54), *sci-sci:* 23 (21–26), *c2-c2:* 79 (76–82), *ve-sce* 28 (24–29), *sce-c2* 68 (65–68), *vi-sci* 31 (29–33). Genital plate rounded with an anterior projection (Fig. 2A). Penis 90 (90–91) long. Ventral idiosoma (Fig. 2B). All coxal setae filiform.

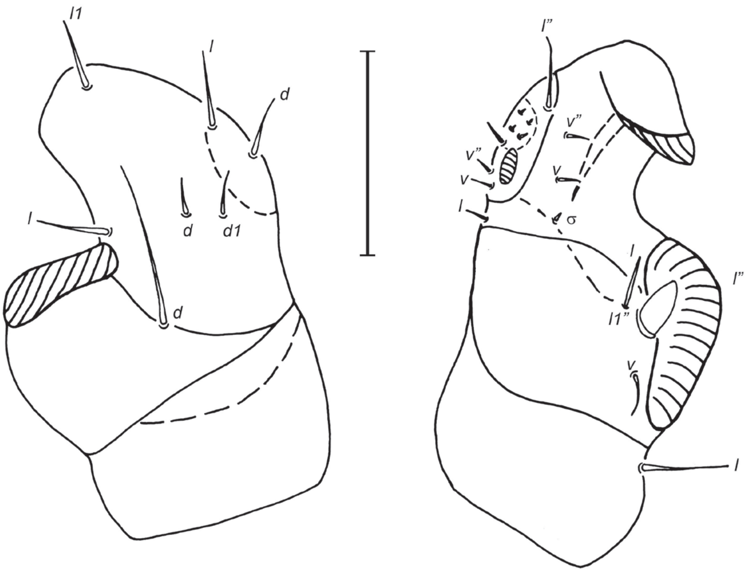

Figure 3. *Ioanella mimon*, male, leg I. **A** Dorsal view **B** Ventral view. Scale bar: 25 µm.

Gnathosoma. Normally developed, with a pair of ventral flat and retrorse processes as in the female (Fain, 1978) but slightly less pronounced.

Legs. Tibia and tarsus I fused forming a small complex devoid of apical claws (Fig. 3). Genua I large, strongly oblique with a ventral clasping process recurved inwards and with 3 setae (Fig. 3). Trochanter I very broad, with the anterior end strongly expanded (Fig. 3). Legs II–IV narrow, ending in two short, subequal, and slightly curved claws. Setation for legs II–IV: tarsi 6-6-6, tibiae 6-6-6, genua 5-3-4, femora 5-3-2, trochanters 3-2-2. Tibia II–IV with a long and sinuous seta and a little thorn-like seta.

Description. Trytonymph (Based on 4 tritonymphs). Dorsal idiosoma. Posterior region of dorsum with 3 pairs of cylindrical and toothed setae: *e1* 14 (11–18), *e2* 15 (14–18), *f1* 14 (12–15) (Fig. 4A). Setae *ve*, *vi*, *sce*, *sci*, *c1*, *d1*, *d2* absent. Ventral idiosoma. Setae *h1* very thin. Setae *2a*, *3a*, *4a* present and minute. Setae *1b* and *1c* shell-shaped, setae *1a* very thin (Fig. 4B). Legs. Tarsi II–IV with 2-1-1 claws. Legs I unequal in shape (Fig. 4B); clasping process with internal striations (Fig. 4B). Setation for legs II–IV: Tarsi 6-6-6, tibiae 5-4-3, genua+femur 2-0-0, trochanters 0-0-0. Number of shell-shaped setae on legs I as follows: 2-0-1-2-1 (Tibia+Tarsus) (Fig. 4B).

Remarks. The male described in this study was determined as part of the genus *Ioanella* by the presence of legs I with the tibia and tarsus fused forming a small complex devoided of apical claws, legs II–IV with two claws, *vi* and *sci* thin and short, all intercoxal setae very short and the lacking of *f2* (Fain 1978). The tritonymph was characterized by the presence of legs I unequal in shape and legs II–IV with 2-1-1 claws (Fain 1978).

The identification of males and tritonymphs as *I. mimon* was done correlating the presence of females on the same analyzed bats considering that myobiids exhibit high specificity to their hosts (Fain 1994).

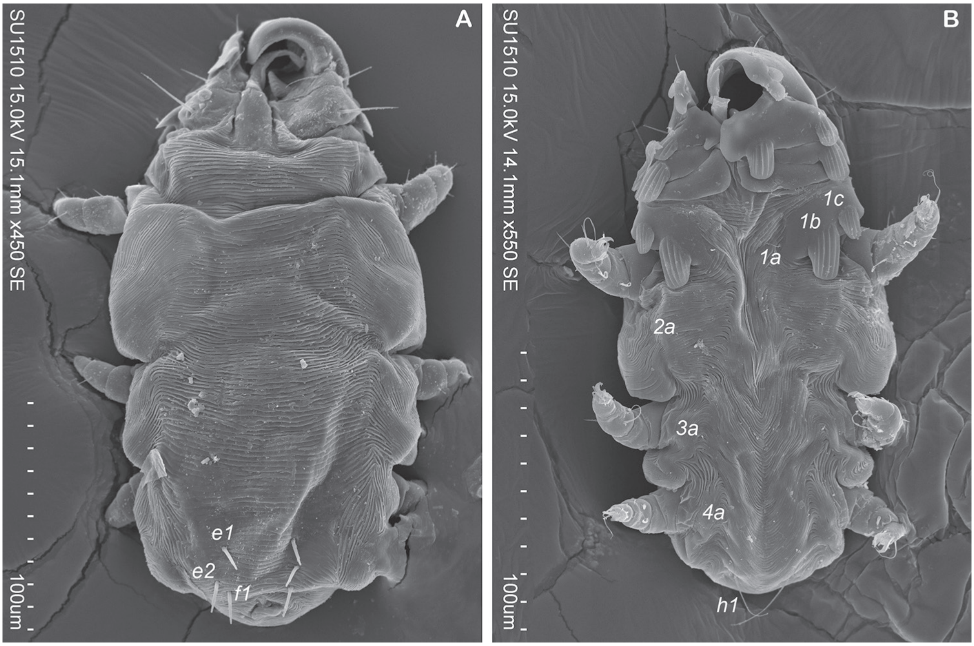

Figure 4. *Ioanella mimon*, tritonymph. **A** Dorsal view **B** Ventral view.

Comparing our male specimens with the female described by Fain (1973), the only differences observed were in relation to femur and genua III due to we reported three setae instead of two and three setae instead of four, respectively.

This work represents the first description of a male of the genus *Ioanella*, and the second that describes a tritonymph for the genus; previously Fain (1973) described the tritonymph of *Ioanella chrotopterus* (Fain, 1973).

Eudusbabekia mimon and *I. mimon* are two species of myobiids recorded originally parasitizing to *M. bennettii*, in this work both species are referred for the first time in association with *M. cozumelae*, species formerly included as subspecies of *M. bennettii* (Ortega and Arita 1997, Villa-Ramírez 1967, Hall 1981), but considered by McCarthy (1987) and Wilson and Reeder (2005), as valid species.

Recent studies suggest that there is no sufficient morphological evidence to maintain *M. cozumelae* in a specific level (Gregorin et al. 2008; Hoppe and Ditchfield 2015).

On the other hand, Hurtado and Pacheco (2014) suggested that the genus *Mimon* is not a monophyletic taxon. They proposed to elevate to a genus category the two subgenera (*Mimon* and *Anthorhina*) referred by Gardner and Patton (1972). In accordance with Hurtado and Pacheco (2014), the genus *Mimon* must include to *M. bennettii* and *M. cozumelae*, and the genus *Gardnerycteris* (=*Anthorhina*) to *Gardnerycteris crenulatum* (É. Geoffroy, 1803) and *Gardnerycteris koepckeae* (Gardner and Patton, 1972). In this context, *E. mimon* and *I. mimon* will be associated with the bat species of the genus *Mimon*, while *Eudusbabekia anthorhinae* Dúsbabek and Lukoschus, 1974 and *Ioanella martae* Dúsbabek and Lukoschus, 1973 to the species of the genus *Gardnerycteris.*

Considering of degree of specificity of myobiid mites to genera or groups of species of hosts (Fain 1994), the referred association could support the Hurtado and Pacheco´s proposal.

Distribution. Guyana (Bartica), Mexico (Yucatan).

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A review of the Neotropical genus *Bidessodes* Régimbart, 1895 including description of four new species (Coleoptera, Adephaga, Dytiscidae, Hydroporinae, Bidessini)

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Abstract

The Neotropical genus *Bidessodes* Régimbart, 1895 is reviewed. Four new species are described, *B. chlorus* Miller, **sp. n.**, *B. erythros* Miller, **sp. n.**, *B. leukus* Miller, **sp. n.**, and *B. melas* Miller, **sp. n.**, bringing the total number of species in the genus to 20. A key to species is provided. Important diagnostic features are illustrated and described and distributions of all species based on examined specimens and published records are provided. Recognition of the subgenera of *Bidessodes* is not justified, and the two names *Hughbosdineus* Spangler, 1981 **syn. n.** and *Youngulus* Spangler, 1981 **syn. n.**, described at the genus rank, are placed in synonymy with *Bidessodes*.

Resumen

El género neotropical *Bidessodes* Régimbart, 1895 se revisa. Cuatro nuevas especies se describen, *B. chlorus* Miller, **sp. n.**, *B. erythros* Miller, **sp. n.**, *B. leukus* Miller, **sp. n.**, y *B. melas* Miller, **sp. n.**, con lo que el número total de especies en el género se eleva a 20. Se proporciona una clave para las especies. Características diagnósticas importantes se ilustran y describen y se proporcionan las distribuciones de todas las especies basándose en los especímenes examinados y registros publicados. El reconocimiento de los subgéneros de *Bidessodes* no está justificado, y los nombres *Hughbosdineus* Spangler, 1981 **syn. n.** y *Youngulus* Spangler, 1981 **syn. n.**, descritos como géneros, son sinonimizados con *Bidessodes*.

Keywords

Water beetles, taxonomy, revision, Neotropical, *Bidessodes*, Dytiscidae

Introduction

The Neotropical genus *Bidessodes* Régimbart, 1895 currently includes 16 described species (Nilsson 2016) distributed among three subgenera. Thirteen are in the nominal subgenus with two in *B.* (*Hughbosdinius*) Spangler, 1981 and one in *B.* (*Youngulus*) Spangler, 1981. Historically, a group of similar looking species of Bidessini in Australia were also placed in this genus, but these were transferred to *Neobidessodes* Hendrich and Balke thereafter restricting *Bidessodes* to the New World (Hendrich et al. 2009). Relationships of *Bidessodes* to other Bidessini genera are not yet clear. The New World *Bidessodes* were revised by Young (1986).

Within Bidessini, *Bidessodes* is very similar to *Neobidessodes*, but *Bidessodes* have a series of fine denticles along the posterior margins of abdominal ventrites III–V that are absent in *Neobidessodes*. Several species have conspicuous male dimorphisms, particularly in the meso- and metalegs, prosternum and prosternal process, and last abdominal ventrite. The male genitalia (both the median and lateral lobes) are usually strikingly complex, and the male median lobe is bilaterally symmetrical and deeply bifid.

The first *Bidessodes* species were described in *Bidessus*, but most were later described in *Bidessodes*. Three of these species were described in the genera *Youngulus* Spangler, 1981 and *Hughbosdineus* Spangler, 1981, based especially on unusual modifications of males (Spangler 1981). These genera were soon placed as subgenera of *Bidessodes* by Young (1986).

The genus includes a mix of species some of which are relatively abundant and widespread, and others that are rare and restricted in distribution. They occur in shallow lentic and lotic (especially sandy forest stream) habitats.

The purpose of this research is to describe four new species discovered in northern South America as the result of focused collecting in the region. Most *Bidessodes* species are very distinctive, and new species are relatively easily recognized and diagnosed from others. Because a number of species were described since the last revision (Braga and Ferreira-Jr. 2009) and there have been nomenclatural changes (Hájek 2012; Hendrich et al. 2009), the entire genus is briefly reviewed here.

Material and methods

Measurements. Measurements were made with an ocular scale on a Zeiss Discovery V8 dissecting microscope. The diagnostic range of measurements of structures was emphasized, so the largest and smallest specimens were preferentially measured. Measurements include: 1) total length (TL), 2) greatest width across elytra (EW), 3) greatest width of pronotum (PW), 4) greatest width of head (HW), and 5) distance between eyes (ED). The ratios TL/EW and HW/ED were also calculated.

Images. Illustrations were made using a drawing tube on a Zeiss Discovery V8 dissecting scope. Sketches were first done in pencil then scanned, placed into an Adobe Illustrator artboard and "inked" digitally using vector lines.

Material. Specimens of all species were examined except *B. fragilis* Régimbart, 1900, the identity of which is in question since the type is a female (Young 1986), and female specimens are difficult to distinguish. Type specimens were not examined, but there seems to be little question about the identity of any species in the group except *B. fragilis* (Young 1986). Specimens were examined from the following collections:

CSBD	Center for Biological Diversity, University of Guyana (type specimens currently reposed with KUNHM)
FSCA	Florida State Collection of Arthropods, University of Florida, Gainesville, FL, USA (P. Skelley)
KBMC	Kelly B. Miller Collection, Museum of Southwestern Biology, University of New Mexico, Albuquerque, NM, USA
KUNHM	University of Kansas Natural History Museum, University of Kansas, Lawrence, Kansas, USA (A.E.Z. Short)
MIZA	Museo del Instituto de Zoología Agrícola Francisco Fernández Yépez, Universidad Central de Venezuela, Maracay, Venezuela (L. Joly)
MSBA	Museum of Southwestern Biology Division of Arthropods, University of New Mexico, Albuquerque, NM, USA (K.B. Miller)
NZCS	National Zoological Collection of Suriname, Paramaribo, Suriname (P. Ouboter)
USNM	United States National Collection of Insects, Smithsonian Institution, Washington, DC, USA (T. Erwin)

Distribution maps. Dot maps presented here are derived from examined specimens and specific localities reported by Spangler (1981), Young (1986) and Braga and Ferreira-Jr. (2009).

Taxonomic characters

Head. The anterior clypeal margin is vaguely thickened in many *Bidessodes*, such as *B. semistriatus*, but this is usually indistinct and not especially useful as a taxonomic character. Punctation of the head has been used historically as a taxonomic character, also, with some species with very sparse punctation and others with it more distinctive (Zimmermann 1921). Reassessment of this character suggests that it is also ambiguous at best.

Pronotum. The pronotum ranges from laterally strongly curved to nearly parallel-sided. The pronotal striae (plicae) are somewhat variable in length between species but extend usually about 1/3 the distance across the pronotum.

Elytra. The coloration of the elytra is variable between species with some nearly immaculate, others vaguely or indistinctly maculate and others more distinctly maculate or longitudinally striate.

Prosternum. The prosternum in some species is medially longitudinally carinate and setose in either just males (*B. obscuripennis* (Zimmermann, 1921)) or in both males and females (*B. knischi* (Zimmermann, 1921)). Most species have the prosternum and prosternal process not conspicuously modified. The prosternal process is somewhat variable in shape, however, with lateral margins curved to subparallel and the apex truncate to broadly rounded to pointed or acuminate. The process may be longitudinally grooved, slightly convex or flat.

Metasternum. There is a distinctive transverse impression across the metaventrite in *B. knischi*. Other species are unmodified.

Legs. The male pro- and mesotarsomeres are generally more or less broadly expanded than those of the female as occurs in most species of Dytiscidae. This is less evident in some species, especially *B. subsignatus* (Zimmermann, 1921). In some species, the male mesofemur is apically swollen or expanded. In several species, the base of the male mesotibia is distinctly bent (e.g. Fig. 66). A few species have the metatibia and metafemur expanded or otherwise modified in characteristic ways (e.g. Figs 50, 81).

Male genitalia. The male genitalia hold the best set of diagnostic features for species identification. The median lobe in all species is bilaterally symmetrical but is highly species-specific in shape. The lateral lobes are bisegmented and bilaterally symmetrical, as are most Bidessini, and their shapes are highly species-specific, similar to the median lobe. Some are quite complex in shape.

Taxonomy

Bidessodes Régimbart, 1895

Bidessodes Régimbart, 1895:76; type species: *Bidessodes elongatus* Sharp, 1882b:25 by monotypy.

Bidessodes Régimbart, 1900:528; type species: *Bidessodes semistriatus* Régimbart, 1900:529 by subsequent designation of Young 1969:2; preoccupied by Régimbart 1895:76; Blackwelder 1944:76; Young 1967:82; 1969:2; 1986:219; Biström 1988:7; Nilsson 2016:98.

Bidessus (*Bidessodes*), Zimmermann, 1919:61; 1921:200.

Hughbosdineus Spangler, 1981:65 **syn. n.**

Youngulus Spangler, 1981:69 **syn. n.**

Bidessodes (*Hughbosdineus*), Young, 1986:206; Biström, 1988:7.

Bidessodes (*Youngulus*), Young, 1986:207; Biström, 1988:7.

Diagnosis. *Bidessodes* are characterized by the following features: (1) a transverse occipital line is absent (e.g. Fig. 1), (2) the anterior clypeal margin is unmodified (Fig. 1),

(3) the basal pronotal striae are present (Fig. 1), (4) the basal elytral stria is absent (Fig. 1), (5) the elytral sutural stria is absent (Fig. 1), and (6) the transverse carina across the epipleuron at the humeral angle of the elytron is absent. The genus most similar in general appearance to *Bidessodes* in Bidessini is *Neobidessodes* Hendrich and Balke, 2009, a group of species from Australia previously placed in *Bidessodes*. The main difference between these genera is a series of very fine serrations or denticles along the posterior margins of the abdominal ventrites, present in *Bidessodes* and absent in *Neobidessodes*.

Comments. The genera *Hughbosdineus* and *Youngulus* were proposed by Spangler (1981) and relegated to subgenera of *Bidessodes* by Young (1986). It seems clear, though, that the species were placed in their own genera based on unusual apomorphies rather than clear evidence of phylogenetic isolation. Although there has not been a phylogenetic analysis of the group, these two species appear to be well within the general character-based concept of *Bidessodes*. There is little justification for continued recognition of three subgenera in *Bidessodes*, so, *Hughbosdineus* Spangler, 1981 and *Youngulus* Spangler, 1981 are each placed as junior synonyms of *Bidessodes* Régimbart, 1895 (new synonymies).

Key to species of *Bidessodes*

The following key is modified from Young (1986) and Braga and Ferreira-Jr. (2009). Keys to *Bidessodes* have been historically based on male attributes. This key is similarly limited. Females of many species are extremely similar and cannot be easily distinguished without association with males. Much of the key requires dissection of male genitalia, and even with the key the best diagnostic method is to dissect male genitalia and compare with descriptions and images of them. *Bidessodes fragilis* is not keyed given ambiguity about its identity and character combination.

1 Prosternal process anterior to procoxae distinctly carinate with distinctive setae or spines anteriorly in only males or both males and females **2**

– Prosternal process anterior to procoxae not distinctly carinate in either sex, simply rounded or only weakly carinate, without distinctive setae or spines **3**

2 Prosternal process carinate anterior to procoxae in both males and females; males with distinctive transverse impression across metaventrite behind mesocoxae; metatrochanter and metafemur large, but not conspicuously modified (Fig. 71); length: 2.3–2.6 mm; male median lobe in lateral aspect apically somewhat curved with distinct subapical dorsal expansion (Fig. 68); lateral lobe very broad, apical segment large, broadly subtriangular, oriented obliquely with respect to basal segment (Fig. 70); Bolivia, Brazil, Guyana, and Venezuela (Fig. 104) .... ***B. knischi***

– Prosternal process anterior to procoxae carinate in males but not females; metaventrite not impressed in either sex; metatrochanter large and rounded apically, conspicuously extending beyond ventral margin of metafemur (Fig. 81); length: 2.4–2.9 mm; male median lobe in lateral aspect apically strongly curved without distinct subapical expansion (Fig. 78); lateral lobe with apical segment very large, expanded apically, broadly rounded at apex, linear with respect to small basal segment (Fig. 80); Guyana, Brazil (Fig. 100).........***B. obscuripennis***

3 Male metatrochanter large, almost square in outline and metafemur enlarged (Fig. 50); male abdominal ventrite VI transversely impressed subapically, apex weakly carinate; male median lobe in lateral aspect with apical portion medially broadly expanded, narrowed to elongate, slender, straight at apex (Fig. 47); length: 2.8–3.1 mm; Colombia, Venezuela, Guyana (Fig. 98)............***B. franki***

– Male metatrochanter variable, in some cases slightly modified in males but not conspicuously modified as above in either sex; male abdominal ventrite VI variable; male genitalia different from described above...........................**4**

4 Male mesotibia distinctly bent at base (as in Fig. 66) **5**

– Male mesotibia not bent...**9**

5 Pronotum widest at base, nearly as wide as distance across bases of elytra (Fig. 61); male median lobe with two long branches, each of which is broadly spatulate and trilobed (Fig. 63); lateral lobe with apical segment broad and round (Fig. 64); size small, about 2.2–2.4 mm in length; Brazil and Bolivia (Fig. 103)...***B. jucundus***

– Pronotum widest medially, narrowed posteriorly; male median lobe may be comprised of two long branches, but not apically spatulate and trilobed; lateral lobe with apical segment various, but not broad and round..................**6**

6 Last visible abdominal ventrite of male with distinct transverse sulcus; length: 2.6–2.7 mm; Brazil (Fig. 104) ....***B. hamadae***

– Last visible abdominal ventrite of male unmodified or variously impressed, but without carina or sulcus...7

7 Mesofemur of male not expanded; length: 2.2–2.6 mm; Brazil (Fig. 102) ....***B. nessimiani***

– Mesofemur of male expanded and distinctly swollen in apical 1/3 ....**8**

8 Elytra dark, without pale fasciae or maculae (Fig. 21); male median lobe in lateral aspect broadly curved, slender with elongate expansion along dorsal margin medially (Fig. 22); lateral lobe short, apical segment broad, apically truncate with broad expansion subapically along dorsal margin (Fig. 24); length: 2.5–2.8 mm; Bolivia and Brazil (Fig. 99) ....***B. acharistus***

– Elytra with pale fasciae (Fig. 92); male median lobe simple, in lateral aspect shallowly curved, expanded medially along ventral margin (Fig. 93); lateral lobe long, apical segment elongate, sinuate and apically slender and sharply pointed (Fig. 95); length: 2.4–2.8 mm; Brazil (Fig. 103) ....***B. zimmermanni***

9 Abdominal ventrite VI of male deeply impressed on each side, impression medially carinate; pro- and mesotarsomere I of male not laterally expanded, similar to female mesotarsomeres; male median lobe deeply bifid, with each branch with distinctive apical "hooks" in ventral aspect (Fig. 89); size small, length: 2.0 mm (Fig. 87); Brazil and Guyana (Fig. 103)....... ***B. subsignatus***

– Abdominal ventrite VI of male not or only weakly impressed on each side, usually impressed in an oval or round area subapically or otherwise modified;

pro- and mesotarsomere I of male distinctly expanded; male median lobe various, but not deeply bifid with apical "hooks" in ventral aspect; size larger, length > 2.0 mm **10**

10 Apex of abdominal ventrite VI of male with distinct strigose sculpture or a longitudinal sulcus **11**

– Apex of abdominal ventrite VI of male unmodified or variously impressed, but without carina or sulcus **12**

11 Abdominal ventrite VI of male with an area of coarse strigose sculpture subapically; male median lobe in lateral aspect extremely slender and curved with slender, pointed apical branches (Fig. 42); lateral lobe with apical portion irregularly shaped, subquadrate with apical short lobe (Fig. 43); length: 2.2–2.4 mm; Brazil, Guyana, Suriname, and Venezuela (Fig. 102)... ***B. evanidus***

– Abdominal ventrite VI of male without sculpturing subapically, sulcate instead; male median lobe with apex in lateral aspect sinuate (Fig. 32); lateral lobe with apical portion oval (Fig. 34); length: 2.4–2.6 mm; Brazil (Fig. 100) .... ***B. demarcoi***

12 Male median lobe in lateral aspect with apical portion moderately broad, sublinear, apically slender and very narrowly rounded (Fig. 83); length: 2.5–3.4 mm (Fig. 82); Brazil, French Guiana, and Suriname (Fig. 100) .... ***B. semistriatus***

– Male median lobe not as described above; length < 3.0 mm **13**

13 Male median lobe robust, curved, apically linear along dorsal margin, broadly expanded along ventral margin (Fig. 56); length: 2.4–2.6 mm; Venezuela, French Guiana (Fig. 100) .... ***B. hygrobius***

– Male median lobe not as described above **14**

14 Male median lobe in lateral aspect elongate, slender, evenly curved (Fig. 17); size small, length: 1.6–1.7 mm; Venezuela (Fig. 98) .... ***B. melas***

– Male median lobe in lateral aspect robust, or differently shaped; size larger, length > 2.0 mm **15**

15 Male median lobe in lateral aspect very broad and evenly curved, apically very slender (Fig. 27); length: 2.1–2.6 mm; Venezuela, Guyana, Suriname (Fig. 99) .... ***B. charaxinus***

– Male median lobe in lateral aspect abruptly curved apically or linear, apex robust **16**

16 Male median lobe in lateral aspect apically straight and broad (Fig. 7); length: 2.3–2.4 mm; Guyana (Fig. 97) .... ***B. erythros***

– Male median lobe in lateral aspect apically abruptly curved **17**

17 Male median lobe in ventral aspect extremely broad with broad lateral lobes (Fig. 12); length: 2.4 mm; Venezuela (Fig. 97) .... ***B. leukus***

– Male median lobe in ventral aspect not so broad, without broad lateral lobes...... **18**

18 Male median lobe in lateral aspect with apex extremely broad and truncate (Fig. 2); length: 2.3–2.5 mm; Suriname (Fig. 97) .... ***B. chlorus***

– Male median lobe in lateral aspect somewhat more slender, apically pointed (Fig. 36); length: 2.6–2.9 mm; Central America (Fig. 101) ...... ***B. elongatus***

Bidessodes chlorus sp. n.

http://zoobank.org/BD275772-CBAB-47AC-B94F-97470EF62292
Figs 1–5, 97

Type locality. Suriname, Sipaliwini District, Camp 1, on Kutari River, 2°10.521'N 56°47.244'W.

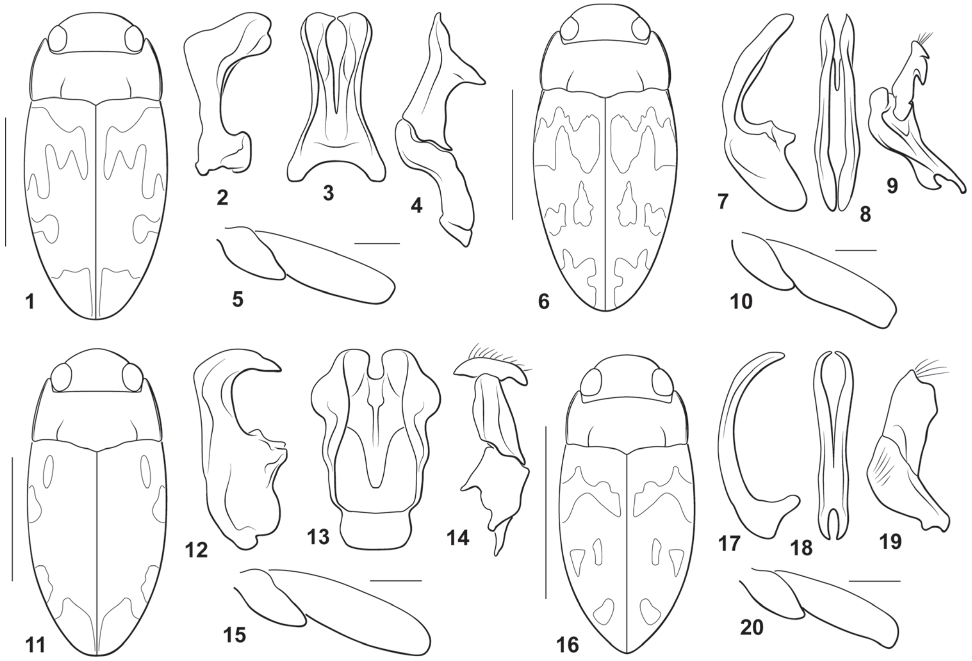
Type material. Holotype in MIZA, male labeled, "SURINAME Sipaliwini District 2°10.521'N 56°47.244'W: 228m Camp 1, on Kutari River leg.A.E.Z.Short, UV-light 19-24.viii.2010; SR10-0819-LT1 2010 CI-RAP Survey/ SEMC0915810 KUNHM-ENT [barcode label]/ HOLOTYPE *Bidessodes chlorus* Miller, 2016 [red label with black line border]." Paratypes, 6, labeled same as holotype except with different specimen barcode labels and each with "…PARATYPE *Bidessodes chlorus* Miller, 2016 [blue label with black line border]."

Diagnosis. This species does not have a carinate prosternum in either male or female. The prosternal process is longitudinally slightly convex and relatively narrow with the lateral margins distinctly convergent to a pointed apex. The male mesotibia is unmodified. The male metatrochanter and metafemur are unmodified (Fig. 5). The male abdominal ventrite VI is unmodified. The male median lobe in lateral aspect is very small basally with the apical portion abruptly bent and broadly expanded with the apex bilobed (Fig. 2). In ventral aspect the median lobe is very broad basally with the lateral margin concave and the apex broad with a deep, narrow medial emargination (Fig. 3). The basal segment of the lateral lobe is elongate and subsinuate (Fig. 4). The apical segment is elongate and obliquely T-shaped with the apical margin broadly emarginate (Fig. 4). Externally, *B. chlorus* is similar to many other species of *Bidessodes* with relatively unmodified ventral surfaces and legs in males or females. The main difference between this species and others is the male genitalia. The shape of the male median lobe and lateral lobes as described above (Figs 2-4) are unlike any other species in the genus. The very broad, angled apical section of the median lobe in lateral aspect (Fig. 2) is particularly unique.

Description. *Measurements*. TL = 2.3–2.5 mm, EW = 1.0–1.1 mm, PW = 0.9–1.0 mm, HW = 0.7–0.9 mm, ED = 0.4–0.5 mm, TL/EW = 2.1–2.2, HW/ED = 1.8–1.9. Body shape elongate oval, pronotum widest medially, similar in width to greatest width of elytra, lateral outline discontinuous between pronotum and elytron.

Coloration (Fig. 1). Head and pronotum yellow, posterior margin of pronotum medially brown. Elytron with base color brown to dark brown with diffuse, transverse pale regions anteriorly, medially and at apex (Fig. 1); surface not iridescent. Head appendages, legs and ventral surfaces yellow to yellow-orange.

Sculpture and structure (Fig. 1). Head with dorsal surface smooth and shiny, impunctate. Pronotum (Fig. 1) smooth and shiny with few micropunctures, broadly distributed; lateral margins broadly rounded, pronotum broadest medially, slightly constricted at posterior angles, about same width as greatest width of elytra; basal striae moderately well impressed, extending about 2/5 distance across pronotum. Elytron



Figures 1–20. *Bidessodes* species. **1–5** *B. chlorus* **1** dorsal habitus, scale = 1 mm **2–4** male genitalia **2** median lobe, right lateral aspect **3** median lobe, ventral aspect **4** right lateral lobe, right lateral aspect **5** left metatrochanter and metafemur, anterior aspect, scale = 0.25 mm **6** *B. erythros* **6** dorsal habitus, scale = 1 mm **7–9** male genitalia **7** median lobe, right lateral aspect **8** median lobe, ventral aspect **9** right lateral lobe, right lateral aspect **10** left metatrochanter and metafemur, anterior aspect, scale = 0.25 mm **11** *B. leukus* **11** dorsal habitus, scale = 1 mm **12–14** male genitalia **12** median lobe, right lateral aspect **13** median lobe, ventral aspect **14** right lateral lobe, right lateral aspect **15** left metatrochanter and metafemur, anterior aspect, scale = 0.25 mm **16** *B. melas* **16** dorsal habitus, scale = 1 mm **17** male genitalia **17** median lobe, right lateral aspect **18** median lobe, ventral aspect **19** right lateral lobe, right lateral aspect **20** left metatrochanter and metafemur, anterior aspect, scale = 0.25 mm.

(Fig. 1) very broadly curved laterally; shiny, finely microreticulate across surface, irregularly and inconsistently micropunctate. Prosternal process elongate triangular, basally broad and posteriorly convergent to sharply pointed apex; surface weakly convex. Metaventrite process anteriorly produced with weak lateral carinae that do not extend posteriorly; surface of metaventrite smooth and shiny, not carinate or otherwise modified. Metacoxa with lateral portions shiny, not punctate; metacoxal lines elongate, subparallel. Abdominal ventrites smooth, impunctate; ventrite VI smooth, evenly convex, apically pointed.

Male genitalia. Median lobe in lateral aspect short and robust, basal portion small, apical portion robust, strongly angulate medially, apically broad and truncate (Fig. 2); median lobe in ventral aspect broad basally, medially constricted and expanded apically with lateral margins each broadly concave, medially deeply and narrowly emarginate, lateral branches apically rounded with small medially-directed point (Fig. 3); lateral lobe in lateral aspect irregular, basal portion elongate, curved and constricted medially along ventral margin, apical portion broad basally, apically broadly and obliquely T-shaped with lateral apices pointed and truncate apex shallowly and irregularly concave (Fig. 4).

Sexual dimorphism. Male pro- and mesotarsomeres I-III broader than in female with extensive ventral adhesive setae. Male and female otherwise similar.

Variation. Specimens vary in the extent and intensity of coloration on the elytral surface, though all specimens have some degree of maculation.

Etymology. This species is named *chlorus*, Greek for "pale green" after one of the four horsemen of the apocalypse.

Distribution. *Bidessodes chlorus* is known only from southern Suriname (Fig. 97).

Habitat. The type specimens were collected at a UV light. No other natural history information is known about this species.

Bidessodes erythros sp. n.

http://zoobank.org/13FCB617-738B-4272-AA9A-225E7C88B53E
Figs 6–10, 97

Type locality. Guyana, Region 8, Konawaruk River, Basecamp (blackwater camp), 5°03.884'N 59°12.838'W.

Type material. Holotype in MIZA, male labeled, "GUYANA:Region 8 5°03.884'N 59°12.838'W, 75 m Konawaruk River, Basecamp (blackwater camp): Blackwater crk along margin, with leaf litter leg. Salisbury & La Cruz 10.ix.2014: GY14-0910-02/ SEMC1428326 [barcode label]/ HOLOTYPE *Bidessodes erythros* Miller, 2016 [red label with black line border]." Paratypes, 15, labeled same as holotype except with different specimen barcode labels and each with "…PARATYPE *Bidessodes erythros* Miller, 2016 [blue label with black line border]."

Diagnosis. This species does not have a carinate prosternum in either male or female. The prosternal process is broadly triangular, slightly convex and apically acuminate. The male mesotibia is unmodified. The male metatrochanter and metafemur are unmodified (Fig. 10) and the male last abdominal ventrite is unmodified. The male median lobe in lateral aspect is broadly lobate basally with the apical portion long, sublinear, moderately broad with somewhat undulate dorsal and ventral margins and of somewhat even width to a rounded apex (Fig. 7). In ventral aspect the median lobe is moderately broad and similar in width to the apex which is divided into two long rami separated by a narrow, deep medial emargination, with the apex of each ramus narrowed to a point (Fig. 8). The basal segment of the lateral lobe is elongate and irregularly shaped (Fig. 9). The apical segment is small with the apex characterized by an anteriorly directed spinous process on the dorsal margin (Fig. 9). Externally, *B. erythros* is similar to many other species of *Bidessodes* with relatively unmodified ventral surfaces and legs in males or females. The main difference between this species and others is the male genitalia as described above. The male median lobe and lateral lobes (Figs 7-9) are unlike any other species in the genus.

Description. *Measurements*. TL = 2.3–2.4 mm, EW = 1.2–1.3 mm, PW = 1.0–1.1 mm, HW = 0.7–0.9 mm, ED = 0.4–0.5 mm, TL/EW = 2.1–2.3, HW/ED = 1.7–1.8. Body shape elongate oval, pronotum widest medially, width less than greatest width of elytra, lateral outline slightly discontinuous between pronotum and elytron, posteriorly somewhat attenuate.

Coloration (Fig. 6). Head and pronotum yellow-orange, posterior margin of pronotum medially narrowly brown. Elytron with base color dark brown with weakly differentiated, diffuse, transverse pale fasciae anteriorly, medially and at apex, anterior and medial pale regions meeting in longitudinal areas medially (Fig. 6); surface not iridescent. Head appendages, legs and ventral surfaces yellow to yellow-orange.

Sculpture and structure (Fig. 6). Head with dorsal surface smooth and shiny, with extremely fine micropunctures, broadly dispersed. Pronotum (Fig. 6) smooth and shiny with broadly dispersed micropunctures; lateral margins broadly rounded, pronotum broadest medially, slightly constricted at posterior angles, somewhat less in width than greatest width of elytra; basal striae moderately well impressed, extending about 2/5 distance across pronotum. Elytron (Fig. 6) very broadly curved laterally; shiny, finely microreticulate across surface, distinctly punctate. Prosternal process basally broad and posteriorly slightly convergent to broadly pointed apex, lateral margins somewhat straight and convergent; surface approximately flat. Metaventrite process anteriorly produced with weak lateral carinae that do not extend posteriorly; surface of metaventrite smooth and shiny, not carinate or otherwise modified. Metacoxa with lateral portions shiny, not punctate; metacoxal lines elongate, subparallel, apically distinctly convergent; metatrochanter and metafemur relatively unmodified. Abdominal ventrites smooth, impunctate; ventrite VI smooth, evenly convex, apically broadly pointed.

Male genitalia. Median lobe in lateral aspect with elongate, oval basal part, apical portion nearly straight, robust, with lateral margins subparallel to rounded apex (Fig. 7); median lobe in ventral aspect broad, lateral margins weakly sinuate, similar in width throughout, apex bifid, each branch apically broadly pointed and slightly curved inward, emargination V-shaped (Fig. 8); lateral lobe in lateral aspect with basal segment elongate, subtriangular with distict apicoventral lobe at base of apical segment; apical segment short and small, apically with truncate and laterally toothed apex, with large, basally-directed tooth on dorsal margin (Fig. 9).

Sexual dimorphism. Male pro- and mesotarsomes I-III broader than in female and with extensive ventral adhesive setae. Otherwise males and females similar.

Variation. Specimens are relatively consistent in color pattern and other features.

Etymology. This species is named *erythros*, Greek for "red" after one of the four horsemen of the apocalypse.

Distribution. This species is known only from central Guyana (Fig. 97).

Habitat. The type series was collected from a leaf litter area along the margins of a blackwater creek.

Bidessodes leukus sp. n.

http://zoobank.org/D4CA601F-769D-4B0E-B3E1-CE35E70E30E5
Figs 11–15, 97

Type locality. Venezuela, Amazonas State, Comunidad Caño Gato, Rio Sipapo 4°58.838'N, 67°44.341'W.

Type material. Holotype in MIZA, male labeled, "VENEZUELA: Amazonas State 4°58.838'N, 67°44.341'W: 95m Comunidad Caño Gato Rio Sipapo: 16.i.2009; leg. Short, Miller, Camacho, Joly & Garcia VZ09-0116-01X: along stream/ SM0842868 KUNHM-ENT [barcode label]/ HOLOTYPE *Bidessodes leukus* Miller, 2016 [red label with black line border]."

Diagnosis. This species does not have a carinate prosternum in either male or female. The prosternal process is broad, broadly convex, with the lateral margins convergent to the rounded apex. The male mesotibia is unmodified. The male metatrochanter and metafemur are unmodified (Fig. 15) and the male abdominal ventrite VI is unmodified. The male median lobe in lateral aspect is very broad basally with the apical portion short and abruptly curved (Fig. 12). In ventral aspect the median lobe is very broad with undulate lateral margins and the apex broad and medially emarginate (Fig. 13). The basal segment of the lateral lobe is short and subquadrate with the proximate margin toothed (Fig. 14). The apical segment is elongate and T-shaped with the apical margin broadly curved and with a series of setae (Fig. 14). Externally, *B. leukus* is similar to many other species of *Bidessodes* with relatively unmodified ventral surfaces and legs in males or females. The main difference between this species and others is the unique male genitalia. The male median lobe and lateral lobes (Figs 12-14) are unlike any other species in the genus. In particular, the median lobe is very broad in ventral aspect (Fig. 12) and robust and strongly curved in lateral aspect (Fig. 13).

Description. *Measurements*. TL = 2.4 mm, EW = 1.1 mm, PW = 1.0 mm, HW = 0.7 mm, ED = 0.4 mm, TL/EW = 2.3, HW/ED = 1.9. Body shape elongate oval, pronotum widest medially, width somewhat less that greatest width of elytra, lateral outline discontinuous between pronotum and elytron, posteriorly somewhat attenuate.

Coloration (Fig. 11). Head and pronotum yellow, posterior margin of pronotum medially narrowly brown. Elytron with base color brown with very weakly differentiated, diffuse, transverse pale regions anteriorly, medially and at apex (Fig. 11); surface not iridescent. Head appendages, legs and ventral surfaces yellow to yellow-orange.

Sculpture and structure (Fig. 11). Head with dorsal surface smooth and shiny, with extremely fine micropunctures. Pronotum (Fig. 11) smooth and shiny with few broadly dispersed micropunctures; lateral margins broadly rounded, pronotum broadest medially, slightly constricted at posterior angles, about same width as greatest width of elytra; basal striae moderately well impressed, extending to nearly 1/2 distance across pronotum. Elytron (Fig. 11) very broadly curved laterally; shiny, finely microreticulate across surface, impunctate. Prosternal process basally broad and posteriorly slightly convergent to broadly rounded apex, lateral margins broadly rounded; surface approximately flat. Metaventrite process anteriorly produced with weak lateral carinae that do not extend posteriorly; surface of metaventrite smooth and shiny, not carinate or otherwise modified. Metacoxa with lateral portions shiny, not punctate; metacoxal lines elongate, subparallel, apically distinctly convergent. Abdominal ventrites smooth, impunctate; ventrite VI smooth, evenly convex, apically broadly pointed.

Male genitalia. Median lobe in lateral aspect with basal portion broad and irregular, apical portion robust, short, abruptly curved at nearly right angle medially, apically narrowed to elongate pointed apex (Fig. 12); median lobe in ventral aspect very broad, apically with lateral margins broadly expanded into lobes laterally, apex bifid (Fig. 13); lateral lobe in lateral aspect irregular, basal portion broad and short, basally with lobes and teeth, apical portion elongate and T-shaped, apex broadly expanded laterally, apical margin curved (Fig. 14).

Sexual dimorphism. Females not examined, but male pro- and mesotarsomeres I-III laterally expanded with ventral adhesive setae, similar to other *Bidessodes* species that exhibit this dimorphism.

Variation. Only a single male specimen was examined.

Etymology. This species is named *leukus*, Greek for "white" after one of the four horsemen of the apocalypse.

Distribution. *Bidessodes leukus* is known only from southwestern Venezuela (Fig. 97).

Habitat. The type was collected from slow areas along a sandy forest stream with extensive leaf pack.

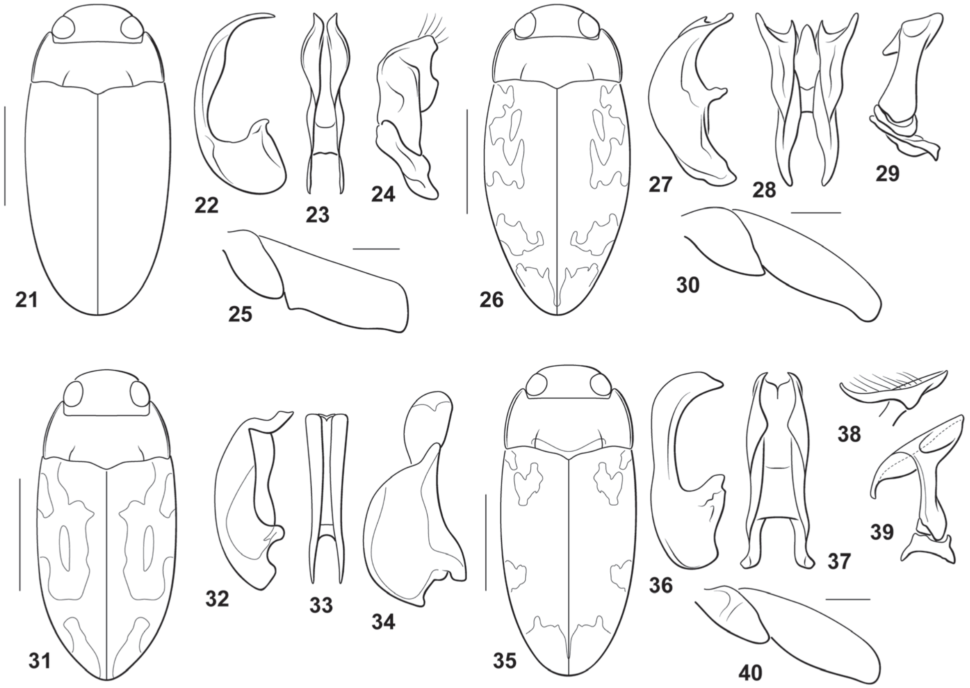
Bidessodes melas sp. n.

http://zoobank.org/EE844E6C-8E46-4E2B-BCFE-029827906382
Figs 16–20, 98

Type locality. Venezuela, Amazonas State, Comunidad Caño Gato, Rio Sipapo, 4°58.838'N, 67°44.341'W.

Type material. Holotype in MIZA, male labeled, "VENEZUELA: Amazonas State 4°58.838'N, 67°44.341'W: 95m Comunidad Caño Gato Rio Sipapo: 16.i.2009; leg. Short, Miller, Camacho, Joly & Garcia VZ09-0116-01X: along stream/ SM0842862 KUNHM-ENT [barcode label]/ HOLOTYPE *Bidessodes melas* Miller, 2016 [red label with black line border]." Paratypes, 66, labeled same as holotype except with different specimen barcode labels and each with "…PARATYPE *Bidessodes melas* Miller, 2016 [blue label with black line border]."

Diagnosis. This species does not have a carinate prosternum in either male or female. The prosternal process is longitudinally slightly convex and relatively narrow with the lateral margins distinctly convergent to a pointed apex. The male mesotibia is unmodified. The male metatrochanter and metafemur are unmodified (Fig. 20) and the male last abdominal ventrite is unmodified. The male median lobe in lateral aspect is very small basally with the apical portion long, slender and evenly curved to a narrowly rounded apex (Fig. 17). In ventral aspect the median lobe is slender basally with the lateral margins expanded apically, divided into two long, slender curved rami that bend



Figures 21–40. *Bidessodes* species. **21–25** *B. acharistus* **21** dorsal habitus, scale = 1 mm **22** male genitalia **22** median lobe, right lateral aspect **23** median lobe, ventral aspect **24** right lateral lobe, right lateral aspect **25** left metatrochanter and metafemur, anterior aspect, scale = 0.25 mm **26–30** *B. charaxinus* **26** dorsal habitus, scale = 1 mm **27** male genitalia **27** median lobe, right lateral aspect **28** median lobe, ventral aspect **29** right lateral lobe, right lateral aspect **30** left metatrochanter and metafemur, anterior aspect, scale = 0.25 mm **31–34** *B. demarcoi* **31** dorsal habitus, scale = 1 mm **32** male genitalia **32** median lobe, right lateral aspect **33** median lobe, ventral aspect **34** right lateral lobe, right lateral aspect **35–40** *B. elongatus* **35** dorsal habitus, scale = 1 mm **36** male genitalia **36** median lobe, right lateral aspect **37** median lobe, ventral aspect **38** apex of right lateral lobe, apical aspect **39** right lateral lobe, right lateral aspect **40** left metatrochanter and metafemur, anterior aspect, scale = 0.25 mm.

medially apically (Fig. 18). The basal segment of the lateral lobe is broadly obliquely triangular (Fig. 19). The apical segment is broad and obliquely subrectangular with the apex obliquely subtruncate (Fig. 19). Externally, *B. melas* is similar to many other species of *Bidessodes* with relatively unmodified ventral surfaces and legs in males or females. The main difference between this species and others is the male genitalia. The slender, elongate, longitudinally emarginate male median lobe and broad and uniquely shaped lateral lobes (Figs 17–19) are unlike any other species in the genus. This is also one of the smallest species in the genus.

Description. *Measurements*. TL = 1.6–1.7 mm, EW = 0.8–0.9 mm, PW = 0.7–0.8 mm, HW =0.5–0.6 mm, ED = 0.3–0.4 mm, TL/EW = 2.1–2.3, HW/ED = 1.7–1.8. Body shape elongate oval, pronotum widest medially, width somewhat less than greatest width of elytra, lateral outline discontinuous between pronotum and elytron.

Coloration (Fig. 16). Head and pronotum yellow, posterior margin of pronotum medially narrowly brown. Elytron with base color brown with diffuse, transverse pale regions anteriorly, medially and at apex (Fig. 16); surface slightly but distinctly purplish iridescent. Head appendages, legs and ventral surfaces yellow to yellow-orange.

Sculpture and structure (Fig. 16). Head with dorsal surface smooth and shiny, with extremely fine micropunctures. Pronotum (Fig. 16) smooth and shiny with few broadly dispersed micropunctures; lateral margins broadly rounded, pronotum broadest medially, slightly constricted at posterior angles, about same width as greatest width of elytra; basal striae moderately well impressed, extending to nearly 1/2 distance across pronotum. Elytron (Fig. 16) very broadly curved laterally; shiny, finely microreticulate across surface, impunctate. Prosternal process elongate, basally broad and posteriorly convergent to narrowly rounded apex, lateral margins broadly rounded; surface approximately flat. Metaventrite process anteriorly produced with weak lateral carinae that do not extend posteriorly; surface of metaventrite smooth and shiny, not carinate or otherwise modified. Metacoxa with lateral portions shiny, not punctate; metacoxal lines elongate, subparallel. Abdominal ventrites smooth, impunctate; ventrite VI smooth, evenly convex, apically pointed.

Male genitalia. Median lobe in lateral aspect with small basal portion, apical portion elongate, slender, broadly and evenly curved to narrowly rounded apex (Fig. 17); median lobe in ventral aspect deeply bifid into two elongate, slender rami, apically pointed and with apices curved towards each other apically (Fig. 18); lateral lobe in lateral aspect very robust, basal and apical portions similar in length and width, apical portion broad, apically truncate and toothed (Fig. 19).

Sexual dimorphism. Male pro- and mesotarsomeres I-III broader than in female with extensive ventral adhesive setae. Male and female otherwise similar.

Variation. Specimens vary in the intensity and extent of elytral maculae which are not strongly evident in any specimens.

Etymology. This species is named *melas*, Greek for “black” after one of the four horsemen of the apocalypse.

Distribution. This species is known only from southwestern Venezuela (Fig. 98).

Habitat. The type series was collected from leaf pack in slow areas along a sandy forest stream.

Bidessodes acharistus Young, 1986

Figs 21–25, 99

Bidessodes (*Bidessodes*) *acharistus* Young, 1986:217; Biström, 1988:7; Nilsson, 2016:98.

Diagnosis. This species does not have a carinate prosternum in either male or female. The prosternal process is flat and parallel-sided with the apex broadly acuminate. The male mesotibia is basally bent. The male metatrochanter and metafemur are broad, the metafemur is apically truncate with a distinct denticle along the ventral margin near the apex of the metatrochanter (Fig. 25). The male abdominal ventrite VI is apically slightly impressed medially. The male median lobe in lateral aspect is moderately broad basally with an elongate, broadly curved, slender apical portion that is medially somewhat expanded (Fig. 22). In ventral aspect the median lobe is slender and deeply bifid with each ramus sinuate and subapically expanded and ending in a single pointed process (Fig. 23). The basal segment of the lateral lobe is short and oblique (Fig. 24). The apical segment is very broad and has a broad dorsal expansion apically (Fig. 24). Specimens are relatively immaculate (Fig. 21).

Distribution. Known from few localities in Brazil and Bolivia (Fig. 99).

Bidessodes charaxinus **Young, 1986**

Figs 26–30, 99

Bidessodes (*Bidessodes*) *charaxinus* Young, 1986: 213; Biström, 1988: 7; Nilsson, 2016: 98.

Diagnosis. This species does not have a carinate prosternum in either male or female. The prosternal process is impressed longitudinally. The lateral margins are slightly convergent apically to the broadly pointed apex. The male mesotibia is elongate, curved, not basally bent. The male metatrochanter and metafemur are not noticeably modified (Fig. 30). The male abdominal ventrite VI is apically somewhat impressed. The male median lobe in lateral aspect is broad with a broad elongate basal region and an apical region that is broad basally and abruptly tapered to an elongate slender apex with a distinct subapical pointed process representing the apicomedial portion of each ramus (Fig. 27). In ventral aspect the median lobe is complex and deeply bifid with each ramus elongate, broad and apically terminating in two sharply pointed processes, and also with a medial terminal lobe between each lateral ramus (Fig. 28). The basal segment of the lateral lobe is small, irregular, and transverse (Fig. 29). The apical segment is broad and complex, terminating in a broad, transverse structure (Fig. 29). Specimens are relatively large and maculate (Fig. 26).

Distribution. Known from northern South America (Venezuela, Suriname, Guyana, French Guiana) south into Brazil (Fig. 99).

Bidessodes demarcoi **Braga and Ferreira-Jr., 2009**

Figs 31–34, 100

Bidessodes (*Bidessodes*) *demarcoi* Braga and Ferreira-Jr., 2009: 46; Nilsson, 2016: 98.

Diagnosis. *Bidessodes demarcoi* does not have a carinate prosternum in males or females. The prosternal process is relatively flat, the lateral margins are slightly convergent to the broadly pointed apex. The male mesotibia is unmodified. The male metatrochanter and metafemur are not modified. The male abdominal ventrite VI is sulcate apically. The male median lobe in lateral aspect is broad and broadly curved throughout its length to a sinuate, apically truncate apical region (Fig. 32). In ventral aspect the median lobe is moderately broad with each lateral margin straight, apically slightly divergent and rounded with medial shallow emargination (Fig. 33). The lateral lobe in lateral aspect is extremely broad with a broadly rounded basal portion and the apical portion smaller, but broadly rounded (Fig. 34). Specimens are maculate on the elytra (Fig. 31).

Distribution. Known from north-central Brazil (Fig. 100).

Bidessodes elongatus (Sharp, 1882)

Figs 35–40, 101

Bidessus elongatus Sharp, 1882:25; Blackwelder, 1944;76.
Bidessus (*Bidessodes*) *elongatus*, Zimmermann, 1919: 61; 1921: 200.
Bidessodes elongatus, Young: 1969: 2.
Bidessodes (*Bidessodes*) *elongatus*, Young, 1986: 216; Biström, 1988: 7; Nilsson, 2016: 98.

Diagnosis. This species does not have a carinate prosternum in either male or female. The prosternal process is somewhat medially longitudinally sulcate, the lateral margins are slightly convergent to the rounded apex. The male mesotibia is unmodified. The male metatrochanter is medially transversely somewhat ridged, but the metafemur is not noticeably modified (Fig. 40). The male abdominal ventrite VI is apically and laterally slightly impressed. The male median lobe is basally moderately broad and apically robust and strongly curved to a narrowly rounded apex (Fig. 36). In ventral aspect it is broad and laterally broadly sinuate with the apex shallowly emarginate with each ramus short and sharply pointed (Fig. 37). The basal segment of the lateral lobe is small and transverse (Fig. 38). The apical segment is formed as a slender stalk basally with a very large, transverse apical lobe that is abruptly curved on the ventral apex (Fig. 39). Specimens are elongate slender with maculate elytra (Fig. 35).

Discussion. Sharp (1882) mentioned that this species, "… will no doubt form a distinct genus." That eventually proved to be the case as *B. elongatus* became the type of *Bidessodes*.

Distribution. The type locality for this species is somewhat ambiguous. The specimens were evidently collected by Champion, but the localities, "Paso Antonio" and "Tortola" are not easily identified today. In a letter from Champion (http://james-champion.com/diary-2012/thursday-14th-june-2012-letter-13th-march-1881/) he mentions the "Rio Michotoya," which is more easily located, and the star on the map included here reflects that locality (Fig. 101). Known from Guatemala and Costa Rica (Fig. 101).

Bidessodes evanidus **Young, 1986**

Figs 41–45, 102

Bidessodes (*Bidessodes*) *evanidus* Young, 1986: 212; Biström, 1988: 7; Nilsson, 2016: 98.

Diagnosis. This species does not have a carinate prosternum in either male or female. The prosternal process is flat, the lateral margins are slightly convergent to the apically rounded apex. The male mesotibia is unmodified. The male metafemur and metatrochanter are not noticeably modified (Fig. 45). The male abdominal ventrite VI is apically and laterally somewhat impressed. The male median lobe is basally broad, but apically very slender with an apical broad, denticulate expansion (Fig. 42). In ventral aspect it is deeply bifid with each branch slender and apically irregular, and sharply angulate (Fig. 43). The basal segment of the lateral lobe is moderately small and elongate triangular. The apical segment is broad and extremely irregular with a prominent apical, finger-like lobe (Fig. 44). Specimens are elongate oval with the elytra longitudinally vittate (Fig. 41);

Distribution. Known from lowland South America from northern Venezuela to southeastern Brazil (Fig. 102).

Bidessodes fragilis **Régimbart, 1900**

Fig. 103

Bidessodes fragilis Régimbart, 1900: 530; Blackwelder, 1944: 76; Young, 1969: 2.
Bidessus (*Bidessodes*) *fragilis*, Zimmermann, 1919:61;1921:200.
Bidessodes (*Bidessodes*) *fragilis*, Young, 1986: 219; Biström, 1988: 7; Nilsson, 2016: 98.

Diagnosis. According to the original description and Young (1986), this species has the clypeus thickened but not margined, the pronotum has punctation similar to the head, the pronotal plicae extend about 1/3 distance across pronotum, the apex of the prosternal process is truncate, not acuminate, the prosternum and prosternal process are not carinate or spinous, and the last abdominal ventrite is not modified.

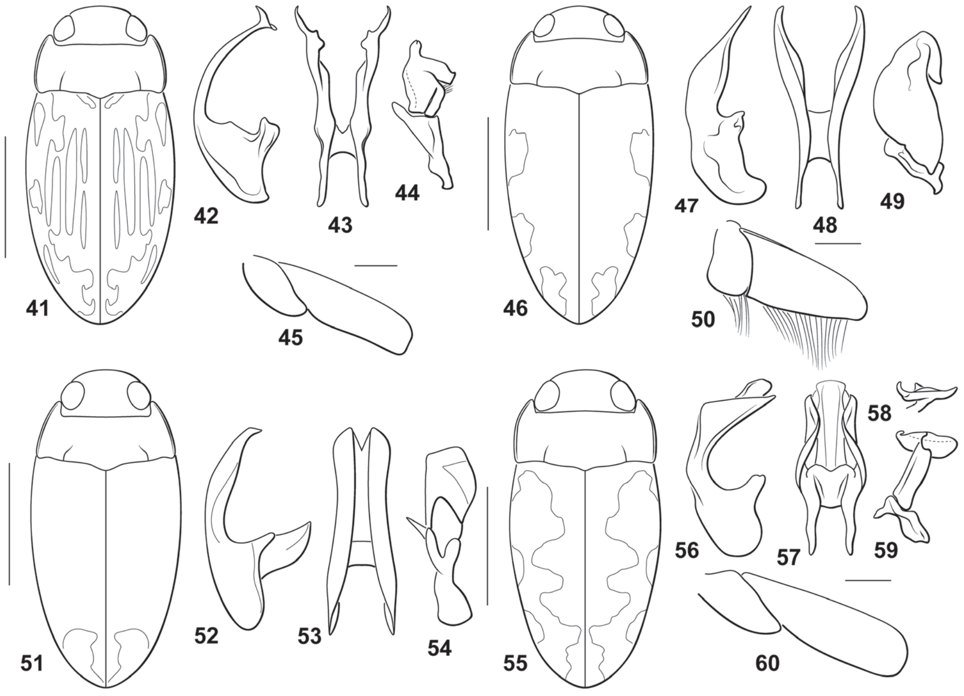
Discussion. The holotype is a female (Young 1986). Young (1986) was unable to identify this species, but thought it close to *B. semistriatus* and *B. knischi*, but also thought *B. acharistus* may represent the species.

Distribution. Only known from the type locality in Paraguay (Fig. 103).

Bidessodes franki **(Spangler, 1981)**

Figs 46–50, 98

Youngulus franki Spangler, 1981:71.
Bidessodes (*Youngulus*) *franki*, Young, 1986: 209; Biström, 1988: 7; Nilsson, 2016: 98.



Figures 41–60. *Bidessodes* species. **41–45** *B. evanidus* **41** dorsal habitus, scale = 1 mm **42** male genitalia **42** median lobe, right lateral aspect **43** median lobe, ventral aspect **44** right lateral lobe, right lateral aspect **45** left metatrochanter and metafemur, anterior aspect, scale = 0.25 mm **46–50** *B. franki* **46** dorsal habitus, scale = 1 mm **47** male genitalia **47** median lobe, right lateral 6spect **48** median lobe, ventral aspect **49** right lateral lobe, right lateral aspect **50** left metatrochanter and metafemur, anterior aspect, scale = 0.25 mm **51–54** *B. hamadae* **51** dorsal habitus, scale = 1 mm **52** male genitalia **52** median lobe, right lateral aspect **53** median lobe, ventral aspect **54** right lateral lobe, right lateral aspect **55–60** *B. hygrobius* **55** dorsal habitus, scale = 1 mm **56** male genitalia **56** median lobe, right lateral aspect **57** median lobe, ventral aspect **58** right lateral lobe apex, apical aspect **59** right lateral lobe, right lateral aspect **60** left metatrochanter and metafemur, anterior aspect, scale = 0.25 mm.

Diagnosis. Males and females do not have a medially modified prosternum. The prosternal process is flat, the lateral margins are convergent to the broadly pointed apex. The male mesotibia is unmodified. *Bidessodes franki* are unique in having males with an extremely broad metatrochanter and metafemur with a distinctive fringe of setae along their posterior margins (Fig. 50). The male abdominal ventrite VI is apically distinctly impressed, and broadly impressed laterally. The male genitalia are distinctive with the median lobe in ventral aspect deeply bifid with each branch unforked and tapered to a point (Fig. 47). In lateral aspect the median lobe is medially very broad and apically strongly tapered and straight to a sharp apex (Fig. 48). The lateral lobe has a reduced basal segment and the apical segment large and irregularly margined with a distinctive lobe on the apicodorsal margin that is directed basally (Fig. 49). Specimens are robust, relatively large and have maculate elytra (Fig. 46).

Distribution. Found across northern South America from central Colombia to southern Suriname (Fig. 98).

Bidessodes hamadae Braga and Ferreira-Jr., 2009

Figs 51–54, 104

Bidessodes (*Bidessodes*) *hamadae* Braga and Ferreira-Jr., 2009: 46; Nilsson, 2016: 98.

Diagnosis. Specimens do not have modified prosternum. The prosternal process is flat with the lateral margins somewhat convex and the apex acuminate. The male mesotibia is bent basally. The metafemur and metatrochanter are unmodified. The male abdominal ventrite VI is impressed and sulcate apically. The male median lobe in lateral aspect is basally elongate with an elongate dorsally-directed flange, the apical portion is elongate, medially slightly expanded but nearly straight with the apex slightly hooked dorsally (Fig. 52). In ventral aspect the median lobe is broad with the lateral rami moderately broad, divergent basally, apically obliquely truncate with medial shallow emargination between the apices (Fig. 53). The lateral lobe has the apical segment irregular, broad and apically truncate. The basal portion is elongate Y-shaped (Fig. 54). Specimens are elongate-slender and relatively immaculate with an indistinct apical pale spot (Fig. 51).

Discussion. Only females were examined for this study and the figures of the male genitalia (Figs 52–54) are redrawn from Braga and Ferreira-Jr. (2009).

Distribution. Known from north-central Brazil (Fig. 104).

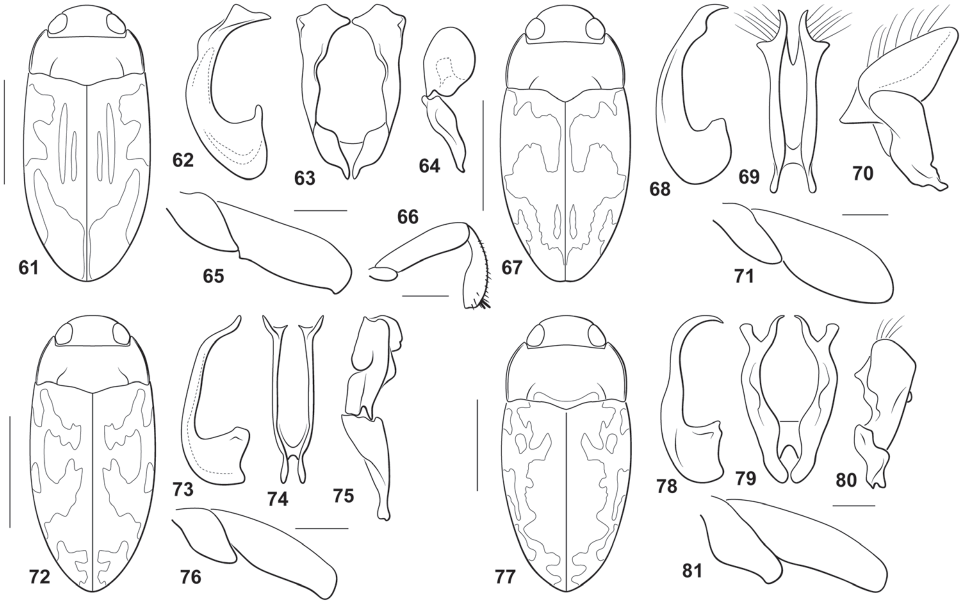
Bidessodes hygrobius Young, 1986

Figs 55–60, 100

Bidessodes (*Bidessodes*) *hygrobius* Young, 1986: 216; Biström, 1988: 7; Nilsson, 2016: 98.

Diagnosis. This species does not have a carinate prosternum in either male or female. The prosternal process is longitudinally approximately flat, the lateral margins are subparallel, the apex is pointed. The male mesotibia and the male metafemur and metatrochanter are not noticeably modified (Fig. 60). The male abdominal ventrite VI is unmodified. The male median lobe is robust in lateral aspect, abruptly curved, apically pointed with a distinct ventral expanded angulation and a subapical projecting lobe with the apex elongate pointed (Fig. 56). In ventral aspect it is similarly robust with sinuate lateral margins (Fig. 57). The basal segment of the lateral lobe is small and irregular (Fig. 58). The apical segment is extremely irregular with a prominent transverse apical lobe which is hooked on the ventral apex (Fig. 59). Specimens are robust with maculate elytra (Fig. 55).

Distribution. Known from lowland Venezuela and French Guiana (Fig. 100).



Figures 61–81. *Bidessodes* species. **61–66** *B. jucundus* **61** dorsal habitus, scale = 1 mm **62** male genitalia **62** median lobe, right lateral aspect **63** median lobe, ventral aspect **64** right lateral lobe, right lateral aspect **65** left metatrochanter and metafemur, anterior aspect, scale = 0.25 mm **66** left mesotrochanter, mesofemur and mesotibia, anterior aspect, scale = 0.25 mm **67–71** *B. knischi* **67** dorsal habitus, scale = 1 mm **68** male genitalia **68** median lobe, right lateral aspect **69** median lobe, ventral aspect **70** right lateral lobe, right lateral aspect **71** left metatrochanter and metafemur, anterior aspect, scale = 0.25 mm **72–76** *B. nessimiani* **72** dorsal habitus, scale = 1 mm **73** male genitalia **73** median lobe, right lateral aspect **74** median lobe, ventral aspect **75** right lateral lobe, right lateral aspect **76** left metatrochanter and metafemur, anterior aspect, scale = 0.25 mm **77–81** *B. obscuripennis* **77** dorsal habitus, scale = 1 mm **78** male genitalia **78** median lobe, right lateral aspect **79** median lobe, ventral aspect **80** right lateral lobe, right lateral aspect **81** left metatrochanter and metafemur, anterior aspect, scale = 0.25 mm.

Bidessodes jucundus Young, 1986

Figs 61–66, 103

Bidessodes (*Bidessodes*) *jucundus* Young, 1986: 209; Biström, 1988: 7; Nilsson, 2016: 98.

Diagnosis. This species does not have a carinate prosternum in either male or female. The prosternal process is longitudinally slightly impressed, the lateral margins are convergent to the pointed apex. The male mesotibia is basally abruptly curved (Fig. 66). The male metafemur is moderately broad and has a distinct denticle along the ventral margin apically and another near the apex of the trochanter (Fig. 65). Unlike other species, the lateral pronotal margins are not strongly curved (Fig. 61). The male abdominal ventrite VI is unmodified. The male median lobe is deeply bifurcate with each branch narrow and apically broadly expanded and spatulate in ventral aspect (Fig. 63). In lateral aspect the median lobe is narrow and abruptly and evenly curved (Fig. 62).

The basal segment of the lateral lobe is very slender and small, and the apical segment is large and broadly round (Fig. 64).

Distribution. The species is known from Brazil and Bolivia (Fig. 103). Young (1986) mentioned a potential specimen from Panama, but this seems unlikely.

Bidessodes knischi **(Zimmermann, 1921)**

Figs 67–71, 104

Bidessus (*Bidessodes*) *knischi* Zimmermann, 1921: 198; Blackwelder, 1944: 76.
Bidessodes knischi, Young, 1969: 2; 1986: 209.
Hughbosdinius leechi Spangler, 1981: 67; synonymy by Young 1986: 206.
Bidessodes (*Hughbosdinius*) *knischi*, Young, 1986: 209; Biström, 1988: 7; Nilsson, 2016: 98.

Diagnosis. This species differs from all other species in having the base of the prosternal process distinctly carinate to tectiform in both sexes. In males the ridge anteriorly is flattened and distinctly setose with those setae anteriorly distinctly forked. This species and *B. obscuripennis* each have the prosternal process basally carinate, at least in males, but they are otherwise rather different. In *B. obscuripennis*, only males are carinate. The prosternal process is flat and broad, the lateral margins are slightly convergent to the broadly rounded apex. Males of *B. knischi* have the metaventrite with a prominent transverse groove. The male mesotibia is unmodified. The male metafemur is very broad and rounded (Fig. 71). The male abdominal ventrite VI is distinctly impressed apically. The male genitalia are distinctive. The median lobe in ventral aspect is apically bifid with each branch obliquely bifurcated (Fig. 69). In lateral aspect the median lobe is broadly curved and apically sharply pointed with a distinct expansion along the ventral margin corresponding with the lateral branch of each bifurcation (Fig. 68). The lateral lobe is extremely broad with the apical segment very large and broadly triangular (Fig. 70). Specimens are large and robust with maculate elytra (Fig. 67).

Distribution. The types were collected from Mato Grosso, Brazil with other specimens collected from lowland areas of South America from Venezuela and Guyana south to Bolivia (Fig. 104).

Bidessodes nessimiani **Braga and Ferreira-Jr., 2009**

Figs 72–76, 102

Bidessodes (*Bidessodes*) *nessimiani* Braga and Ferreira-Jr., 2009: 44; Nilsson 2016: 98.

Diagnosis. This species lacks modifications to the prosternum and male metathoracic legs. The prosternal process is approximately parallel sided with the apex rounded. The male mesotibia is bent basally. The male metafemur and metatrochanter are unmodified (Fig. 76). The male abdominal ventrite VI is unmodified. The male median lobe in lateral aspect is basally small and subtriangular with the apical portion slender, sublinear, medially and apically recurved (Fig. 73). In ventral aspect the median lobe is broad with the lateral rami extremely slender, apically slender and pointed obliquely with medial broad emargination (Fig. 74). The lateral lobe in lateral aspect is long and complex. The apical portion is broad, apically truncate and variously and broadly lobed on dorsal and ventral margins. The basal portion is slender and elongate sub-triangular (Fig. 75). Specimens are broad with maculate elytra (Fig. 72).

Distribution. Known from north-central Brazil (Fig. 102).

***Bidessodes obscuripennis* (Zimmermann, 1921)**

Figs 77–81, 100

Bidessus (*Bidessodes*) *obscuripennis* Zimmermann, 1921: 19; Blackwelder 1944: 76.
Bidessodes obscuripennis, Young 1969: 2.
Bidessodes (*Hughbosdinius*) *obscuripennis*, Young 1986: 209; Biström 1988: 7; Nilsson 2016: 98.

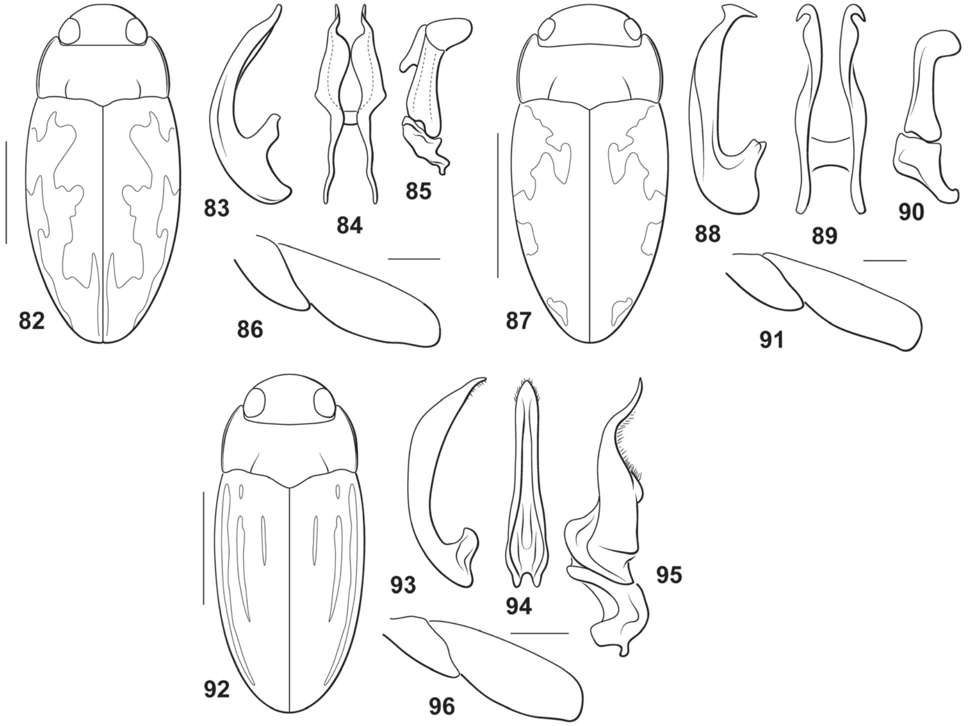
Diagnosis. The species differs from others in having the prosternal process anteriorly carinate with distinctive setae in males. Females have the prosternal process unmodified. This species and *B. knischi* each have the prosternal process basally carinate, at least in males, but they are otherwise rather different. The prosternal process is narrow, flat, with the lateral margins slightly convergent to the pointed apex. The metaventrite is not transversely grooved. The male mesotibia is unmodified. The metatrochanter in males is exceptionally large, distinctly offset and prominent apically (Fig. 81). The male abdominal ventrite VI is apically broadly impressed. The male genitalia are also distinctive. In lateral aspect the median lobe is slender and apically abruptly curved (Fig. 78). In ventral aspect the median lobe is deeply bifid, each branch ending in a bifurcation. The medial branch of each bifurcation is sinuate and apically pointed, the lateral branch is broad and apically subtruncate (Fig. 79). The lateral lobe has the apical segment extremely broad and irregularly margined (Fig. 80). Specimens are robust with complex maculae on the elytra (Fig. 77).

Distribution. Known from Guyana and western Brazil (Fig. 100).

***Bidessodes semistriatus* Régimbart, 1900**

Figs 82–86, 100

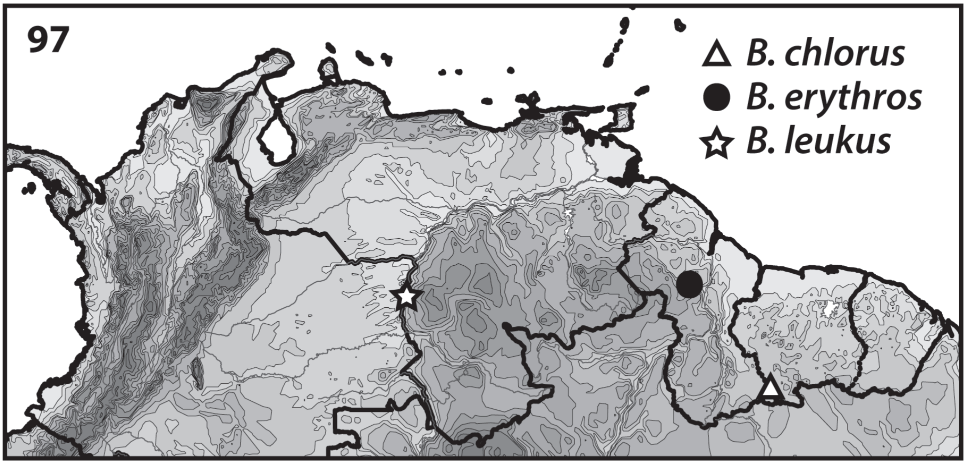
Bidessodes semistriatus Régimbart, 1900: 529; Blackwelder 1944: 76.
Bidessus (*Bidessodes*) *semistriatus*, Zimmermann, 1919: 61;1921: 200.
Bidessodes (*Bidessodes*) *semistriatus*, Young 1986: 213; Biström, 1988: 7; Nilsson, 2016: 98.

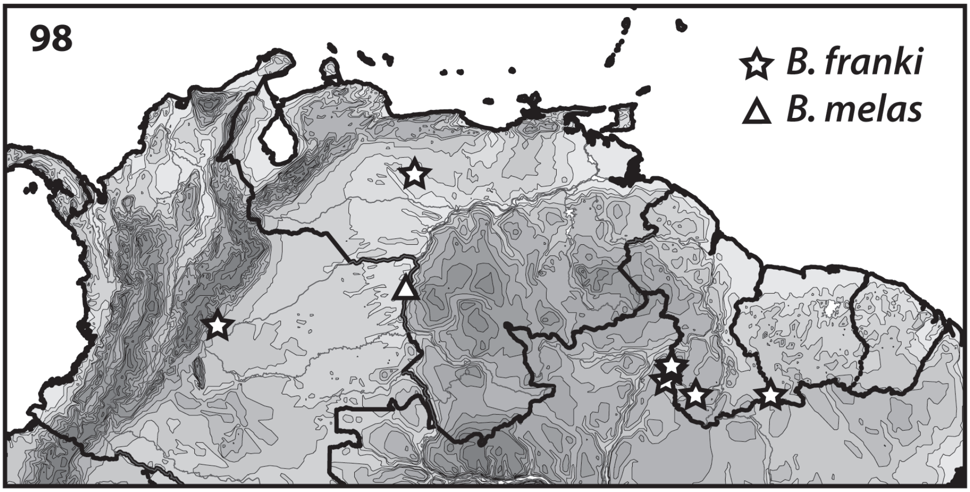


Figures 82–96. *Bidessodes* species. **82–86** *B. semistriatus* **82** dorsal habitus, scale = 1 mm **83** male genitalia **83** median lobe, right lateral aspect **84** median lobe, ventral aspect **85** right lateral lobe, right lateral aspect **86** left metatrochanter and metafemur, anterior aspect, scale = 0.25 mm **87–91** *B. subsignatus* **87** dorsal habitus, scale = 1 mm **88** male genitalia **88** median lobe, right lateral aspect **89** median lobe, ventral aspect **90** right lateral lobe, right lateral aspect **91** left metatrochanter and metafemur, anterior aspect, scale = 0.25 mm **92–96** *B. zimmermanni* **92** dorsal habitus, scale = 1 mm **93** male genitalia **93** median lobe, right lateral aspect **94** median lobe, ventral aspect **95** right lateral lobe, right lateral aspect **96** left metatrochanter and metafemur, anterior aspect, scale = 0.25 mm.

Diagnosis. This species lacks a carinate and spinous prosternum in males and females. The prosternal process is narrow, flat, with the lateral margins subparallel with the apex rounded. The male mesotibia, metafemur and metatrochanter are not modified (Fig. 86). The male abdominal ventrite VI is apically impressed. The male median lobe in lateral aspect is evenly curved (Fig. 83). In ventral aspect the median lobe is deeply bifid and broad, with the lateral rami broad and apically slender, sinuate and apically pointed (Fig. 84). The lateral lobe in lateral aspect is apically broadly T-shaped with the dorsal portion of the "T" broadly lobate (Fig. 85). Specimens are elongate-slender with maculate elytra (Fig. 82).

Distribution. Known from Guyana, Suriname and Brazil (Fig. 100).



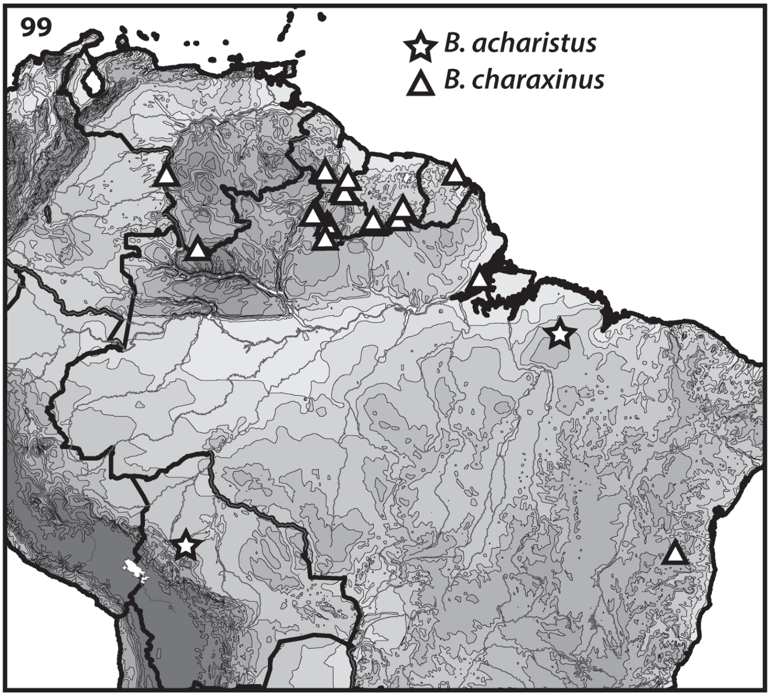


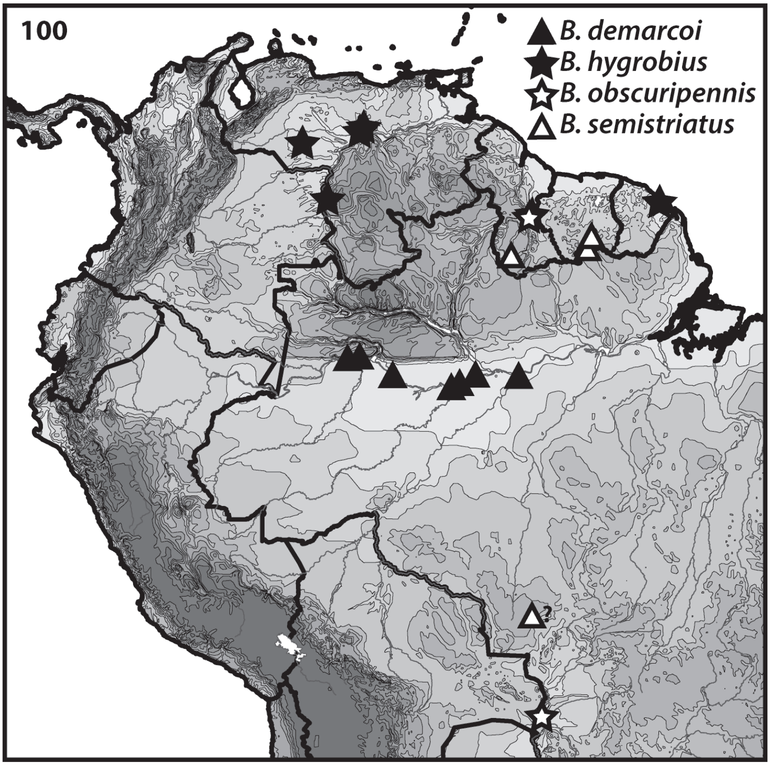
Figures 97–98. Distributions of *Bidessodes* species based on examined specimens and published records.

Bidessodes subsignatus **(Zimmermann, 1921)**
Figs 87–91, 103

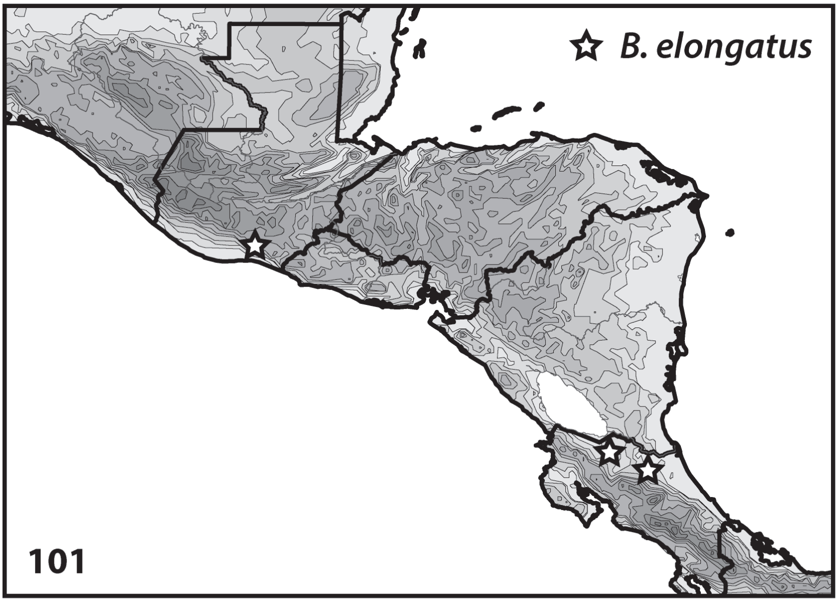
Bidessus (*Bidessodes*) *subsignatus* Zimmermann, 1921: 199; Blackwelder, 1944: 76.
Bidessodes subsignatus, Young, 1969: 2.
Bidessodes (*Bidessodes*) *subsignatus*, Young, 1986: 213; Biström, 1988: 7; Nilsson, 2016: 98.

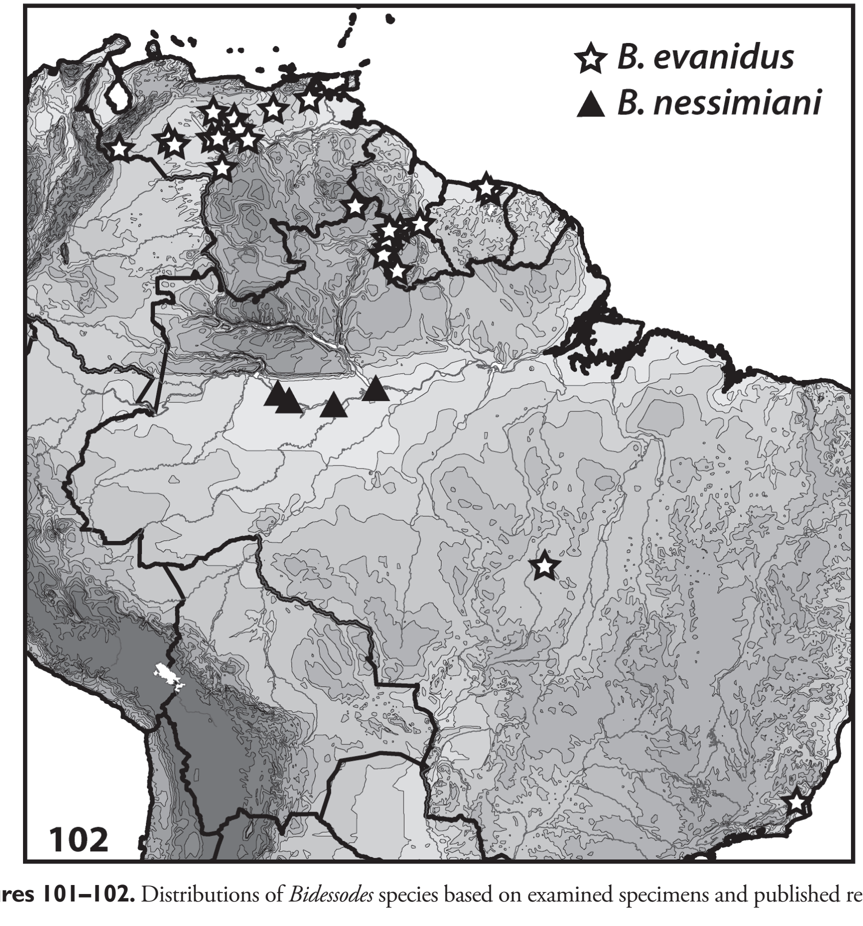
Diagnosis. This species lacks a carinate and spinous prosternum in either sex. The prosternal process is flat, the lateral margins are slightly convergent to the pointed apex. The male mesotibia is unmodified. The male metafemur and metatrochanter are unmodified (Fig. 91). The male abdominal ventrite VI is deeply indented laterally and apically impressed. The male median lobe in lateral aspect is slender and only slightly curved through most of its length to the apex which is abruptly curved and sharply





Figures 99–100. Distributions of *Bidessodes* species based on examined specimens and published records.





Figures 101–102. Distributions of *Bidessodes* species based on examined specimens and published records.

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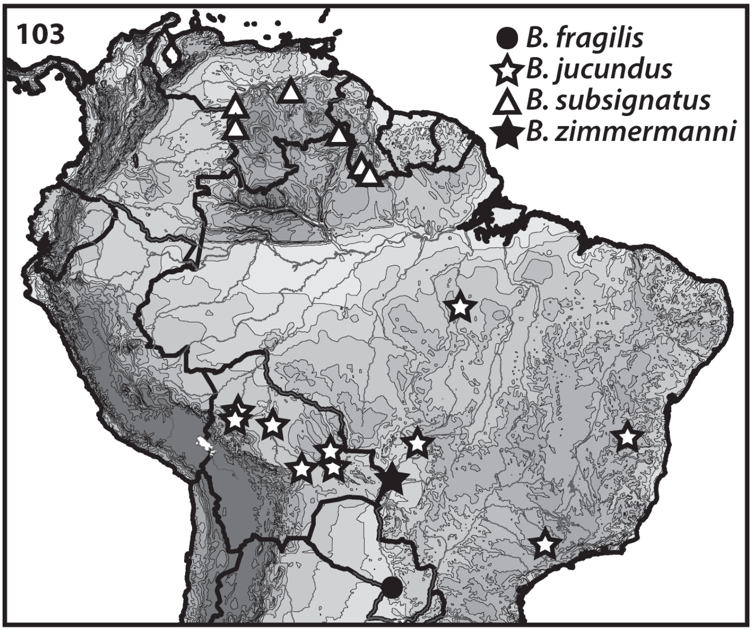

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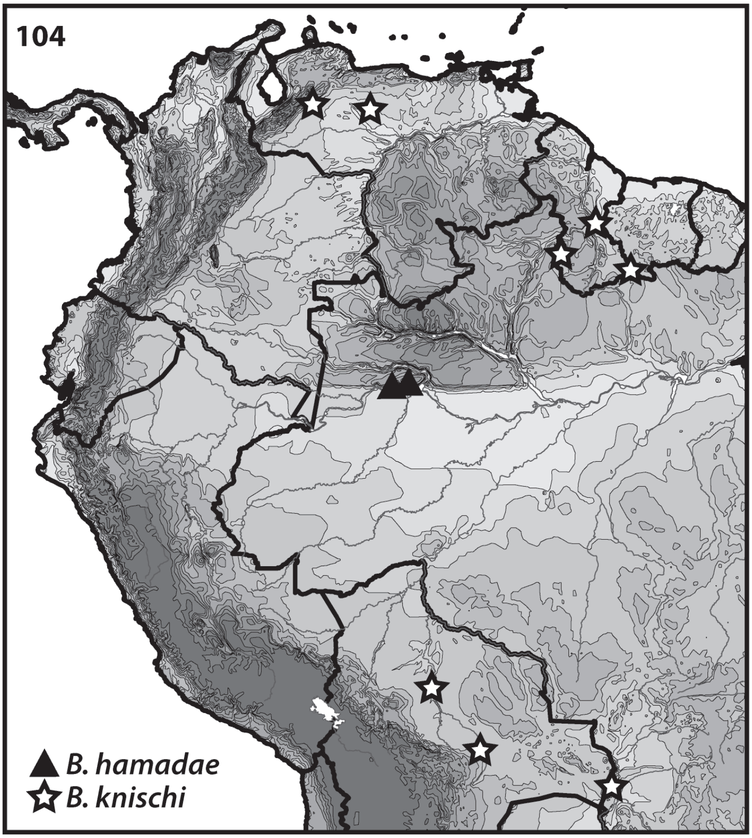

Figures 103–104. Distributions of *Bidessodes* species based on examined specimens and published records.

pointed with a subapical tooth (Fig. 88). In ventral aspect the median lobe is deeply bifid with irregular lateral rami which terminate apically in laterally directed hooks (Fig. 89). The lateral lobe in lateral aspect has a small basal portion with the apical portion moderately large, and apically with a broad dorsally directed rounded lobe (Fig. 90). This is a small species, only about 2 mm in length, with maculate elytra (Fig. 87).

Distribution. Known from Venezuela, Guyana and Brazil (Fig. 103).

Bidessodes zimmermanni **Hájek, 2012**

Figs 92–96, 103

Bidessus (*Bidessodes*) *plicatus* Zimmermann, 1921: 199; Blackwelder, 1944: 76; preoccupied, replaced by *Bidessodes zimmermanni* Hájek, 2012.
Bidessodes plicatus, Young, 1969: 2.
Bidessodes (*Bidessodes*) *plicatus*, Young, 1986: 218; Biström, 1988: 7.
Bidessodes zimmermanni Hájek, 2012: 67; Nilsson, 2016: 98; replacement for *Bidessus plicatus* Zimmermann, 1921.

Diagnosis. This species lacks a carinate and spinous prosternum in males and females. The terminal visible abdominal ventrite is broadly impressed apically. The male mesofemur is apically somewhat swollen. The male mesotibia is basally bent. The male metatibia and metatrochanter are relatively unmodified (Fig. 96). The male median lobe in lateral aspect is evenly curved, somewhat expanded medially and apically narrowly rounded (Fig. 93). In ventral aspect the median lobe is narrow and apically simple with short setae (Fig. 94). The lateral lobe in lateral aspect has the basal segment short and irregularly sinuate, the apical portion is extremely large, elongate subtriangular and sinuate with the apex sharply pointed (Fig. 95).

Distribution. This species is only known from Mato Grosso, Brazil (Fig. 103).

Checklist of species in *Bidessodes*

Bidessodes **Régimbart, 1895**

B. acharistus Young, 1986
B. charaxinus Young, 1986
B. chlorus **sp. n.**
B. demarcoi Braga & Ferreira-Jr., 2009
B. elongatus (Sharp, 1882) (*Bidessus*)
B. erythros **sp. n.**
B. evanidus Young, 1986
B. fragilis Régimbart, 1900
B. franki (Spangler, 1981) (*Youngulus*)
B. hamadae Braga & Ferreira-Jr., 2009

B. hygrobius Young, 1986
B. jucundus Young, 1986
B. knischi (Zimmermann, 1921) (*Bidessus*)
  =*Hughbosdinius leechi* Spangler, 1981
B. leukus **sp. n.**
B. melas **sp. n.**
B. nessimiani Braga & Ferreira-Jr., 2009
B. obscuripennis (Zimmermann, 1921) (*Bidessus*)
B. semistriatus Régimbart, 1900
B. subsignatus (Zimmermann, 1921) (*Bidessus*)
B. zimmermanni Hájek, 2012
  =*Bidessus plicatus* Zimmermann, 1921

Acknowledgements

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RESEARCH ARTICLE

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Two genera of Mymaridae (Hymenoptera) new to Africa, a remarkable new species of *Anaphes* and new generic synonymy

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Abstract

Bakkendorfia Mathot, **syn. n.** is placed in synonymy under *Cleruchus* Enock and its only described species transferred as *Cleruchus musangae* (Mathot), **comb. n.** *Anaphes quinquearticulatus* Huber & Triapitsyn, **sp. n.** is described; it is the only known *Anaphes* Haliday species with a 5-segmented funicle in females. Two genera are reported for the first time from the Afrotropical region and two species are described: *Paranaphoidea* (*Idiocentrus*) *africana* Huber & Triapitsyn, **sp. n.**, and *Allanagrus occidentalis* Huber & Triapitsyn, **sp. n**.

Keywords

Mymaridae, *Paranaphoidea*, *Cleruchus*, *Allanagrus*, central Africa, taxonomy

Introduction

While studying specimens representing many species of Mymaridae (Hymenoptera: Chalcidoidea) from the Afrotropical region in preparation for an illustrated identification key to the genera occurring in the region we discovered that *Bakkendorfia* Mathot is an unrecognized junior synonym, which we place in the proper synonymy. A new species of *Anaphes* Haliday is also described because it has some remarkable unusual features that expand the generic definition of the genus. Finally, we also describe one new species in each of the two genera not previously reported for the region: *Paranaphoidea* Girault and *Allanagrus* Noyes & Valentine.

Methods

Specimens of the new species were all slide mounted in Canada balsam. Absolute measurements are given in micrometers, converted from filar micrometer eyepiece measurements. However, ratios for the body parts of each specimen were first determined from filar eyepiece micrometer measurements of length and width in order to find the minimum and maximum ratio for each antennal segment. The measurements were then converted to micrometers. Because of rounding errors, it appears that the ratios are slightly incorrect compared to those that are calculated using the absolute measurements (micrometers) but, in fact, they are more accurate and are therefore given in the species descriptions. Specimens are deposited in the Natural History Museum, London, England, UK (**BMNH**), the Canadian National Collection of Insects, Arachnids and Nematodes, Ottawa, Ontario, Canada (**CNC**), and the Entomology Research Museum, University of California, Riverside, California, USA (**UCRC**). Photographs were taken with a ProgRes C14^{plus} digital camera attached to a Nikon Eclipse E800 compound microscope, and a selection of the resulting layers combined electronically in Zerene Stacker™. Abbreviations used in the descriptions are: $\mathbf{fl}_x$ for funicle segment, $\mathbf{gt}_x$ for gastral tergum and mps for multiporous plate sensilla.

Taxonomy

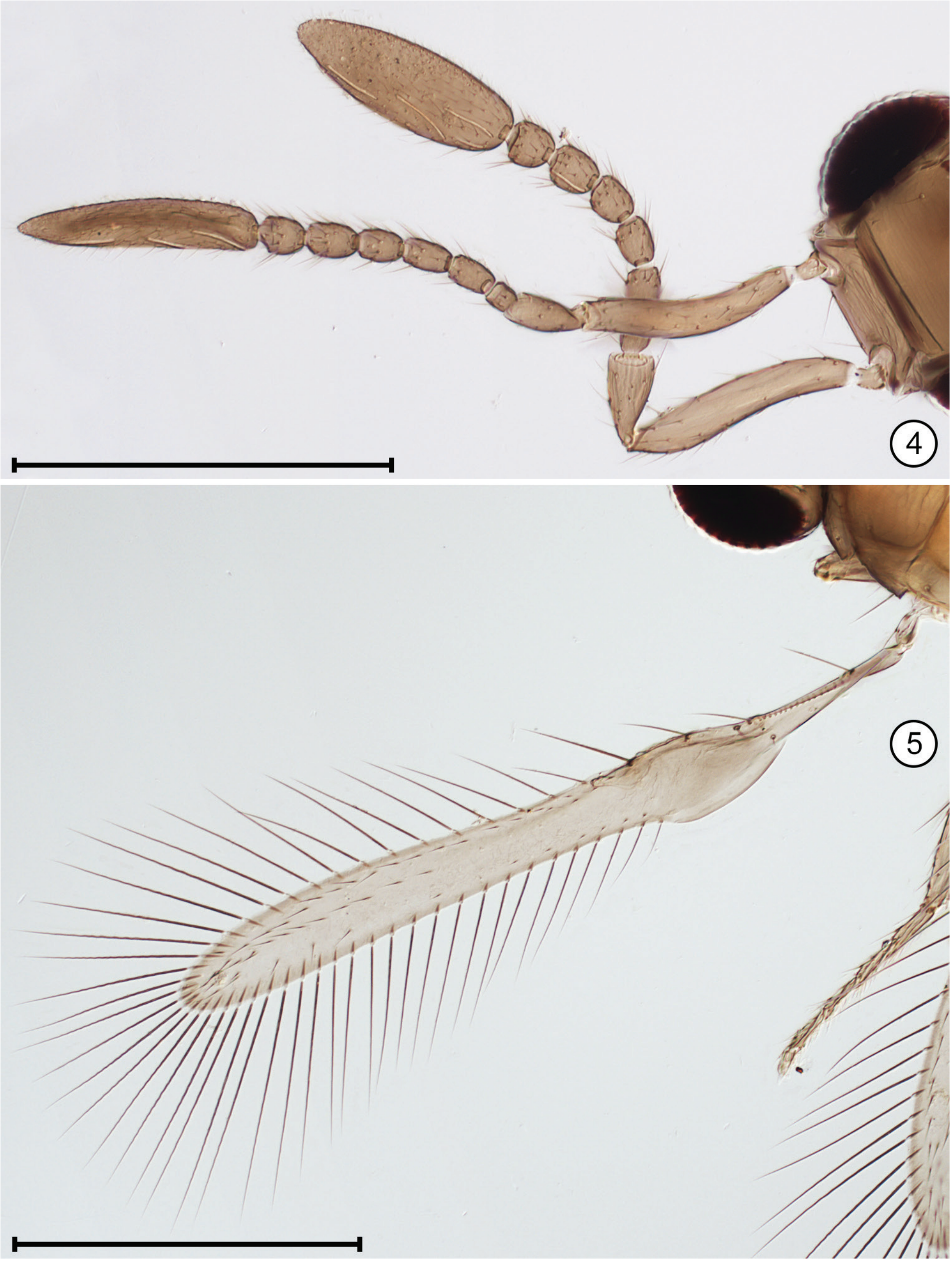
Cleruchus Enock, 1909

Bakkendorfia Mathot, 1966. **Syn. n.**
Douttiella Annecke, 1961. Synonymy under *Cleruchus* by Noyes & Valentine, 1989: 31.
Eucleruchus Ogloblin, 1940. Synonymy under *Cleruchus* by Luft Albarracin et al., 2009: 26.
Haplochaeta Noyes & Valentine, 1989. Synonymy under *Cleruchus* by Lin et al., 2007: 29.
Paracleruchus Yoshimoto, 1971. Synonymy under *Cleruchus* by Viggiani, 1974: 88.
Stenopteromymar Ferrière, 1952. Synonymy under *Cleruchus* by Viggiani, 1974: 88.

Type species. *Cleruchus pluteus* Enock.

The worldwide genus *Cleruchus* contains a variety of species known as parasitoids of Coleoptera (Triapitsyn et al. 2013, Barnes 2014). *Bakkendorfia* contains only one described species, *B. musangae* Mathot that Mathot (1966) treated as being

Figures 1–3. *Cleruchus musangae* (Mathot), holotype habitus **1** dorsal **2** ventral, as seen through body from above **3** holotype slide. Scale bar: 500 µm.



Figures 4, 5. *Cleruchus musangae* (Mathot), holotype **4** antennae **5** fore wing. Scale bars: 200 µm.

related to *Parallelaptera* Enock (now a subgenus of *Erythmelus* Enock) based on a large hypopygium. While this is one defining feature of *Erythmelus*, Mathot's species differs from *Erythmelus* in many other respects, particularly in the structure of the head and mandibles.

Figure 6. *Cleruchus biciliatus* (Ferrière), paratype habitus. Scale bar: 500 µm.

We examined the type series (Fig. 3, holotype slide) and found that *Bakkendorfia* matches *Cleruchus* in all its features. We therefore transfer the type species to *Cleruchus* as *C. musangae* (Mathot), comb. n., and illustrate it. Features that define *Cleruchus* include: posterior ocelli widely separated and close to the eye margins, forming a low ocellar triangle (Fig. 1); frenum transverse and somewhat oval in shape (Fig. 1); head in lateral view with a distinctly bulging face; and mandible with 2 teeth. Females have a short ovipositor (Fig. 2) and large clava almost as long as the relatively short funicle, the individual segments of which are usually more or less quadrate (Figs 1, 2, 4). The most obvious generic feature, a parallel-sided fore wing with few microtrichia on its surface and a slightly widened and curved stigmal vein (Fig. 5), is one that is not always present because the degree of wing development varies considerably among species of *Cleruchus*. Wingless species have been described (Yoshimoto 1971, Triapitsyn et al. 2013, Triapitsyn 2014a) and among fully winged species, the fore wing of *C. biciliatus* (Ferrière) has a greatly reduced surface and only two (or sometimes four) long marginal setae and the hind wing is greatly shortened, without marginal setae (Fig. 6).

Anaphes Haliday, 1833

Extensive synonymy given in Huber (1992).

Type species. A formal decision by ICZN on the correct type species to use is pending so the species in not named here. See petition by Huber et al. (2011) and comments and corrigendum (Huber 2014).

The worldwide genus *Anaphes* contains a variety of species known as parasitoids of several insect orders, summarized in Huber (1986). Features that define *Anaphes* include: fore wing with socketed seta present at apex of frenal fold; propodeum with a median longitudinal groove; petiole short, almost vertical, much wider than long crescent closely appressed to gt_1; and gt_1 longitudinally divided medially.

Anaphes quinquearticulatus Huber & Triapitsyn, sp. n.

http://zoobank.org/28FA1177-48E1-4F82-A67A-36B01C59705D
Figs 7–16

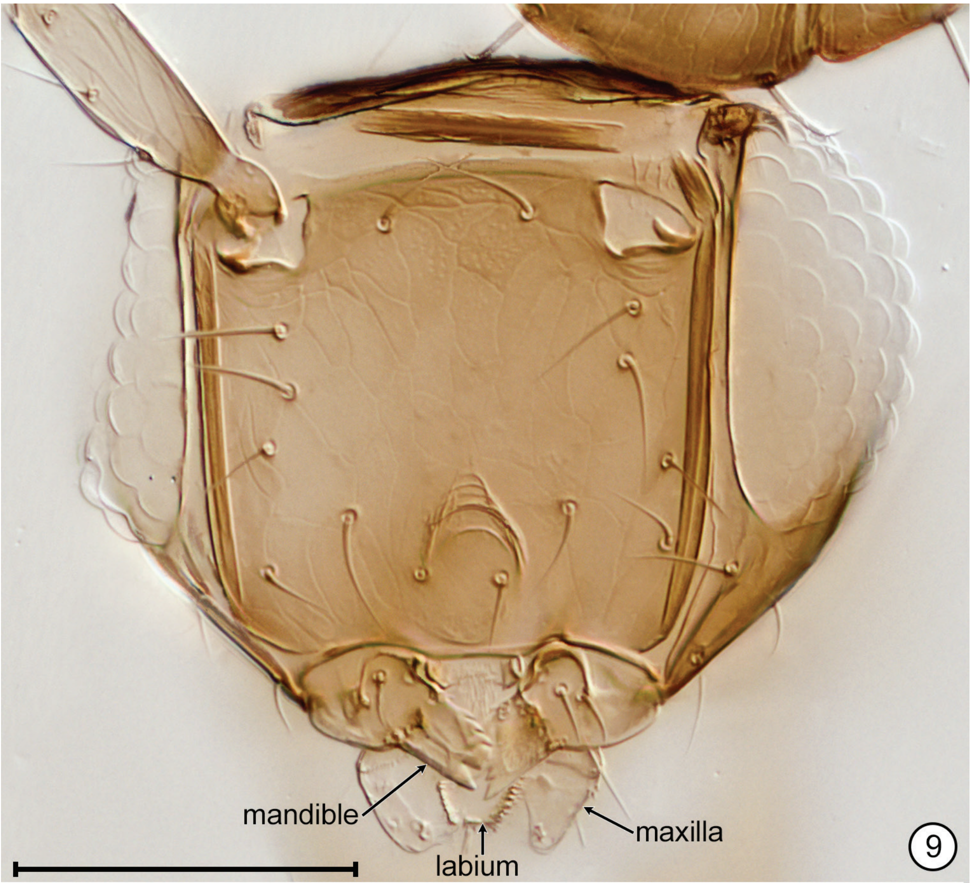
Type material. Holotype female (UCRC) on slide (Fig. 16) labelled: 1. “Anaphes quinquearticulatus Huber & Triapitsyn ♀ dorsal Holotype”. 2. “Rep. Congo: Pool Abio, Lesio-Louna Park, 3°6'1"S, 15°31'26"E 29.vii.2008 Sharkey MT”. 3.“Univ. Calif. Riverside Ent. Res. Museum UCRC Ent. 264592”. 4. “Mounted at UCR/ERM by V.V. Berezovskiy 2008 in Canada balsam”. Paratypes: 3 females. REPUBLIC OF THE CONGO. Pool. Lesio-Louna Wildlife Reserve, Abio, 330 m, 3°06.020'S, 15°31.440'E, 29.vii.2008, M. Sharkey & Y. Braet, MT (1 female, UCRC); Iboubikro, 3°16'11"S, 15°28'16"E, 23.vii.2008, M. Sharkey, MT (2 females, CNC, UCRC).

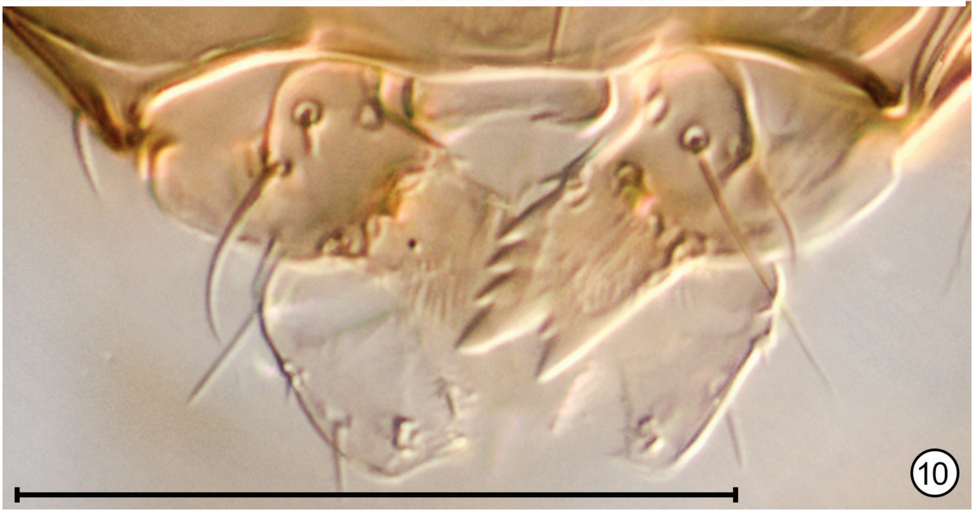
Diagnosis. Female. Funicle 5-segmented (Figs 8, 15), with 1 mps on fl_1–fl_4 and 2 mps on fl_5 (Fig. 8), the mps unusually wide (Figs 7, 8). Mandible with 5 teeth (Figs 9, 10).

This species is unique among *Anaphes* in having only five funicle segments, instead of six as in all other described species. Otherwise, *A. quinquearticulatus* has all the diag-

Figures 7, 8. *Anaphes quinquearticulatus*, holotype **7** head + mesosoma **8** antennae. Scale bars: 100 µm.

nostic features (listed above) of *Anaphes*. Because fl_1 bears a distinct mps and is as long as any of the remaining segments it is almost certain that the first funicle segment in *A. quinquearticulatus*, not some other segment, was lost, i.e., fl_1 in this species is equivalent to fl_2 in any other *Anaphes* species. This is because fl_1 in females of all other *Anaphes* never have mps and is almost always distinctly shorter than fl_2 or any other segment. The fore wing almost devoid of surface microtrichia is also unique; the single line of microtrichia present represents the line that separates the marginal from the medial spaces in any other *Anaphes* species. The narrow evenly curved fore wing is also interesting; it is most similar to undescribed *Anaphes* species found near water in the Oriental region.





Figures 9, 10. *Anaphes quinquearticulatus*, paratype **9** head, anterior showing other mandible **10** mouthparts. Scale bars: 50 µm.

Description. Female. Body length 255–358 (n=4, slide specimens) (dry length of one paratype before slide mounting 264). Dark brown (presumably), appendages apparently lighter in colour (cleared specimens so colour not really known). Fore wing margin in apical half narrowly but distinctly margined with brown, otherwise with faint uniform brown suffusion over most of surface except partly behind venation.

Head. Head width 123–135 (n=3). Face with 7 setae on each side (Fig. 9) and with faint reticulate sculpture. Mouthparts (Figs 9, 10) with mandible about as long as maxilla and with 5 teeth, the two ventral ones large, the 3 dorsal ones small and in one specimen a small tooth between the large ventral ones (Figs 9, 10). Occiput with vertexal suture (= supraorbital suture extension onto occiput) long and in line with supraorbital trabecula, only weakly diverging from posterior eye margin.

Antenna. Scape on inner surface and pedicel with longitudinally reticulate sculpture; funicle 5-segmented, with 1 mps on fl_1–fl_4 and 2 mps on fl_5 (Fig. 8, 15), the mps unusually wide (Figs 7, 8); clava with 6 mps. Measurements (length/width, n = 3 or 4) of antennal segments: scape 53–60/12–16, pedicel 29–34/20–22, fl_1 35–37/11–12, fl_2 33–35/10–12, fl_3 32–34/10–11, fl_4 33–35/10–12, fl_5 38–42/13–16, clava 79–86/19–23. Length/width ratios of antennal segments: scape 3.29–4.26, pedicel 1.52–1.66, fl_1 3.10–3.41, fl_2 3.19–3.63, fl_3 3.04–3.44, fl_4 3.04–3.48, fl_5 2.60–2.79, clava ≈3.69–4.55 (clava not always oriented in perfect lateral view).

Mesosoma. Mesoscutum width 82–90 (n=3), with coarse reticulate sculpture, the cells irregularly shaped but more longitudinally stretched on midlobe, more isodiametric anteriorly on lateral lobe (Fig. 7); scutellum with coarse reticulate sculpture, the cells smaller on anterior scutellum, larger and more transversally stretched on frenum (Fig. 7); dorsellum apparently smooth (Figs 11, 12; propodeum with sculpture as on frenum (Figs 11, 12). Mesoscutal midlobe and axilla with relatively long setae.

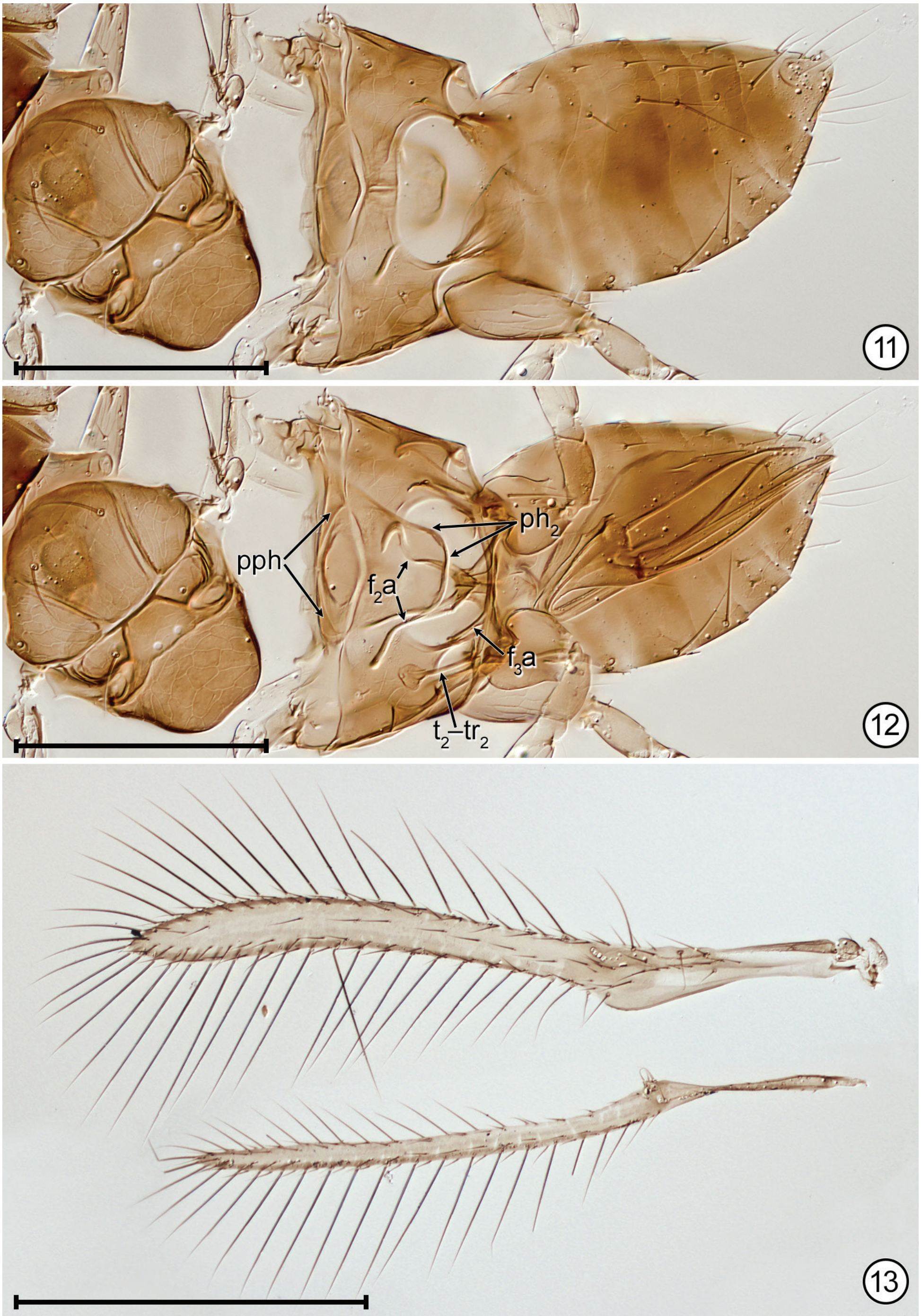
Wings. Fore wing narrow, beyond level of venation with evenly concave posterior margin and surface with one row of about 10 microtrichia extending from stigmal vein almost to wing apex and a second row extending proximally from socketed seta at apex of frenal fold to just past base of parastigma (Fig. 13). Hind wing without microtrichia on surface between the usual anterior and posterior rows. Fore wing length (n=4) 394–428, width 30–33, length/width 13.0–13.5, longest marginal setae ≈106–127. Hind wing length 376–414, width 13–15, longest marginal setae 86–94.

Legs. Metatarsomere 1 0.78–0.92 × as long as metatarsomere 2 (Fig. 14).

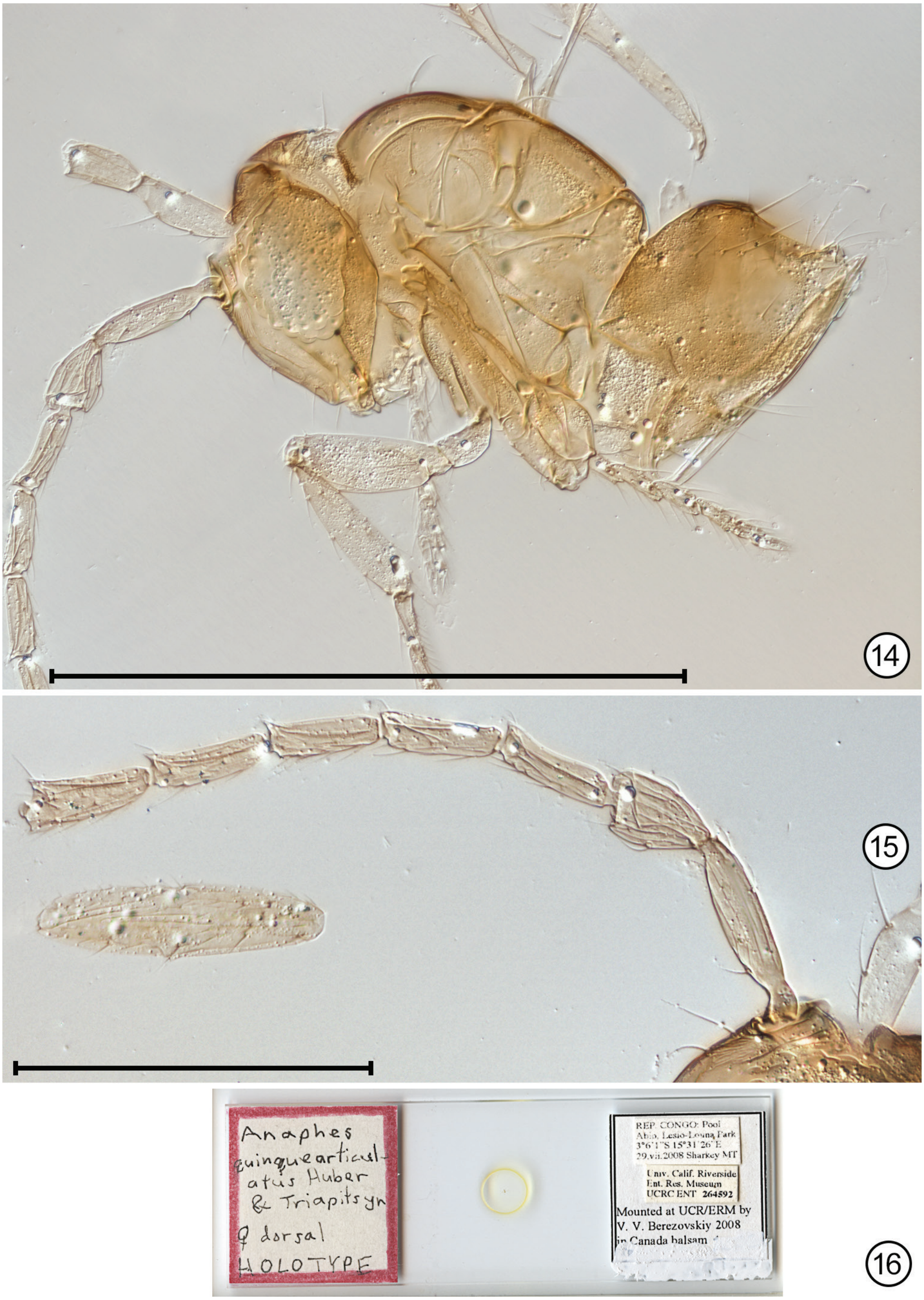
Metasoma. Ovipositor length 124–129 (n=4), 1.13–1.20 × as long as metatibia length (104–114) and extending slightly forward of junction between mesosoma and metasoma (Fig. 14, gaster slightly crushed and poorly oriented).

Male. Unknown.

Derivation of species name. Latin for five + articulated; an adjective referring to the unique 5-segmented funicle, the first *Anaphes* to be described with this reduced antennal segmentation.



Figures 11–13. *Anaphes quinquearticulatus.* **11** holotype mesosoma + metasomadorsal **12** holotype mesosoma + metasoma, ventral as seen through body **13** paratype wings. Scale bars: 100 µm (**11, 12**), 200 µm (**13**).



Figures 14–16. *Anaphes quinquearticulatus.* **14** paratype, lateral habitus **15** antenna **16** holotype slide. Scale bars: 500 µm (**14**), 100 µm (**15**).

Paranaphoidea Girault, 1913

Idiocentrus Gahan, 1927: 35. Proposed as a subgenus and synonymized under *Paranaphoidea* by Lin et al., 2007: 43.

Type species. *Paranaphoidea egregia* Girault.

Paranaphoidea contains several described species in Australia (Noyes & Valentine 1989) and one in New Zealand, *P. mira* (Gahan), that was supposedly reared from *Melampsalta muta* Fabricius (Hemiptera: Cicadidae) (Gahan 1927). The species name of *P.* (*Idiocentrus*) *mira*, which was transferred to *Paranaphoidea* by an implied combination at the time of generic synonymy of *Idiocentrus* by Lin et al. (2007), is an adjective and consequently is being treated here to properly match the feminine gender of *Paranaphoidea*. Features that define *Paranaphoidea* include: clava 2- or 3-segmented; face with subantennal groove extending ventrally from each torulus; occiput with a transverse curved groove from eye to eye and medially above foramen; ovipositor projecting anteriorly under mesosoma; and frenum medially divided by a shallow longitudinal groove. The fore wing apex is truncate or rounded and the hind wing is relatively wide in most, but not all, Australian species compared to the rounded fore wing apex and relatively narrow hind wing in the New Zealand species. The ovipositor projects forward under the mesosoma to varying degrees in Australian species and beyond the front of the head in the New Zealand species and also in one undescribed *P.* (*Idiocentrus*) sp. from Western Australia (UCRC). The two subgenera are most easily separated by the number of segments in the clava, either two in *P.* (*Paranaphoidea*), as in all the Australian species described so far, or three in *P.* (*Idiocentrus*), as in the single described New Zealand species.

Even taking into account two specimens (CNC) of an unidentified species of *P.* (*Idiocentrus*) from Thailand, the presence of a species of *P.* (*Idiocentrus*) in West Africa represents a huge extension in range of *Paranaphoidea*. We thought perhaps that the African specimen was either mislabelled or was accidentally introduced but these possibilities seem unlikely. Other cases of wide ranges in representatives of a genus initially known to occur only in one region are not uncommon in Mymaridae, e.g., *Chrysoctonus* Mathot (Huber & Triapitsyn 2015), and intensive collecting eventually results in more specimens of different (or sometimes the same) species from intervening areas being discovered. We treat the specimen below as a new species even though it is extremely similar to *P. mira* from New Zealand. The recorded host of *P. mira*, *Melampsalta muta* is now in *Kikihia* Dugdale, all of whose species are endemic to New Zealand. It would be interesting to discover the host(s) of *Paranaphoidea* species that occur outside of New Zealand.

***Paranaphoidea* (*Idiocentrus*) *africana* Huber & Triapitsyn, sp. n.**

http://zoobank.org/8D8E3FC0-1475-4C6F-A11A-36F3FF5ED373

Figs 17–24

Type material. Holotype female (UCRC) on slide (Fig. 17) labelled: 1. "Paranaphoidea africana Huber & Triapitsyn ♀ lateral Holotype". 2. "Nigeria: Osun State Ile-Ife, 215m, MT Obafemi Awololo [sic] Univ. 7°31'16"N, 4°31'20"E". 3. "UCRC Mounted by V.V. Berezovskiy 2015 in Canada balsam JDR 2016-818".

Diagnosis. Female. Clava 3-segmented (division between segment 1 and 2 faint), fl_1 1.54 × as long as fl_2 and without mps (Fig. 24). *Paranaphoidea africana* differs in claval segmentation from the Australian species of *P.* (*Paranaphoidea*), all of which have a 2-segmented clava. It is most similar to *P.* (*Idiocentrus*) *mira* from New Zealand. It differs from a non-type specimen (in CNC) of *P. mira* by its fore wing wider (narrower in *P. mira*, with length/width = 4.88), the hind wing uniformly narrow from apex of venation to just before wing apex and length/width = 16.3 (hind wing slightly wider towards apex, with length/width = 13.7 in *P. mira*).

Description. Mesosoma + metasoma length 1180 (head mounted face view so its length cannot be measured). Body brown (presumably) except frenum yellowish; upper half of occiput, pedicel, and perhaps also pronotum laterally, propodeum laterally and metapleuron lighter brown; legs except coxae lighter than body (cleared specimen so colour not really known) (Figs 18, 22, 23). Fore wing margin narrowly but distinctly margined with brown, otherwise with faint uniform brown tinge behind submarginal vein and parastigma (except narrowly immediately behind submarginal vein) and along proximal third of hind margin. Hind wing with apical half slightly suffused with brown (Fig. 19).

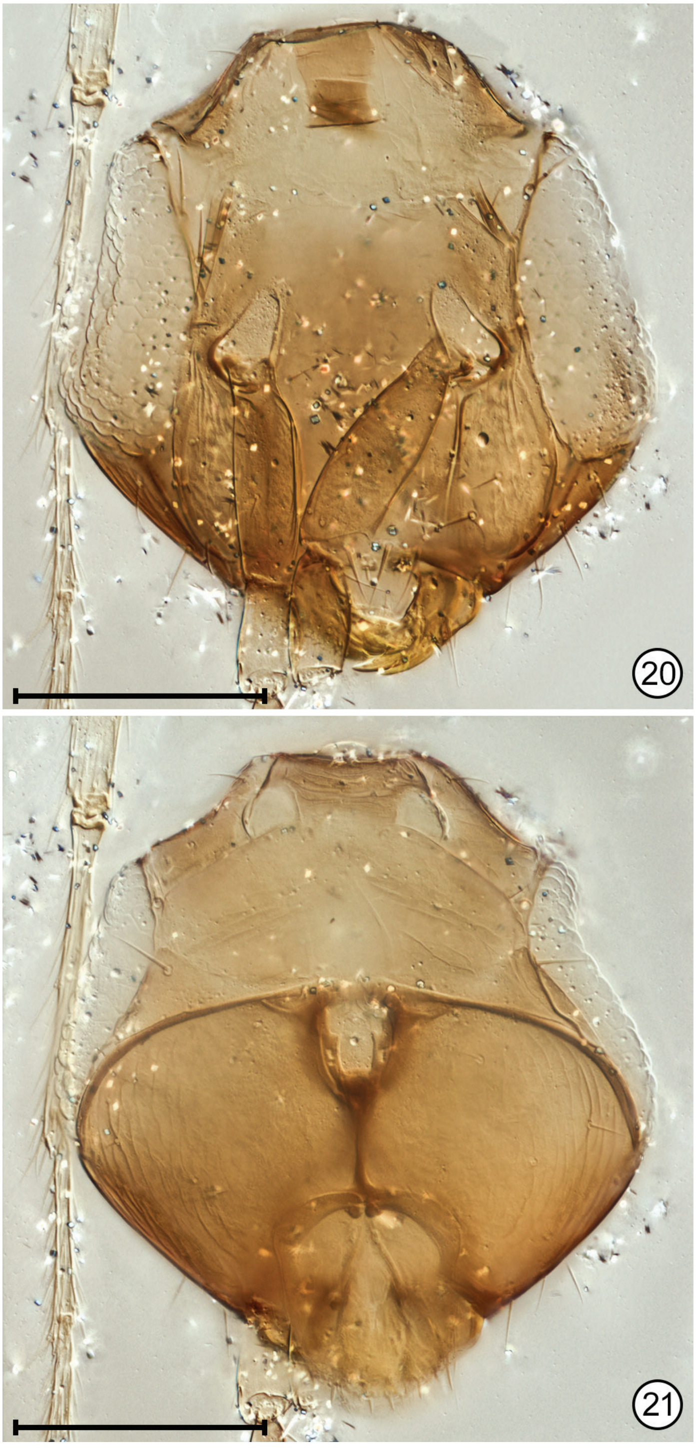
Head. Head width 236 (eyes collapsed so width should be slightly wider) (Figs 20, 21).

Antenna. Funicle without mps on fl_1 and with 2 mps on fl_2–fl_6 (Fig. 24); clava with 7 mps, 2 each on segments 1 and 2, and 3 on segment 3 (Fig. 24). Measurements (length/width) of antennal segments: scape 100/30, pedicel 55/24, fl_1 ≈50/18, fl_2 94/19, fl_3 93/18, fl_4 87/18, fl_5 86/18, fl_6 86/21, entire clava 181/50, with segments 1–3 (measured along dorsal margin) 40, 50, and 92, respectively. Length/width ratios of antennal segments: scape 3.33, pedicel 2.25, fl_1 2.84, fl_2 4.90, fl_3 5.04, fl_4 4.93, fl_5 4.88, fl_6 4.13, entire clava 3.65.

Mesosoma. Frenum poorly sclerotized and collapsed inward (Figs 22, 23).

Wings. Fore wing with evenly rounded apex, without microtrichia behind and just beyond venation, then microtrichia evenly distributed to wing apex. Hind wing parallel-sided throughout its length beyond venation and apex pointed, with a few widely spaced proximally beyond venation then microtrichia more numerous in apical 0.4 of wing between the usual anterior and posterior rows (Fig. 19). Fore wing length 954, width 222, length/width 4.30, longest marginal setae 128. Hind wing length 872, width 47, longest marginal setae 118.

Figures 17–19. *Paranaphoidea africana* holotype **17** holotype slide **18** habitus **19** wings. Scale bars: 1000 µm (**18**), 500 µm (**19**).



Figures 20, 21. *Paranaphoidea africana* holotype **20** head, anterior **21** head, posterior as seen through head. Scale bars: 100 µm.

Figures 22–24. *Paranaphoidea africana* holotype **22** mesosoma + metasoma, lateral **23** mesosoma + base of metasoma, lateral **24** antenna. Scale bars: 500 µm.

Metasoma. Ovipositor length 1300, 4.15 × as long as metatibia length (313) and extending anteriorly well forward of head (if it were attached and in its normal position) (Fig. 18).

Male. Unknown.

Derivation of species name. The species is named after the continent of Africa, because this is the first species of *Paranaphoidea* reported from there.

Allanagrus Noyes & Valentine, 1989

Type species. *Allanagrus magniclava* Noyes & Valentine.

Allanagrus contains three described species in Australia (Lin et al. 2007) and one in New Zealand (Noyes & Valentine 1989), but the genus also occurs in the Oriental region (Triapitsyn 2014b). *Allanagrus* species have the clava 3-segmented (or apparently so in some doubtful cases) and tarsi 4-segmented, both features shared by at least one species of 18 other genera: *Allarescon* Noyes & Valentine, *Anaphes*, *Anneckia* Subba Rao, *Eustochus* Haliday, *Kompsomymar* Lin & Huber, *Krokella* Huber, *Neostethynium* Ogloblin, *Nesomymar* Valentine, *Nesopatasson* Valentine, *Notomymar* Doutt & Yoshimoto, *Paracmotemnus* Noyes & Valentine, *Paranaphoidea*, *Parastethynium* Lin & Huber, *Platystethynium* Ogloblin, *Polynemoidea* Girault, *Pseudanaphes* Noyes & Valentine, *Pseudocleruchus* Donev & Huber, and *Stethynium* Enock. These genera are not necessarily related, however. Three genera, *Nesomymar*, *Nesopatasson* and *Notomymar*, are only known from wingless specimens whose relationships are uncertain—these genera may be represented also by winged species described in other genera. The genera most similar to *Allanagrus* appear to be *Anneckia*, *Parastethynium* (both in Australasian region) and *Stethynium* (almost worldwide) based on: face with subantennal grooves, and frenum weakly sclerotized and apparently divided medially by a longitudinal groove. The strongly oblique suture of the compact clava in *Stethynium* removes this genus from further consideration here. The new species described below differs from *Anneckia* in that the campaniform sensilla of the dorsellum abut the anterior margin, as in one of the two species of *Parastethynium* (well separated from anterior margin in *Anneckia* and in the type species of *Parastethynium*) and the mandible (female) is well developed and probably has 2 distinct ventral teeth (not clearly visible in holotype of new species) and a dorsal, serrated edge somewhat as in *Parastethynium* (1 tooth in the reduced mandible of *Anneckia*). It differs from *Parastethynium* in that the fore wing is fairly narrow with rounded apex, and the hind wing is narrow (fore wing wide and apically truncate and hind wing quite wide in *Parastethynium*) and eye is much less setose (eye with many setae in *Parastethynium*). On balance of features we tentatively place the new species in *Allanagrus*. A detailed study of all these genera is needed to clarify their relationships and determine if some should be synonymized under others or, conversely, more should be proposed.

Allanagrus occidentalis Huber & Triapitsyn, sp. n.

http://zoobank.org/60090A76-341C-4DAE-B56D-6ECD7A2FC5CC

Figs 25–31

Type material. Holotype female (BMNH) on slide (Fig. 31) labelled: 1. "Allanagrus occidentalis Huber & Triapitsyn ♀ dorsal Holotype". 2. "Gabon, Forêt de la Mondah, 15–25 km N of Libreville, 25.xi-3.xii.1987 J.S. Noyes. MT". 3. "Mounted by V. Berezovskiy 1999 Canada balsam".

Diagnosis. Features that together distinguish *A. occidentalis* from other described species of *Allanagrus* (all of which occur in the Australian or Oriental regions) are: body small; fl_1 and fl_2 together shorter than either pedicel or fl_3 (Fig. 26); and ovipositor shorter than metatibia and scarcely exserted beyond apex of gaster.

Description. Female. Body length 450 (mesosoma + metasoma only). Head, midlobe of mesoscutum and metasoma brown; mesosoma mostly, antenna, and legs light brown or yellowish; wings mostly with faint brown suffusion except fore wing with oval hyaline area in about apical third.

Head. Head width 210. Subantennal groove ventral to each torulus present but apparently faint (Fig. 25). Mandible apparently with 2 distinct ventral teeth and a dorsal serrated edge.

Antenna. Funicle without mps on fl_1 and $fl_{2,}$ and with 1 mps on fl_3–fl_6 (Fig. 26); clava with at least 3 mps, apparently 1 on each of segments 1–3 (possibly more on each segment but clava mounted in dorsal view and not clearly visible). Scape with row of several setae along ventral margin. Measurements (length/width) of antennal segments: scape 68/18, pedicel 38/21, fl_1 15/9, fl_2 17/10, fl_3 37/13, fl_4 36/13, fl_5 34/13, fl_6 34/14, entire clava 100/≈18 (clava oriented in mostly dorsal view so appears narrow) with segments 1–3 (measured along dorsal margin) 39, 24, and 41, respectively. Length/width ratios of antennal segments: scape 3.84, pedicel 1.81, fl_1 1.65, fl_2 1.72, fl_3 2.91, fl_4 2.70, fl_5 2.61, fl_6 2.47, entire clava ≈5.53.

Mesosoma. Mesoscutum with oblique reticulate sculpture on lateral lobe and most of midlobe except posteromedially where sculpture is longitudinal. Scutellum with mainly oblique sculpture on anterior scutellum and with longitudinal reticulate sculpture on frenum. Dorsellum with campaniform sensilla in contact with anterior margin (Fig. 27, arrows indicate sensilla) and with a seta on each side at lateral margin.

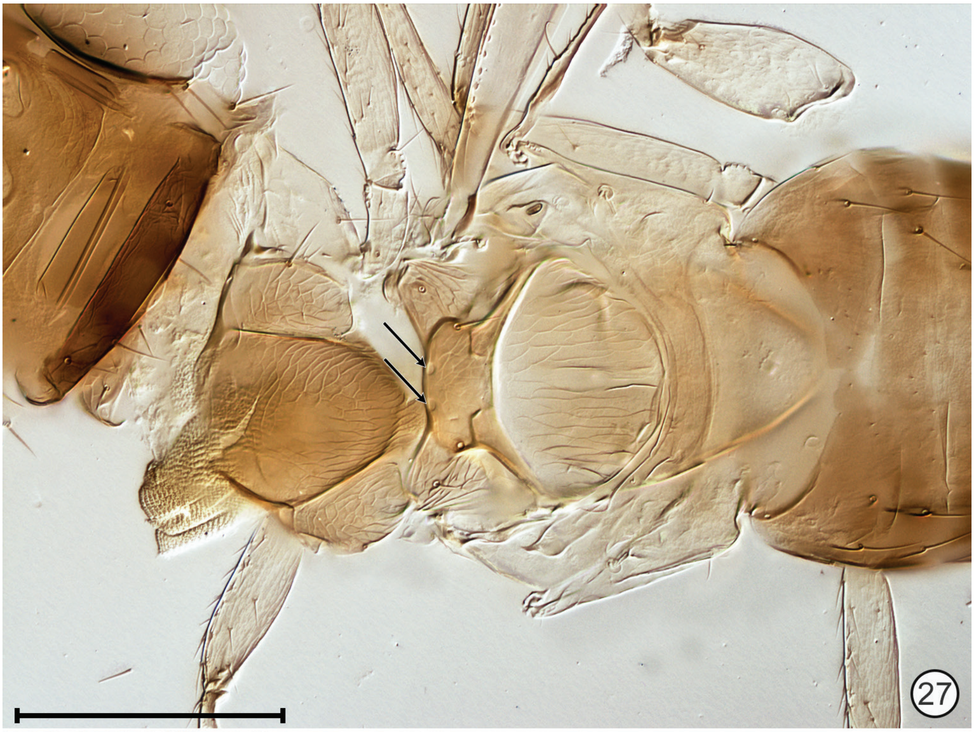
Wings. Fore wing with microtrichia somewhat scattered, present behind parastigma and more evenly distributed in apical 0.4, but absent just beyond apex of venation and in the middle of the hyaline oval area (Fig. 28). Hind wing with a few microtrichia on surface near wing between the usual anterior and posterior rows. Fore wing length 463, width 75, length/width 6.16, longest marginal setae 146. Hind wing length 443, width 20, longest marginal setae 103.

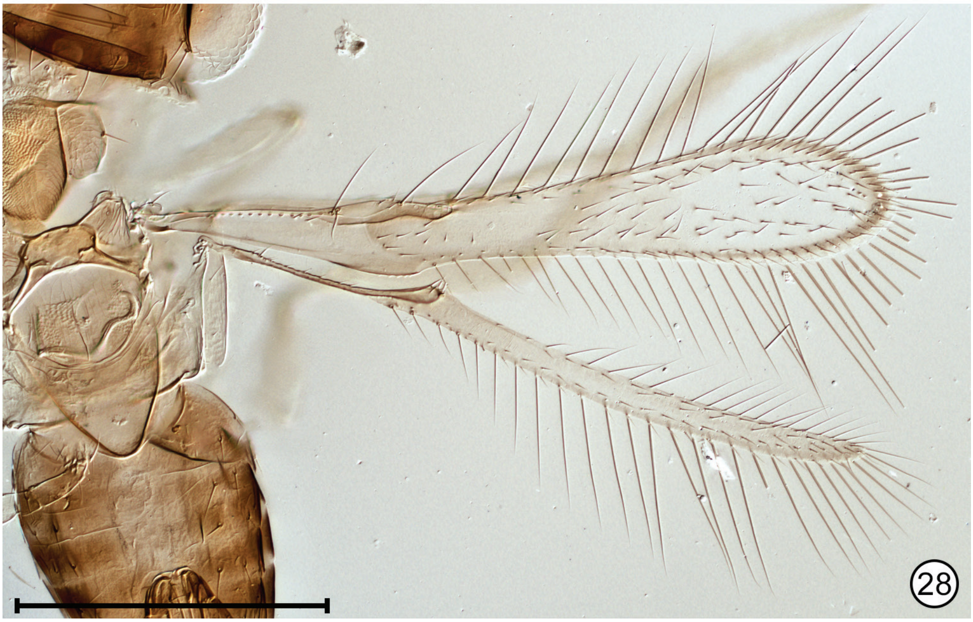
Metasoma. Ovipositor length 134, 0.79 × as long as metatibia length (168) and barely exserted beyond apex of gaster (Figs 29, 30).

Male. Unknown.

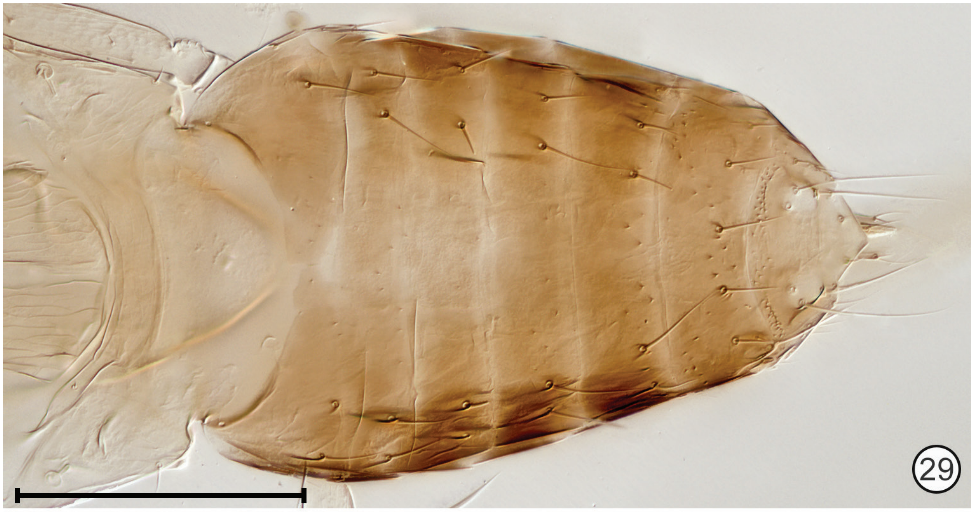
Figures 25, 26. *Paranaphoidea occidentalis* holotype **25** head, anterior + crushed pronotum **26** antenna. Scale bars: 100 µm.

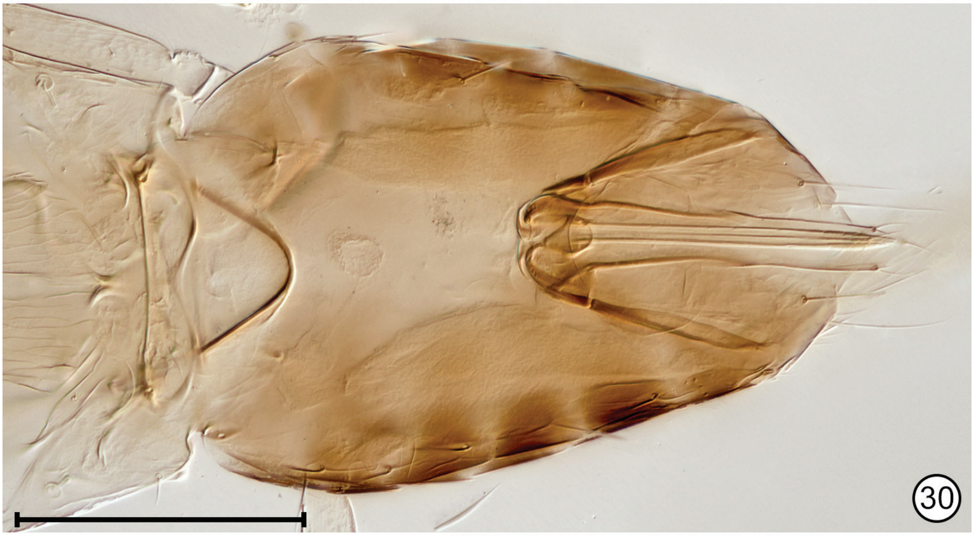
Derivation of species name. The species is the first *Allanagrus* reported from Africa and is named from Latin, *occidens -tis* meaning west, because it is by far the most westerly occurring species known for the genus.





Figures 27, 28. *Paranaphoidea occidentalis* holotype **27** mesosoma + base of metasoma **28** part of mesosoma and metasoma, and wings. Scale bars: 100 µm (**27**), 200 µm (**28**).





Figures 29–31. *Paranaphoidea occidentalis* holotype **29** apex of mesosma + metasoma, dorsal **30** apex of mesosma + metasoma as seen through body **31** holotype slide. Scale bars: 100 µm.

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RESEARCH ARTICLE

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Two new species of *Tipula* (*Vestiplex*) from Southern China based on morphological and molecular data, with redescription of *Tipula* (*Vestiplex*) *bicalcarata* (Diptera, Tipulidae, Tipulinae)

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Abstract

Two new species of subgenus *Tipula* (*Vestiplex*) Bezzi, 1924, *T.* (*V.*) *leigongshanensis* Men & Young, **sp. n.** and *T.* (*V.*) *maoershanensis* Men & Young, **sp. n.** are described and illustrated. *Tipula* (*Vestiplex*) *bicalcarata* Savchenko, 1965 is redescribed and illustrated based on additional morphological characters. Partial mitochondrial cytochrome oxidase subunit I (COI) sequences of these three species are provided. Pairwise genetic distances among two new species and related species, *T.* (*V.*) *bicalcarata*, *T.* (*V.*) *coxitalis* Alexander, 1935, and *T.* (*V.*) *sternotuberculata* Alexander, 1935 range from 0.028 to 0.091 using Kimura-2-parameter model. Diagnostic features of the sperm pump for taxonomic use are discussed.

Keywords

China, COI, crane flies, Diptera, new species, sperm pump, Tipulidae, *Vestiplex*

Introduction

Tipula (*Vestiplex*) Bezzi, 1924 is a large subgenus in *Tipula* Linnaeus, 1758 with 170 species worldwide, distributed mainly in Oriental and Palaearctic regions (Oosterbroek 2016). *Tipula* (*Vestiplex*) was erected by Bezzi (1924) with the type species *Tipula cisalpina* Riedel, 1913 from the West Palaearctic region by original designation. China hosts 67 species of this subgenus, distributed mainly in the southern part of the country (Oosterbroek 2016). It is characterized by the following characters: antennae short to elongate, with flagellum very strongly incised in male; thorax with prescutum generally glabrous; tibial spur with formulation 1-2-2; squama naked; R_{1+2} entire, Rs one-half longer than m-cu; male hypopygium generally very sclerotized and blackened, with ninth tergite forming a saucer and produced into a pair of acute projections, gonocoxite generally elongated; female ovipositor with cerci heavily sclerotized and equipped with saw-like teeth on the lower margins, but smooth in some species; hypovalvae small, extending scarcely beyond the base of cerci (Alexander 1935a).

Many species of subgenus *Tipula* (*Vestiplex*) were originally placed in the subgenus *Oreomyza* Pokorny, 1887, which was subsequently treated as a synonym of the subgenus *Tipula* (*Pterelachisus*) Rondani, 1842. The subgeneric status of species in these two subgenera has always been a troublesome issue to crane fly researchers when identifying from morphological characters only. Therefore, molecular characters have become an important addition to morphological characters, and have been proven successful for separating and identifying insect species when applied to the following instances: fragmented specimens, closely related species with extremely similar morphology, cryptic species, dubious correspondence between larva and adult, or male and female (Hebert et al. 2004, Barcenas et al. 2005, Johanson 2007, Men and Qin 2011, Yang et al. 2012, Serjeant and Beebee 2013), as well as defining the taxonomic status of taxa (Lim et al. 2013, Reijnen et al. 2014).

Two new species of the subgenus *Tipula* (*Vestiplex*) were noticed among recently collected specimens from Guangxi Zhuang Autonomous Region and Guizhou Province in southern China. The present paper provides the descriptions and illustrations of the external morphology of the new species. The COI sequences of the new species are also provided in order to augment characteristic data. The COI sequence data were used to calculate the pairwise genetic distances among the new species and related species, to delineate and establish the two new species. And finally, the subgeneric position of new species is argued based on COI sequences of the new species and some known species of subgenera *Tipula* (*Vestiplex*) and *Tipula* (*Pterelachisus*). *Tipula* (*V.*) *bicalcarata* is redescribed and illustrated based on additional morphological characters. New distribution records for *T.* (*V.*) *bicalcarata* are provided. Diagnostic features and use of the sperm pump for taxonomy are discussed.

Material and methods

Taxonomic analysis

Photographs of the body parts of male adults were obtained using a SOIFXTZ-E stereomicroscope (SOIF, Shanghai, China). The hypopygium of each male was removed and macerated in 10% NaOH for one hour in a 50°C water bath, observed in glycerin and illustrated under a SOIFXTZ-E stereomicroscope (SOIF, Shanghai, China). The body length was measured from the vertex of head to the tip of hypopygium. All measurements were made in millimeters (mm) with the aid of a digital caliper. The angles between compressor apodemes and posterior immovable apodemes of the sperm pump were measured by ImageJ software. The terminology and methods of description and illustration followed that of Alexander and Byers (1981) and Frommer (1963). The type specimens are deposited in the animal specimen room, School of Life Sciences, Anqing Normal University, Anhui Province, P. R. China. Qiu-Lei Men and Chen W. Young were responsible for the taxonomic portion of this paper, thus are the authors of the new species.

Molecular analysis

Genomic DNA was extracted from one leg of dry preserved specimen using Biomiga Insect gDNA Kit (Biomiga, USA). Genomic DNA of four type specimens of new species and two specimens of *T.* (*V.*) *bicalcarata* was extracted. The partial sequence of the mitochondrial COI gene was amplified using the universal primers for metazoan invertebrates, LCO1490 (5'-GGTCAACAAATCATAAAGATATTG-3') and HCO2198 (5'-TAAACTTCAGGGTGACCAAAAAAT-3') (Folmer et al. 1994). PCR amplifications were employed using a final volume of 20 µl containing 10 µl 2 × Pfu PCR MasterMix (Tiangen, Beijing, China), 0.75 µl each primer (10 µM), 1 µl DNA template and 7.5µl ddH$_2$O. PCR amplification was employed with denaturation at 95 °C for 5 mins, followed by 45 cycles of 30 s at 95 °C for denaturation, 30 s at 50 °C for annealing and 1 min 30 s at 72 °C for extension, with a final extension at 72 °C for 10 mins. All PCR sets included a negative control reaction tube in which all reagents were included but the template DNA. After electrophoresis with 1% agarose gel, the target DNA was sent to Genescript Biotechnology Co., Ltd. (Nanjing, China) for sequencing. The partial COI sequences were aligned with CLUSTAL X (Thompson et al. 1997). The aligned sequences were processed by MEGA 6.0 (Tamura et al. 2013) for analyzing the DNA sequence compositions and calculating pairwise genetic distance based on the Kimura-2-parameter model (Kimura 1980). Partial COI sequences of new species and *T.* (*V.*) *bicalcarata* obtained in this study were submitted to GenBank with the following accession numbers: *T.* (*V.*) *bicalcarata* (KU844262), *T.* (*V.*) *leigongshanensis* sp. n. (KU844261) and *T.* (*V.*) *maoershanensis* sp. n. (KU844263). For revealing the subgeneric position of new species, a maximum likelihood tree was constructed using MEGA 6.0 with 1000

Table 1. Accession numbers and sources of COI sequences of some known species in *Tipula* (*Pterela-.chisus*) and *Tipula* (*Vestiplex*

Species	Accession numbers	Sources
Tipula (*Pterelachisus*) *stenostyla*	JQ912049	Pilipenko et al. 2012
Tipula (*Pterelachisus*) *winthemi*	JQ912057	Pilipenko et al. 2012
Tipula (*Pterelachisus*) *jutlandica*	JQ912035	Pilipenko et al. 2012
Tipula (*Pterelachisus*) *octomaculata*	JQ912044	Pilipenko et al. 2012
Tipula (*Pterelachisus*) *submarmorata*	JQ912050	Pilipenko et al. 2012
Tipula (*Pterelachisus*) *pseudovariipennis*	JQ912047	Pilipenko et al. 2012
Tipula (*Pterelachisus*) *varipennis*	JQ912054	Pilipenko et al. 2012
Tipula (*Pterelachisus*) *mutila*	JQ912042	Pilipenko et al. 2012
Tipula (*Pterelachisus*) *wahlgreni*	JQ912055	Pilipenko et al. 2012
Tipula (*Pterelachisus*) *truncorum*	JQ912051	Pilipenko et al. 2012
Tipula (*Vestiplex*) *arctica*	KU374459	Wirta et al. 2016
Tipula (*Vestiplex*) *canadensis*	KM571431	Barcoding Canada Data Release
Tipula (*Vestiplex*) *bicalcarata*	KU844262	New submission in present study
Tipula (*Vestiplex*) *coxitalis*	Not released	Provided by second author
Tipula (*Vestiplex) sternotuberculata*	Not released	Provided by second author

bootstraps (Tamura et al. 2013) based on COI sequences of the new species and known species of *Tipula* (*Vestiplex*) and *Tipula* (*Pterelachisus*), which were mainly downloaded from GenBank (accession numbers presented in Table 1).

Results

COI sequences analysis

Sequences containing 623 base pairs were recovered for the studied species, which included 75 variable sites and 548 conserved sites. Variable sites are shown in Figure 38. Variable sites included 25 parsimony informative sites and 50 singleton sites. The pairwise genetic distances between the two new species and related species ranged from 0.028 to 0.091 based on Kimura-2-parameter model (Table 2).

The maximum likelihood tree (Fig. 39) showed that the two new species clustered with species of *Tipula* (*Vestiplex*), suggesting their subgeneric position.

Taxonomy

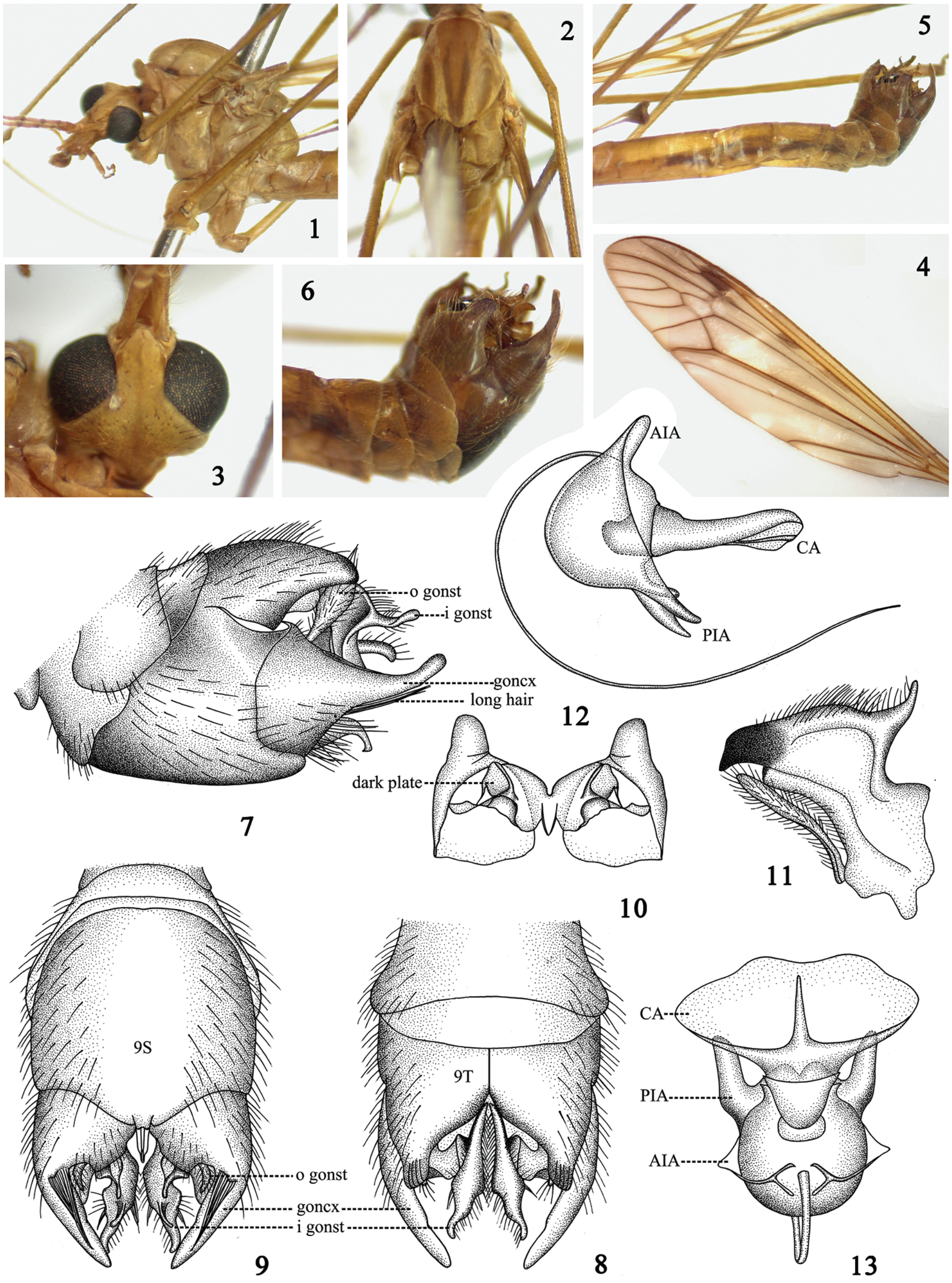
Tipula (*Vestiplex*) *bicalcarata* Savchenko, 1965

Diagnosis. Body generally reddish brown in color (Figs 1–6). Ninth tergite separated by a deeply V-shaped notch, lateral angles produced into an ear-like lobe (Fig. 8).

Table 2. Pairwise genetic distances for COI gene sequences of species examined in the present study.

Species	***lei***	***ste-t***	***cox***	***bic***	***mao***	***win***	***wah***	***var***	***sub***	***ste-s***	***pse***	***oct***	***mut***	***jut***	***arc***	***can***
ste-t	0.086															
cox	0.042	0.084														
bic	0.059	0.088	0.057													
mao	0.047	0.091	0.040	0.028												
win	0.117	0.126	0.119	0.105	0.109											
wah	0.138	0.139	0.136	0.128	0.132	0.067										
var	0.126	0.132	0.124	0.118	0.118	0.057	0.077									
sub	0.138	0.141	0.134	0.130	0.132	0.062	0.089	0.034								
ste-s	0.132	0.128	0.132	0.111	0.118	0.038	0.084	0.079	0.072							
pse	0.138	0.134	0.130	0.130	0.130	0.069	0.085	0.019	0.041	0.088						
oct	0.134	0.134	0.136	0.121	0.119	0.054	0.086	0.080	0.084	0.064	0.082					
mut	0.134	0.134	0.140	0.128	0.138	0.075	0.028	0.085	0.089	0.082	0.094	0.087				
jut	0.128	0.132	0.124	0.117	0.117	0.039	0.074	0.077	0.081	0.054	0.077	0.066	0.081			
arc	0.132	0.136	0.128	0.128	0.132	0.137	0.138	0.142	0.148	0.140	0.148	0.154	0.144	0.150		
can	0.136	0.136	0.134	0.127	0.130	0.121	0.140	0.144	0.150	0.122	0.142	0.145	0.129	0.133	0.088	

Abbreviation: *lei*, *T.* (*V.*) *leigongshanensis*; *ste-t*, *T.* (*V.*) *sternotuberculata*; *cox*, *T.* (*V.*) *coxitalis*; *bic*, *T.* (*V.*) *bicalcarata*; *mao*, *T.* (*V.*) *maoershanensis*; *win*, *T.* (*P.*) *winthemi*; *wah*, *T.* (*P.*) *wahlgreni*; *var*, *T.* (*P.*) *varipennis*; *sub*, *T.* (*P.*) *submarmorata*; *ste-s*, *T.* (*P.*) *stenostyla*; *pse*, *T.* (*P.*) *pseudovariipennis*; *oct*, *T.* (*P.*) *octomaculata*; *mut*, *T.* (*P.*) *mutila*; *jut*, *T.* (*P.*) *jutlandica*; *arc*, *T.* (*P.*) *arctica*; *can*, *T.* (*P.*) *canadensis*.



Figures 1–13. *Tipula* (*Vestiplex*) *bicalcarata* **1** thorax, lateral view **2** thorax, dorsal view **3** head, dorsal view **4** wing **5** abdomen and hypopygium, lateral view **6** hypopygium, lateral view **7** hypopygium, lateral view **8** hypopygium, dorsal view **9** hypopygium, ventral view **10** tergite nine, ventral view **11** inner gonostylus and outer gonostylus **12** sperm pump, lateral view **13** sperm pump, dorsal view. Abbreviation: AIA, anterior immovable apodeme; CA, compressor apodeme; goncx, gonocoxite; i gonst, inner gonostylus; o gonst, outer gonostylus; PIA, posterior immovable apodeme.

Gonocoxite extended into a long arm, directed caudally, widest at base and narrowed to apex (Figs 6–7).

Redescription. Male. Length: *Body*: 12.5–13.0 mm (excluding antenna, n = 5); *Wing*: 19.0–19.5 mm (n = 5); *Antenna*: 4.3–4.5 mm (n = 5).

Head. Reddish-brown except as noted. Vertex without marking (Fig. 3). Antenna reddish-brown, 13-segmented, bent backward extending to root of halteres; scape cylindrical, expanded apically; pedicel short, hemispherical; each flagellomere subequal in length, basal enlargement black with abundant black verticils, longest ones subequal to length of corresponding flagellomeres. Palpi with basal three segments reddish-brown, last one black.

Thorax. Generally reddish-brown except as noted. Pronotum light yellow laterally, gradually becoming reddish-brown, black medially (Figs 1–2). Prescutum with three light brown stripes, median one marginally suffused with brown at basal half, humeral angle with a black marking at lateral side (Figs 1–2). Scutum with two light brown markings (Fig. 2). Scutellum with dark median stripe. Postnotum wholly reddish-brown. Pleura entirely reddish brown (Fig. 1). Legs slender, coxae, trochanters and femora reddish-brown, tibiae and tarsi light brown. Halteres stem reddish-brown, knob darker. Wings reddish-brown, cells c and sc darker than ground color; stigma dark brown; Rs suffused with dark brown at origin point; discal cell transparent; some large hyaline areas at cells m and a (Fig. 4). Venation: R_{1+2} entire, discal cell narrow, elongated, petiole of cell m_1 distinctly shorter than discal cell (Fig. 4).

Abdomen. Generally reddish brown except as noted. Abdominal tergites with brown lateral stripes (Fig. 5). Hypopygium brown (Fig. 6). Tergite nine with a deeply V-shaped notch, separated medially into two parts, produced into ear-like lobe in lateral angle, beneath it with a dark plate on ventral side (Figs 8, 10). Sternite nine broad, not fused with tergite nine (Figs 6–7, 9). Gonocoxite extended into a long arm, directed caudally, widest at base, tapering to apex, ventrally of gonocoxite with a central band of long black setae (Figs 5–9). Outer gonostylus elongated, thin, generally curled as a tube (Fig. 11). Inner gonostylus tapering to apex, terminating in a black beak, with horn-shaped process on its dorsal side (Fig. 11).

Sperm pump. Compressor apodeme fan-shaped with two rounded extensions marginally (Fig. 11), forming a 45° angle with posterior immovable apodeme (Fig. 12). Posterior immovable apodeme distinctly shorter than compressor apodeme, gradually narrowed to apex (Fig. 12). Anterior immovable apodeme short, gradually narrowed to apex (Fig. 12). Aedeagus tubular, almost 3.0 times longer than sperm pump, acute apically (Fig. 12).

Examined material. 3 males, Guizhou Province, Fanjingshan Mountain, 27°55'N, 108°38'E, 12 June 2015, Guoxi Xue leg. 2 males, Guangxi Zhuang Autonomous Region, Dayaoshan Mountain, 24°08'N, 110°11'E, 14 May 2016.

Distribution. China (Beibei, Chongqing; new distribution records in China: Fanjingshan Mountain, Guizhou Province; Dayaoshan Mountain, Guangxi Zhuang Autonomous Region, see Fig. 40).

***Tipula* (*Vestiplex*) *leigongshanensis* Men & Young, sp. n.**

http://zoobank.org/46AEB6CF-724D-4965-A698-A3B43E822DC6

Diagnosis. Body generally brown in coloration (Figs 14–19). Hypopygium expanded and black (Fig. 19). Sternite nine with a pair of nail-shaped processes (Figs 19–20). Gonocoxite produced into a bird-head-shaped lobe (Figs 19–20).

Description. Male. Length: *Body*: 11.5–12.0 mm (excluding antenna, n = 4); *Wing*: 16.0–16.5 mm (n = 4); *Antenna*: 4.5–4.7 mm (n = 4).

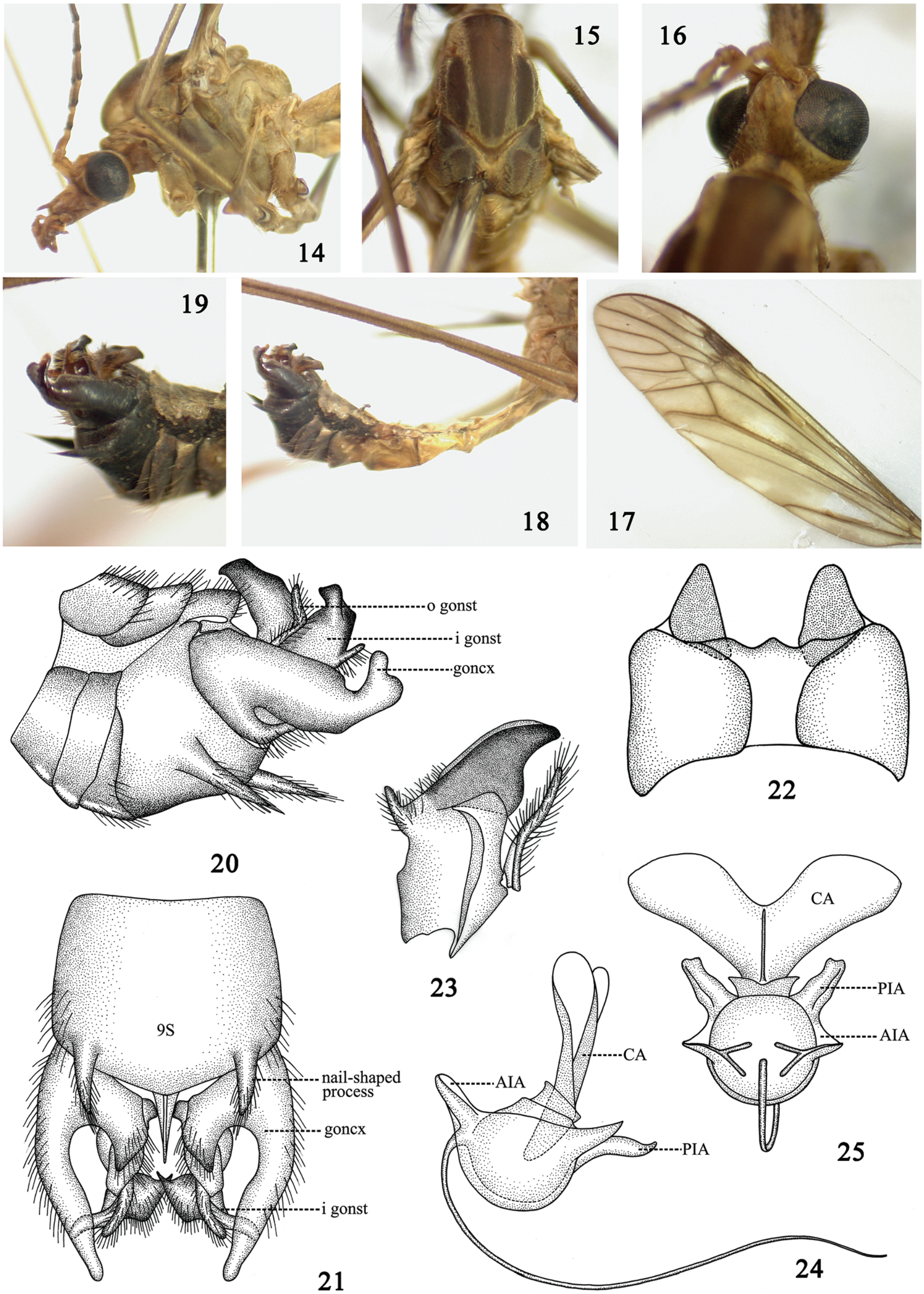
Head. Generally reddish brown except as noted. Rostrum light brown with brownish nasus (Fig. 14). Antenna 13-segmented, bent backward extending to root of first abdominal segment; scape reddish-brown, cylindrical, expanded apically; pedicel reddish-brown, short; flagellum brown, flagellomere subequal in length, basal enlargement black with abundant black verticils, longest ones subequal to length of corresponding flagellomeres. Palpi entirely reddish brown. Vertex without marking (Fig. 16).

Thorax. Generally brown except as noted. Pronotum brown, becoming black medially. Prescutum with three brown stripes. Scutum with two dark brown markings (Fig. 15). Scutellum with a dark median stripe (Fig. 15). Postnotum entirely brown. Pleura reddish-brown, tinged with brown at anepimeron and anepisternum (Fig. 14). Legs slender, coxae and trochanters brown, femora brown with tip black, tibiae, and tarsi black. Halteres with stem brown, knob darker. Wings reddish-brown, cells c and sc darker than ground color; stigma dark brown; Rs suffused with dark brown at origin point; discal cell transparent; several large hyaline areas at cells r, m and a (Fig. 17). Venation: R_{1+2} entire, discal cell narrow, elongated, petiole of cell m_1 distinctly shorter than discal cell (Fig. 17).

Abdomen with basal four segments brown, remaining segments generally darker, with black distinct median and lateral stripes, sternites entirely reddish-brown (Fig. 18). Hypopygium black (Fig. 19). Tergite nine separated medially into two parts, connected with membranous extension, hind margin of tergite nine forming W-shaped emargination (Fig. 22). Ventrad of tergite nine with two semi-triangular process (Fig. 22). Sternite nine broad, not fused with tergite nine, with a pair of nail-shaped processes arising from lateral sides, caudally directed, densely covered with long black setae (Figs 19–21). Gonocoxite produced into bird-head-shaped lobe, with small light-colored depression on base (Figs 19–20). Outer gonostylus elongated, thin, generally curled as a tube (Fig. 23). Inner gonostylus produced into black beak, with horn-shaped process on its dorsal side (Fig. 23).

Sperm pump with compressor apodeme V-shaped, forming a 55° angle with posterior immovable apodeme (Figs 24–25). Posterior immovable apodeme distinctly shorter than compressor apodeme, gradually narrowed to apex (Fig. 24). Anterior immovable apodeme short, gradually narrowed to apex (Fig. 24). Aedeagus tubular, almost 2.5 times longer than sperm pump, acute apically (Fig. 24).

Type material. Holotype male. **CHINA:** Guizhou Province, Leigongshan Mountain, 26°21'N, 108°13'E, 2 June 2015, Guoxi Xue leg. **Paratype.** 1 male, same data as holotype. 2 males, Guizhou Province, Leigongshan Mountain, 26°21'N, 108°13'E, 14 May 2016, Qiulei Men leg.



Figures 14–25. *Tipula* (*Vestiplex*) *leigongshanensis*, sp. n. **14** thorax, lateral view **15** thorax, dorsal view **16** head, dorsal view **17** wing **18** abdomen and hypopygium, lateral view **19** hypopygium, lateral view **20** hypopygium, lateral view **21** hypopygium, ventral view **22** tergite nine, dorsal view **23** inner gonostylus and outer gonostylus **24** sperm pump, lateral view **25** sperm pump, dorsal view. Abbreviation: AIA, anterior immovable apodeme; CA, compressor apodeme; goncx, gonocoxite; i gonst, inner gonostylus; o gonst, outer gonostylus; PIA, posterior immovable apodeme.

Distribution. China (Leigongshan Mountain, Guizhou Province, Fig. 40).

Remarks. The new species is placed in subgenus *Tipula* (*Vestiplex*) because of its male hypopygium with elongated gonocoxite, which is also supported by the results of the molecular analysis (Fig. 39). The new species is mostly similar to *T.* (*V.*) *sternotuberculata* Alexander, 1935, from Taiwan, China, in the body color and the structure of hypopygium. *Tipula* (*V.*) *leigongshanensis* can be easily distinguished from the latter by the bird-headed distal end of gonocoxite (distal end of gonocoxite roundly expanded in *T.* (*V.*) *sternotuberculata* as figure 32 in Alexander, 1935b), and the nail-shaped process on sternite nine distinctly thinner than that of *T.* (*V.*) *sternotuberculata*. Moreover, pairwise genetic distance between these two species is 0.086 based on the Kimura-2-parameter model (the COI sequence of *T.* (*V.*) *sternotuberculata* is unpublished data, provided by the second author). Of 40 interspecific comparisons of genetic distance values among known species, 33 are equal to or lower than 0.086, which could suggest significant genetic variation between the new species and *T.* (*V.*) *sternotuberculata* (Table 2).

Etymology. The specific epithet is a noun '*leigongshan*' with Latin suffix '*ensis*', referring to the type locality of the new species.

***Tipula* (*Vestiplex*) *maoershanensis* Men & Young, sp. n.**

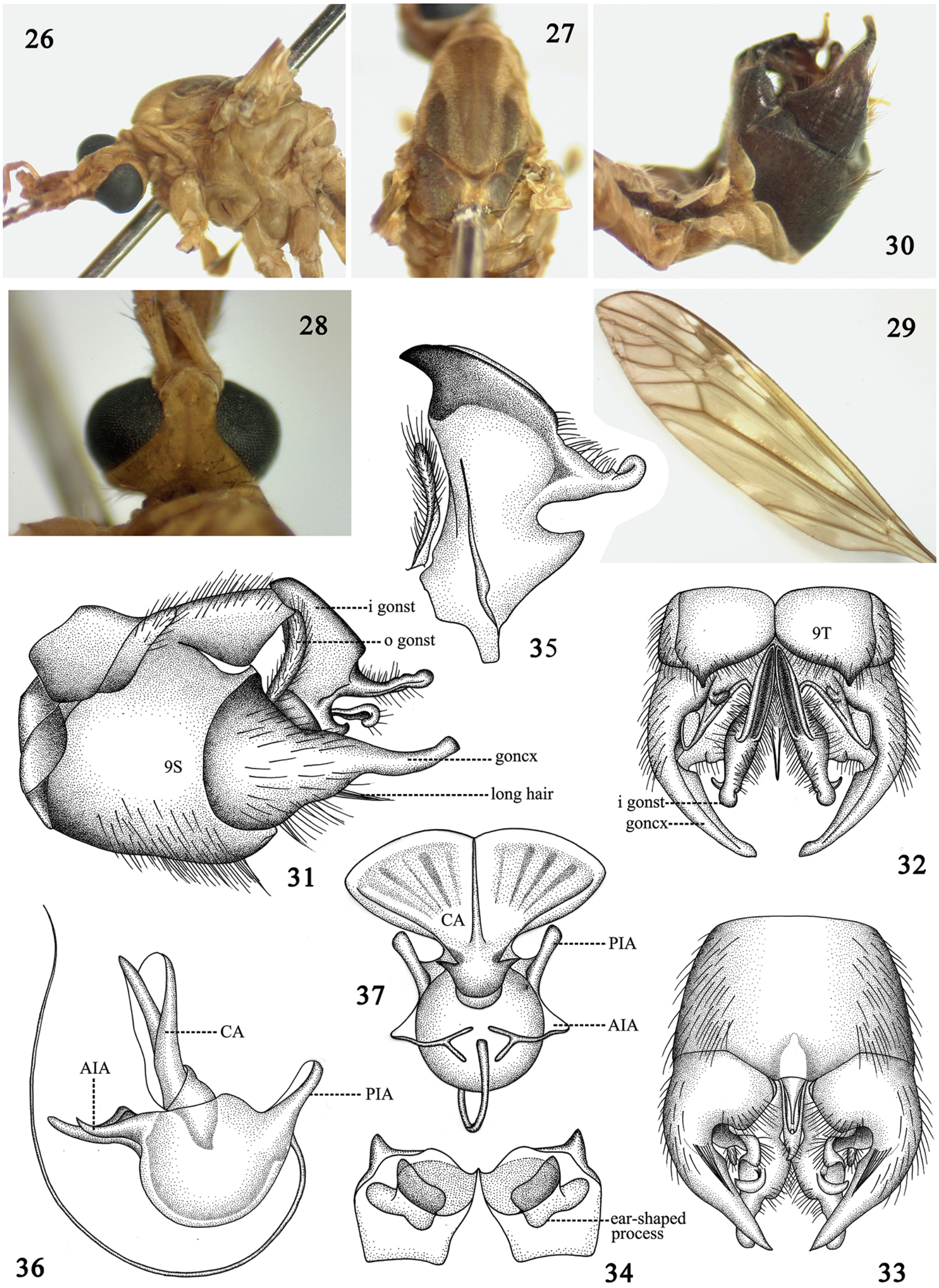
http://zoobank.org/9E2254C1-0F95-4CBA-994E-2649C913FF72

Diagnosis. Whole body generally brownish in coloration (Figs 26–29). Prescutum with median stripe brighter than lateral stripes (Fig. 27). Hypopygium dark brown (Fig. 30). Gonocoxite produced into a long arm, basally broad and gradually narrowed to the apex (Figs 30–31).

Description. Male. Length: *Body*: 12.0–12.3 mm (excluding antenna, n = 2); *Wing*: 16.2–16.5 mm (n = 2); *Antenna*: 3.5–3.7 mm (n = 2).

Head. Rostrum light brown with brownish nasus (Fig. 26). Antenna 13-segmented, bent backward extending to root of wing; scape reddish brown, cylindrical, expanded apically; pedicel reddish-brown, short; flagellum brown, flagellomere subequal in length, basal enlargement black with abundant black verticils, longest ones subequal to length of corresponding flagellomeres. Palpi entirely reddish brown. Vertex without marking (Fig. 28).

Thorax. Generally brown except as noted. Pronotum brown, changed to black medially. Prescutum with three brown stripes, median one darker than laterals (Fig. 27). Scutum with two dark brown markings (Fig. 27). Scutellum with dark median stripe. Postnotum wholly brown. Pleura entirely reddish-brown (Fig. 26). Legs slender, coxae and trochanters brown, femora brown with tip black, tibiae brown with tip black, tarsi black. Halteres with stem brown, knob darker. Wings reddish-brown, cells c and sc darker than ground color; stigma dark brown; Rs suffused with dark brown at origin point; discal cell transparent; several large hyaline areas at cells r, m and a (Fig. 29). Venation: R_{1+2} entire, discal cell narrow, elongated, petiole of cell m_1 distinctly shorter than discal cell (Fig. 29).



Figures 26–37. *Tipula* (*Vestiplex*) *maoershanensis*, sp. n. **26** thorax, lateral view **27** thorax, dorsal view **28** head, dorsal view **29** wing **30** hypopygium, lateral view **31** hypopygium, lateral view **32** hypopygium, dorsal view **33** hypopygium, ventral view **34** tergite nine, ventral view **35** inner gonostylus and outer gonostylus **36** sperm pump, lateral view **37** sperm pump, dorsal view. Abbreviation: AIA, anterior immovable apodeme; CA, compressor apodeme; goncx, gonocoxite; i gonst, inner gonostylus; o gonst, outer gonostylus; PIA, posterior immovable apodeme.

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                                  111111222222222222222333333333333333333444444444444455555555555566
                         112445667466789001233444567788001123334556777889012223566778911227778899901
                         232281695489105146247135846928360970369144058146240697323179316580392514795
leigongshanensis         ATTAAATTTATCGTCTTGTCCCGTTTCATTCCTGCCTTCATTTAATTAATATGGTCCTAGATGTATTTTTAATTC
sternotuberculata        T.CT.T.C.T.TAG.AAACT.TAC..TGCA.TC.TTAGT.A.CTTCC.T.CCA.CT.CTT.CA.TACCCC.....
coxitalis                .C..GG...TC.AAT..A...TAC......T.C....A.G...G........A.C....AG.T.....C...CC.
bicalcarata              .....GC.CT.TA....A.TTT.CCC.G..T.CAT..A...C...C.T.C..A..TT..T..AA...C..GGCCT
maoershanensis           ....GG..CT.TA....A.TTT.C.C....T......AT..C.....G.C..AC..T..AG.AA...C....CC.
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Figure 38. Variable sites from mitochondrial COI gene sequence alignment. Numbers arrayed vertically represent the positions of the nucleotides.

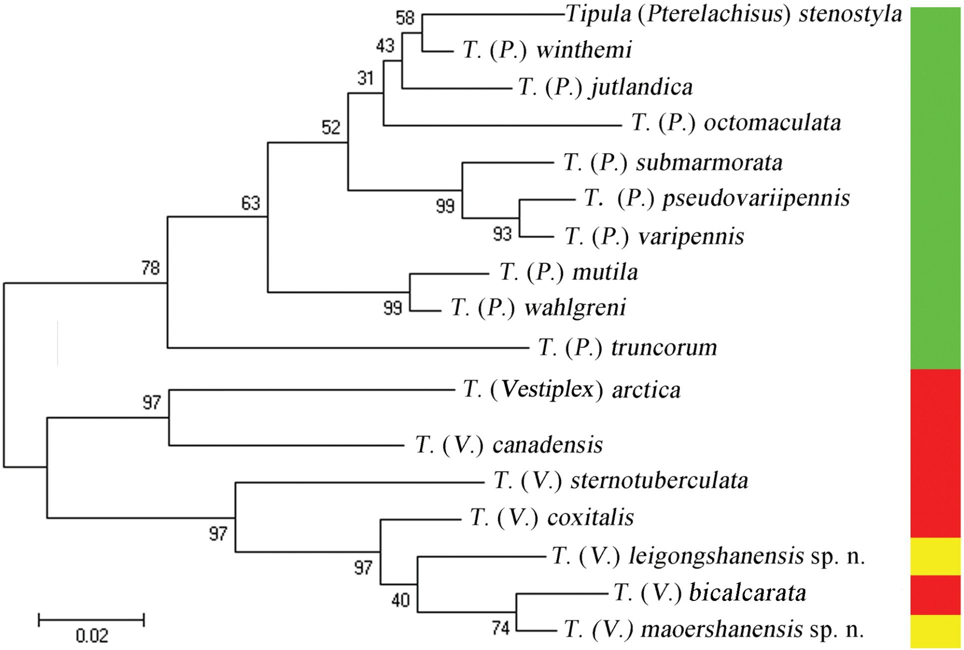

Figure 39. Maximum likelihood tree based on COI sequences of new species and some known species of *Tipula* (*Vestiplex*) and *Tipula* (*Pterelachisus*). Green region represents species of *Tipula* (*Pterelachisus*); red region represents species of *Tipula* (*Vestiplex*); yellow region represents new species.

Abdomen. Abdominal tergites reddish-brown with brown lateral stripes, sternites entirely reddish brown. Hypopygium dark brown (Fig. 30). Tergite nine entirely divided into two parts, produced into horn-shaped process in the lateral angle, ventral side of tergite nine with a pair of ear-shaped processes (Figs 32, 34). Gonocoxite extended into long arm, directed caudally, widened at base and narrowed to apex; ventrally, with central band of long black setae (Figs 30–31, 33). Outer gonostylus elongated, thin, generally curled as a tube (Fig. 35). Inner gonostylus produced into black beak, with a finger-shaped, rounded, expanded apically process on dorsal side.

Sperm pump with compressor apodeme fan-shaped, shallowly emarginated in middle, deeper coloration in median region, suffused by several dark stripes, forming a 65° angle with posterior immovable apodeme (Fig. 37). Posterior immovable apodeme

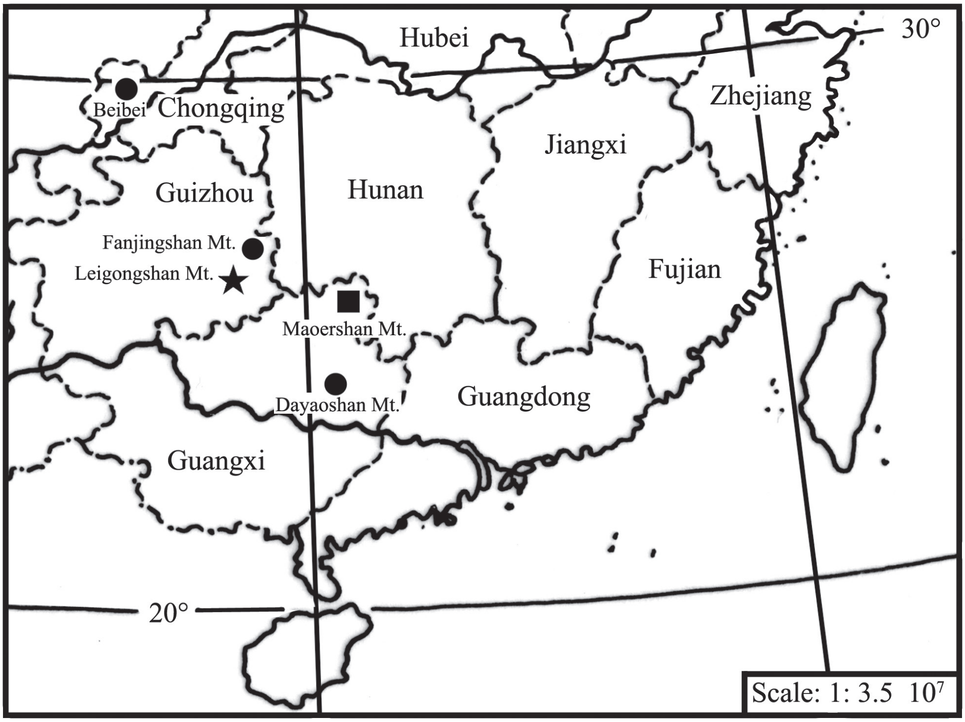

Figure 40. Geographic distribution of the species examined: *T.* (*V.*) *bicalcarata* (●), *T.* (*V.*) *leigongshanensis* sp. n. (★), *T.* (*V.*) *maoershanensis* sp. n. (■).

distinctly shorter than compressor apodeme, gradually narrowed to apex (Fig. 36). Anterior immovable apodeme short, gradually narrowed to apex (Fig. 36). Aedeagus tubular, almost 2.5 times longer than sperm pump, acute apically (Fig. 36).

Type material. Holotype male. **CHINA:** Guangxi Zhuang Autonomous Region, Maoershan Mountain, 25°48'N, 110°25'E, 21 May 2015, Guoxi Xue leg. **Paratype.** 1 male, same data as holotype.

Distribution. China (Maoershan Mountain, Guangxi Zhuang Autonomous Region, Fig. 40).

Remarks. The new species is placed in subgenus *Tipula* (*Vestiplex*) because of its male hypopygium with elongated gonocoxite, which is also supported by the molecular analysis (Fig. 39). The new species is similar to *Tipula* (*Vestiplex*) *coxitalis* Alexander, 1935, in the body color and the structure of gonostylus, it can be easily distinguished from the latter by the gonocoxite not expanded distally (distal end of gonocoxite expanded in *T.* (*V.*) *coxitalis* figs 30, 31 in Alexander, 1935b), by the sternite without a band of long setae on each lateral sides (with such long hair in *T.* (*V.*) *coxitalis* fig. 30 in Alexander, 1935b), by the inner gonostylus with dorsal process distinctly larger than that of *T.* (*V.*) *coxitalis*. Pairwise genetic distance between *T.* (*V.*) *maoershanensis* sp. n. and *T.* (*V.*) *coxitalis* is 0.048 based on the Kimura-2-parameter model, suggesting distinct genetic variation between these two species. Six lower values of pairwise genetic distance were observed in comparisons to known species (Table 2), which could be taken as indirect evidence. The new species is also similar to *T.* (*V.*) *bicalcarata* by the body color and the structure of gonocoxite. It can be easily distinguished from the latter by the tergite nine produced into a horn-like process in lateral angle (the tergite nine produced into an ear-shaped process in *T.* (*V.*) *bicalcarata*, Fig. 8), the dorsal angle of inner gonostylus rounded and expanded apically (the dorsal angle of inner gonostylus gradually narrowed to apex in *T.* (*V.*) *bicalcarata*, Fig. 11). Pairwise genetic distance between these two species is 0.028 based on the Kimura-2-parameter model. Although the value is relatively low, it is equal to the comparison value of *T.* (*P.*) *wahlgreni* and *T.* (*P.*) *mutila*, while higher than the comparison value of *T.* (*P.*) *pseudovariipennis* and *T.* (*P.*) *varipennis* (0.019).

Etymology. The specific epithet is a noun '*maoershan*' with Latin suffix '*ensis*', referring to the distribution of the new species.

Sperm pump

The structures of sperm pumps in the two new species and *T.* (*V.*) *bicalcarata* showed substantial variation in shapes and colors, especially the shapes of the compressor apodemes, which suggests that the characters of sperm pumps can be used to distinguish closely related species (Table 3).

Discussion

In most insect orders, males transfer their sperm to females by spermatophore (Khalifa 1949, Hünefeld and Beutel 2005). However, in most families of Diptera, sperm is transferred by means of semen pump or sperm pump, which also occurs in other members of Antliophora including Mecoptera and Siphonaptera (Hünefeld and Beutel 2005). The sperm pump of crane-flies shows rich morphological diversity in different taxa. sperm pumps have been successfully demonstrated to separate related species within the subgenus *Tipula* (*Yamatotipula*) and the genus *Nephrotoma,* based on the angle between the posterior immovable apodeme and the compressor apodeme, the length of posterior immovable apodeme, and the shape and color of compressor apodeme in previous studies (Men et al. 2015a, 2015b). Frommer (1963) divided the sperm pump of crane-flies into three types based on anatomical studies of male reproductive systems of tipuline crane-flies species from North American. In the present study, sperm pumps of new species belong to type III, which is the most common type characterized by the strongly bowed intromittent organ. After comparing the structures of sperm pumps in the three species examined in this present study, it was observed that they showed substantial variation in shapes of compressor apodemes and color, which indicates that the characters of sperm pumps are useful in distinguishing closely related species.

Table 3. Characters of sperm pump in three species of *Tipula* (*Vestiplex*).

Species	Compressor apodeme (CA)	Posterior immovable apodeme (PIA)	Anterior immovable apodeme (AIA)
bicalcarata (Figs 12, 13)	Fan-shaped, marginally with two rounded extensions. Generally reddish-brown.	Distinctly shorter than CA, narrow, acute apically, in a 45° angle with CA.	Small, inner lateral margins expended in lateral view, not connected apically.
leigongshanensis (Figs 24, 25)	Y-shaped. Generally reddish-brown.	Distinctly shorter than CA, narrow, acute apically, in a 55° angle with CA.	Gradually narrowed to apex, not connected apically. Small, inner lateral margins expended in lateral view.
maoershanensis (Figs 36, 37)	Fan-shaped, shallowly emarginated medially, deeper in coloration in median region, suffused by several dark stripes.	Distinctly shorter than CA, narrow, acute apically, in a 65° angle with CA.	Gradually narrowed to apex, not connected apically.

The pairwise genetic distance between *T.* (*V.*) *maoershanensis* sp. n. and *T.* (*V.*) *bicalcarata* was 0.028, the minimal value found when compared with the other three species, suggesting closer relationship and is in agreement with distinct morphological similarities between these two species. The distances between the two new species and the related species ranged from 0.028 to 0.091, within the range of 0.019 to 0.094, which covers all comparisons of known species inferred in the present study (Table 2). This may provide molecular evidence for the distinctiveness of these two new species.

China has a rich Tipuloidea fauna as indicated by the total numbers in the current catalogue (Oosterbroek 2016). Modern taxonomic studies on insects have been highly developed by integrating data derived from morphology, behavior, ecology, and geographic variation, which in turn is reinforced with complementary information from DNA sequences (Stoeckle 2003). Several published papers on Tipuloidea also show that the characterization of molecular data will likely contribute to our knowledge of the biodiversity and range extension of this group (Pilipenko et al. 2012, Goodman and Grady 2013, Wirta et al. 2016, Denes et al. 2016). We anticipate future intensive field collection and investigation would undoubtedly increase the species numbers and range extension of *Tipula* (*Vestiplex*) in China.

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RESEARCH ARTICLE

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A new species of *Poropoea* Foerster from Africa (Hymenoptera, Chalcidoidea, Trichogrammatidae)

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Abstract

A new species of *Poropoea* Foerster (Hymenoptera, Chalcidoidea, Trichogrammatidae) was obtained from eggs of attelabid beetles (Coleoptera: Attelabidae) associated with *Combretum* sp. (Myrtales, Combretaceae). This species is described from Ogooué-Ivindo province in north-eastern Gabon. The new species is easily distinguished from the known members of the genus *Poropoea* by the following combination of characters: female antennal club unsegmented, premarginal vein of the fore wing with a nodular premarginal vein and the stigma of the stigmal vein black, the wing lacks the RS1 track; front and hind legs more robust than the middle leg and with coxa and femur markedly enlarged, and ovipositor exserted to one-third of the gaster length. Morphological features of this new species are discussed and illustrated. A key to females of *Poropoea* species lacking the Rs1 track in the fore wing has been constructed and is presented here.

Keywords

Attelabidae, club unsegmented, key, leaf-rolling weevils, *Paratomapoderus brachypterus*

Introduction

The trichogrammatid genus *Poropoea* Foerster, 1851 (Hymenoptera, Trichogrammatidae) currently contains 19 species (Noyes 2017), well-known as egg parasitoids of leaf rolling attelabid beetles (Coleoptera: Attelabidae), which are distributed in the Palaearctic, Oriental, and Nearctic regions (Girault 1911, Silvestri 1916, Nowicki 1936, Hirose 1963, Viggiani 1968, Subba Rao 1969, Lin 1994, Luo and Liao 1994, Lou et al. 1996, Kobayashi and Kato 2004, Fursov 2007, Narendran and Hayat 2007, Hayat and Poorani 2013). A *Poropoea* sp. associated with *Apoderus humeralis,* currently included in the genus *Cycnotrachelodes* (Olivier) (Coleopera, Attelabidae) (Reckhaus 1997) was reported from the Afrotropical realm, Madagascar sub-region (Zwick 2009). Recently, female specimens of a *Poropoea* sp. have been collected in Gabon from eggs of *Paratomapoderus brachypterus* (Voss) (Coleoptera, Attelabidae, Apoderinae, Hoplapoderini), in leaf rolls of a species of *Combretum* Loefl. belonging to the Combretaceae. Their taxonomic study showed that they represent an undescribed species, clearly differentiated from all other species of the genus *Poropoea*. This new species, the first record of a member of the genus for the West-Central African sub-region, is described herein, and a key to the females of *Poropoea* species lacking the Rs1 track in the fore wing is given.

Materials and methods

From a *Combretum* sp., 67 leaf rolls of *P. brachypterus* were sampled from 15 to 25 June 2016 in Gabon, Ogooué-Ivindo, Ivindo National Parc, Ipassa Makokou Strict Nature Reserve, Station de Recherche de Ipassa, 500m a.s.l; 0°30'43"N, 12°48'12"E. The emerged parasitoids, two specimens, were initially preserved in 70% alcohol. These specimens were later dissected and mounted on slides using balsam-phenol as permanent mounting medium. For the terminology, Doutt and Viggiani (1968) and Pinto (2006) were followed.

Taxonomy

Poropoea africana Laudonia & Viggiani, sp. n.

http://zoobank.org/E2FA26B9-B944-4572-ABA3-902EAF14C926
Figs 1–6

Holotype ♀ (on slide). Gabon: Ogooué-Ivindo, Parc N. Ivindo, Station de Recherche de Ipassa, m a.s.l 500; 0°30'43"N, 12°48'12"E (DMS), June 2016, leg. Silvano Biondi. **Paratype**: 1 ♀, same data as holotype. Holotype and paratype will be deposited in the Entomological collection of the Dipartimento di Agraria dell'Università degli Studi “Federico II”, Portici, Napoli, Italia.

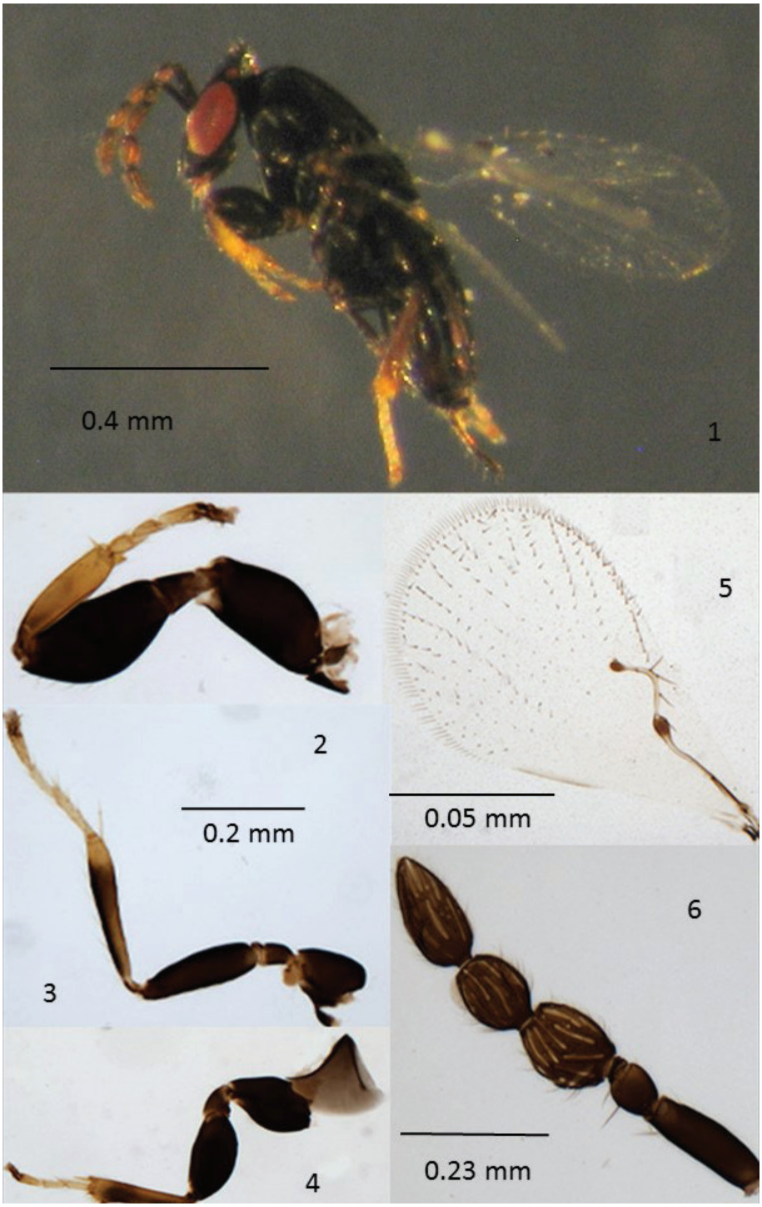

Figure 1–6. *Poropoea africana*, holotype female**. 1** adult **2** fore leg **3** middle leg **4** hind leg **5** fore wing **6** antenna.

Diagnosis. The new species is easily distinguished from the known members of the genus *Poropoea* by the following combination of characters: female antennal club unsegmented; premarginal vein of the fore wing with a basal "knot" and stigma of the stigmal vein black; lack of RS1 track in the fore wing; front and hind legs more robust than the middle ones, and with coxa and femur markedly enlarged; and ovipositor exserted for one-third of the gaster length. For the lack of the RS1 track on fore wing, *P.africana* shares this character only with *P. bella* Hayat et Poorani, *P. longicornis* Viggiani, and *P. orientalis* Subba Rao, but it is unique in having the club unsegmented, a nodular premarginal vein, and the coxa and femur of the front and hind legs markedly enlarged.

Description. Female (Fig. 1): Body length 1.18 mm. Body dark brown and shiny, ocelli and eyes red; antennae, legs (except the yellow-ochraceous tarsi, front tibia, distal part of middle and hind legs), and exserted part of the ovipositor, concolourous with the body. Fore wing hyaline but with basal half of the sub costal vein, base of premarginal vein and stigma of the stigmal vein dark brown. *Head* lenticular, 2.6 wider than long. Maxillary palps 2-segmented and labial palps vestigial. Mandibles with two external acute teeth. Antennal formula 1,1,(2), 2,1 (Fig. 6); scape narrow, three times as long as wide; pedicel small, almost as long as wide; two small anelli present; first funicular segment clearly wider than the second one and 1.3 as long as wide; second funicular segment smaller than the first, 1.2 as long as wide; club coniform, unsegmented, 1.6 as long as the second funicular segment; antennal segments with short and scanty setae; funicular segments with two and club with three rows of longitudinal sensilla. *Mesosoma* rather flat, same plane and slightly longer than metasoma; pronotum short, mid lobe of mesoscutum as long as scutellum but slightly longer and wider, both with a shallow reticulate sculpture and with two pairs of setae; mid lobe of mesoscutum and scutellum without a longitudinal median groove; metanotum very short, with 2-3 transversal thickenings; propodeum medially slightly longer than metanotum with a pair of large, ovoid spiracles near the anterior margin of the sclerite and a thickened strand starting from the internal spiracle margin and reaching the middle of the propodeum. Fore wing (Fig. 5), twice as long as broad, with subcostal, premarginal, marginal, and stigmal vein ratios 23:10:8:8, premarginal vein with a basal nodule and with one seta; arched marginal vein which fails to attain the anterior wing margin, with three setae, stigmal vein with a short seta in the middle; blade without cilia from base to below the level of stigmal vein, with 15 rows of cilia distinct reaching the distal margin of the wing and with few small cilia between them, vein track RS1 lacking; fringe very short, the longest cilia 12.5 times shorter than discal area width. Hind wing with two rows of cilia along anterior margin and two rows of cilia along the posterior margin. Fore leg (Fig. 2) evidently enlarged, with coxa and femur each 1.8 times as long as broad; femur with an outer margin convex; tibia as long as femur length, with its distal end provided with a single spine and a short and bifid apical spur; tarsus shorter than tibia (30:40) with first two tarsomeres sub-equal, approximately twice as long as wide, third tarsomere slightly longer. Middle leg (Fig. 3) thinner than the fore leg, with femur 3.6 times as long as wide; tibial spur a little shorter than basitarsus, the latter narrow and a little shorter than the following two segments combined. Hind leg (Fig. 4) with femur enlarged, twice as long as broad; tibia 1.2 times the femur length and distally provided with a whorl of short, coniform spines, and with a robust spur, shorter than basitarsus.

Metasoma shorter than mesosoma (48:41); ovipositor inserted at level of the first segment of gaster with the exserted part one-third as long as metasoma length; third valvulae nearly one-third the total length of the ovipositor; stylets very long.

Male. unknown.

Etymology. The name refers to the continent of the collection site.

Distribution. Gabon, West-Central Africa.

Remarks. The new species is easily distinguished from the known members of the genus *Poropoea.* The markedly enlarged coxa and femur of the front and hind legs is an interesting character which appears to be clear adaptations to host parasitisation [probably for body stability and propulsive efficiency of the ovipositor], and not reported for any other species of the genus *Poropoea.* Similar features of the legs are present in the male of *Blastophaga psenes* (L.) (Hymenoptera, Chalcidoidea, Agaonidae), a well-known gall maker and pollinator of *Ficus carica* and in other fig-wasps only (Grandi 1929, Hill 1967).

Some characters of *P. africana*, such as the antennal formula, the nodular premarginal vein, and the and modified legs, may suggest the inclusion of this species at least in a new subgenus, but this proposal is deferred until more material, including males, could be collected for a proper evaluation of these characters.

Key to females of *Poropoea* species lacking of the Rs1 track in the fore wing

1 Antennal formula 1(scape), 1(pedicel), (2)(anelli), 3 (funicle), 2 (club)....... **2**

– Antennal formula 1, 1, (2), 2, (3) or 1, 1, (2), 2, 1...................................... **3**

2 Exserted part of the ovipositor about as long as meso-and metathorax combined; funicular segments at least 2.5 times as long as wide .... ***P. longicornis* Viggiani**

– Exserted part of the ovipositor as long as head, meso-and metathorax combined, funicular segments a little more than 2 times as long as wide .... ***P. orientalis* Subba Rao**

3 Antennula formula 1,1,(2), 2, (3); mid lobe of mesoscutum and scutellum with a longitudinal, median groove; normal legs ....***P. bella* Hayat & Poorani**

– Antennal formula 1,1,(2), 2,1; mid lobe of mesoscutum and scutellum without a longitudinal, median groove; middle legs markedly smaller than fore and hind legs .... ***P. africana* sp. n.**

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RESEARCH ARTICLE

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More new records of spider wasps from Colombia (Hymenoptera, Pompilidae)

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Abstract

Aporinellus Banks, *Austrochares* Banks and *Dicranoplius* Haupt are new generic records for Colombia, as well as the species *Dipogon ariel* Banks, *Evagetes peruana* Banks, and *Euplaniceps notabilis* (Smith). Five new combinations are formally endorsed: *Aimatocare argentinica* (Banks), **comb. n.**; *Aimatocare longula* (Banks), **comb. n.**; *Aimatocare imitator* (Evans), **comb. n.**; *Aimatocare impensa* (Evans), **comb. n.**; *Aimatocare vitrea* (Fox), **comb. n.** Although these names have been used in Pompilidae, no formal nomenclatural act had been proposed. The presence of *Chirodamus paramicola* Roig-Alsina, previously reported with uncertainty, is confirmed. Finally, a new combination for *Euplaniceps notabilis* (Smith), **comb. n.** is proposed based on molecular phylogenetics and morphological data. The Colombian fauna of Pompilidae sums up to 38 genera and approximately 150 species.

Keywords

New combination, Pepsinae, Pompilinae

Introduction

The mostly solitary spider wasps (Hymenoptera: Pompilidae) are a widespread group of more than 1,000 species in four subfamilies and 60 genera in the Neotropics (Fernández 2000, Hanson and Wasbauer 2006). Despite some recent progress in the taxonomic study of Neotropical pompilids (*e. g.* Rodriguez et al. 2010, Waichert et al. 2012, Waichert et al. 2015), their nomenclature and systematics remains incipient. As a result, several genera lack identification keys and urge taxonomic revision, and many species remain to be described.

With the growing anthropogenic pressures on the Neotropical forests, one of the main concerns is the loss of biodiversity, which increases the need of prioritizing taxonomic studies in these areas. The authors are currently engaged in the monograph of spider wasps from Colombia, including keys to subfamilies, tribes, genera and species of several genera. This endeavor favored the publication of new genera and species records (Castro-Huertas et al. 2014). Because we are approaching the completion of the book's manuscript, it is desirable to publish some additional new records of genera and species, as well as relevant nomenclatural acts, as a separate note from the forthcoming book.

To date, the fauna of spider wasps from Colombia has 150 known species, belonging to 38 genera and four subfamilies.

Methods

Examined specimens. The specimens are deposited in the Entomological collection at Instituto Alexander von Humboldt, Villa de Leiva, Colombia (**IAvH-E**), Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogotá, Colombia (**ICN**), Entomological Collection of the Museo Javeriano de Historia Natural, Pontificia Universidad Javeriana, Bogotá, Colombia (**MPUJ**) and Museo Entomológico Universidad del Valle, Cali, Colombia (**MUSENUV**). *Dicranoplius* Haupt specimens from the Utah State University Entomology Collection, Logan, UT (**EMUS**) were examined.

Results

The following species and genera are reported for the first time in Colombia.

Subfamily Pompilinae
Aporinellus Banks

Aporinellus aff. *medianus* Banks, 1917

Specimen data. Magdalena. 1♂, PNN Tayrona, Palangana [11°20'0"N, 74°2'0"W]; 30 m, malaise, 4–23 May 2001, R. Henríquez, M1765 (IAvH-E); 1♂, Neguanje, [11°20'0"N, 74°2'0"W], 10 m, Malaise, 28 Jul - 18 Aug 2001, R. Henríquez, M2019 (IAvH-E).

Comments. This is the first record of the genus for Colombia and northern South America. The known distribution of *Aporinellus* is worldwide, except Australia (Evans 1966). The studied specimens probably belong to an undescribed species that will be studied elsewhere.

Austrochares Banks

Austrochares aff. *mexicanus* Dreisbach, 1966

Specimen data. Magdalena. 1♀, PNN Tayrona, Neguanje, [11°20'N, 74°2'W]; 10 m, malaise, 20 Apr–4 May 2001, R. Henríquez, (IAvH-E), 1♂, 4–23 May 2001, R. Henríquez, (IAvH-E).

Comments. This is the first record of the genus for Colombia and northern South America. *Austrochares* was previously known from Mexico to Argentina, including Brazil, Chile, and Peru (Evans 1969). The studied specimen keys out to *A. mexicanus* in Evans's (1969) key, but it probably belongs to an undescribed species that will be further studied elsewhere.

Dicranopilus Haupt

Dicranopilus aff. *areatus* (Taschenberg, 1869)

Specimen data. Bolívar. 2♂, Santuario de Fauna y Flora Los Colorados, Alto el Mirador, 6–24 Oct 2001, E. Deulufeut (IAvH-E). **Magdalena.** 8♂, 1♀, *PNN Tayrona*, Neguanje, 20 Apr–4 May 2001; 9♂, 2♀, 4 –23 May 2001; 3♂, 14–28 Jul 2001; 11♂, 28 Jul–18 Aug 2001; 12♂, 17–27 Sept 2001, R. Henriquez (EMUS, IAvH-E).

Comments. This is the first record of the genus for Colombia. *Dicranoplius* is restricted to the Neotropics, to both temperate and tropical South America. It was previously known from Trinidad south to Argentina (Evans 1969). The studied specimens key out as *D. areatus* in Evans's (1969) key, but they belong to an undescribed species, which will be described elsewhere.

Euplaniceps Haupt

Euplaniceps notabilis (Smith, 1860), comb. n.

Aporus (*Aporus*) *notabilis notabilis* (Smith, 1860), Mem. Am. Entomol. 20: 52.

Planiceps notabilis Smith, 1860, Jour. Ent., 1:80 [Type: female, Mexico] – Cresson, 1867, Trans. Amer. Ent. Soc., 1: 137.

Pompilus (*Planiceps*) *notabilis* Cameron, 1893, Biol. Centr.-Amer., Hymen. II, p. 186.

Pompilus flavomarginatus Cameron, 1893, ibid, p. 191 [Type: female, Mexico: Yucatan. BMNH no. 19,703] Syn. by Evans 1966.

Odontaporus notabilis Bradley, 1944, Trans. Amer. Ent. Soc., 70: 114–115.

Specimen data. See Rodriguez et al. (2015), Appendix S1.

Comments. This is the first record of this species for Colombia. *Euplaniceps notabilis* was previously recorded from Mexico to Costa Rica (Evans 1966). The new combination is proposed based on molecular phylogenetic analyses (Rodriguez et al. 2015), which included *A. notabilis* (labeled "*Euplaniceps* sp.", voucher PO484) in the *Euplaniceps* clade, sister to the Antillean *Drepanaporus.* This species had previously been included in the genus *Odontaporus* by Bradley (1944) based on the presence of a tooth in the margin of the inferior mandible and bare eyes. Bradley (1944) did not mention the presence of this tooth in many *Euplaniceps* species (see Colomo de Correa 1998). Evans (1966) included this species in *Aporus* based mainly on the second submarginal cell receiving only one recurrent vein. This character is very variable even within *Euplaniceps* species (JR pers. obs.), where the second submarginal cell can receive one or two recurrent veins, with the second recurrent vein sometimes being interstitial with the second intercubital vein. Moreover, females of *A. notabilis* do not have a v-shaped spatium frontale as all other *Aporus,* but a flattened area between the antennal alveoli on the same plane as the clypeus which is found in many *Euplaniceps* species (see Colomo de Correa 1998). Finally, the male genitalia have parameres with parallel-side edges and truncated apex, which is a diagnostic character of *Euplaniceps* males. The two subspecies, *A. n. notabilis* and *A. n. pulchritarsis*, are herein included in *Euplaniceps.*

Evagetes Lepeletier

Evagetes peruana (Banks, 1947)

Specimen data. Boyacá. 22♂, SFF Iguaque, Cabaña Chaina, [5°25'N, 73°27'W], 2,600 m, malaise, 9–26 Sept 2002, A. Roberto (IAvH-E).

Comments. This is the first record of this species for Colombia and east of the Andes. *Evagetes* is most diverse in the Holarctic region, having South American species occurring west of the Andes (Argentina, Chile and Peru) (Evans 1966; Fernández 2000). This species was previously known from Trujillo, Peru (Banks 1947).

Priochilus Banks

Priochilus formosum hondurense Dreisbach, 1950

Specimen data. Vichada. 1♀, Centro Gaviotas, 170 m, 17 Oct 1989, F. Fernández leg. (ICN).

Comments. Fernández (2000) cited the occurrence of *P. formosum hondurense* Dreisbrach, 1950 in Colombia (Orinoco region), without providing specimen data and/or specimen voucher. We add a female specimen to this species' range. *Priochilus formosum hondurense* is known from females only and had been known from Honduras to Costa Rica (Evans 1966).

Priochilus imperius Banks, 1944

Specimen data. Meta. 1♀, RNN La Macarena, Caño La Curía, 580 m., 25 Dec 1986, F. Fernández leg. (ICN).

Comments. Fernández (2000) reported the species from Bolivia, Brazil, Ecuador, Colombia (Meta) and in Peru (*apud* Evans 1966). Additionally, the Catalogue of Life (www.catalogueoflife.org) has added Chile to *P. imperius* list of occurrences. Specimen data and/or specimen voucher are not provided by Fernández (2000), making record questionable. Here we record a female specimen from Colombia. *Priochilus imperius* was described based on specimens from Bolivia, British Guiana, Ecuador, Peru, and Surinam (Banks 1944).

Subfamily Pepsinae

Aimatocare Roig-Alsina

Note. Roig-Alsina (1989) established the genus *Aimatocare* for the *Chirodamus argentinicus* species-group, as delimited by Evans (1968), but did not propose new combinations for the newly established genus. Herein, we formalize the following nomenclatural acts: *Aimatocare argentinica* (Banks), **comb. n**.; *Aimatocare imitator* (Evans), **comb. n**.; *Aimatocare longula* (Banks, 1946), **comb. n**.; *Aimatocare impensa* (Evans), **comb. n**.; and *Aimatocare vitrea* (Fox), **comb. n**.

Aimatocare longula (Banks, 1946)

Specimen data. Cauca. 1♀, Morales, El Pomarroso, Finca El Recuerdo, [2°48'34.5"N, 76°37'15.8"W], 1,600 m, by hand, 12 Sept 2013, D. Caraball (MUSENUV).

Comments. This is the first record of this species for Colombia. It was previously known from Bolivia, Brazil and Peru (Fernández 2000).

Chirodamus Haliday

Chirodamus paramicola Roig-Alsina, 1984

Specimen data. Cundinamarca. 1♀, PNN Chingaza, 3,400 m, hand collection, Nov 1988, G.D. Amat (MPUJ).

Comments. Roig-Alsina (1984) recognized five species mostly from southern South America, with one species, *C. paramicola*, in Venezuela and Colombia. The holotype and paratypes are from the Venezuelan Andes, and the single specimen from Colombia was collected in Nariño (southwestern Colombia) and deposited in London without further study. We found a new specimen from Chingaza Park, which slightly differs from the type series by having different fore leg coloration. The Colombian specimen studied here comprises a possible geographical and morphological bridge between the Merida (Venezuela) and Nariño specimens.

Dipogon Fox

Dipogon ariel Banks, 1946

Specimen data. Boyacá. 1♀, SFF Iguaque, Cabaña Chaina, [5°25'0"N, 73°7'0"W], 2,600m, malaise, 10 Jun 2001, 28 Jun 2001, P. Reina (IAvH-E).

Comments. This is the first record of this species for Colombia. *Dipogon ariel* was previously known from Ecuador (Banks 1946).

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RESEARCH ARTICLE

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Larval morphology of *Phratora koreana* Takizawa, 1985 with a key to the larvae of the Palaearctic *Phratora* species (Coleoptera, Chrysomelidae, Chrysomelinae)

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Abstract

The first and third instar larvae of *Phratora koreana* Takizawa, 1985 are described and illustrated in detail for the first time. Morphological changes in the pigmentation, tubercular pattern and defensive glands during the larval development are discussed. The life cycle and host-plant of *P. koreana* and a key to the larvae of the Palaearctic *Phratora* species are also provided.

Keywords

First and third instar larvae, leaf beetles, life cycle, morphology, South Korea

Introduction

The genus *Phratora* Chevrolat, 1836 is widely distributed in the Holarctic region, and also in the Oriental region restricted to montane areas (Ge et al. 2004). In the Palaearctic region, the genus is represented by 32 species (Kippenberg 2010), and larval morphology has been known for nine species (Kimoto and Takizawa 1994, Steinhausen 1994, Zaitzev and Medvedev 2009, etc.). Both adult and larva feed on the leaves of *Salix*, *Populus* and *Betula* (Jolivet and Hawkeswood 1995) and include several important pests, such as *P. vitellinae* (Linnaeus, 1758) and *P. vulgatissima* (Linnaeus, 1758) (Batley et al. 2004). Based on the larval and pupal morphology and biology, the genus *Phratora* belongs to the generic group *Phaedon* proposed by Kimoto (1962) with the genera *Phaedon* Latreille, *Gastrophysa* Chevrolat and *Mesoplatys* Baly and is easily distinguished by the presence of tubercles Dai and Dp on abdominal segment I in the third instar larva (Takizawa 1976).

Phratora koreana was described from South Korea by Takizawa (1985). Later (1990) he reported it from Japan, but nothing is so far known about its immature stages, life cycle and host-plants. The first author collected the adult and egg of *P. koreana* from Mt. Hambaeksan in South Korea, and larvae were obtained from eggs. Here the first and third instar larvae of *P. koreana* are described in detail for the first time. Morphological changes during the larval development are discussed, with a key to the known mature larvae of the Palaearctic *Phratora*.

Materials and methods

Eggs were collected along with adults on the host-plant *Salix caprea* on 6 June 2006 in South Korea, Gangwon Province, Taebaek-si, Mt. Hambaeksan, 37°16.30'N; 128°91.75'E, ca 1500 m. Larvae were reared from eggs in plastic containers (10 cm diameter, 12 cm deep), and then preserved in 70% ethanol. For examination of morphological characters, some larvae were dissected, cleared in 10% sodium hydroxide solution, rinsed in distilled water, and then mounted on slides with glycerine and Swan's liquid (20 g distilled water, 15 g gum arabic, 60 g chlorhydrate, 3 g glucose and 2 g glacial acetic acid). Descriptions and illustrations were prepared using a Nikon SMZ800 stereomicroscope and a Nikon ECLIPSE 80i light microscope with phase contrast, each microscope equipped with a camera lucida. Photographs were taken by a Nikon D5200 digital camera attached to a Nikon SMZ18 microscope, and were edited in Helicon Focus 5.3.12 and Adobe Photoshop CS5. The specimens were deposited in the Department of Biodiversity and Evolutionary Taxonomy, University of Wrocław, Poland and H.-W. Cho's private collection, South Korea. The terminology of the larval tubercles follows Kimoto (1962). The letters L, S and M in parentheses signify long, short, and minute setae, respectively.

Systematics

Phratora koreana Takizawa, 1985

Figs 1–16

Description of the larva. First instar larva. Body length 2.12–2.38 mm, width 0.56–0.62 mm, head width 0.42–0.44 mm (n = 3). Body yellowish-white with head brown, tubercles and legs light brown in alcohol; integument moderately covered with scle-

Figures 1–3. Habitus of *Phratora koreana*, third instar larva. **1** dorsal **2** lateral **3** ventral.

rotized platelets. Defensive glands very large on meso- and metathorax, but almost invisible on abdominal segments I–VII. Egg bursters present on meso- and metathorax. Head and mouthparts similar in the shape and chaetotaxy to those of the third instar larva.

Thorax. Prothorax with D-DL-EPa (2–3L 5–6S 2–3M) entirely pigmented; EPp (1S); P (1M); ES-SS (2M) weakly sclerotized (Fig. 15). Meso- and metathorax with Da (2S); Dp (1S); DLi (1S 2M) with a small egg burster situated anterior to a short seta; DLe (2L 2M) conical with a large defensive gland; EPa (1S); EPp (1S); P (1M); SS (1M) and ES (1M) weakly sclerotized.

Abdomen. Segments I–VI with Dai (1S); Dp (2S 1M); DL (1L 2S); EP (1L 1S 0–1M); P (1S 1M); PS-SS (3M) divided into two tubercles; ES (1M) on both sides generally fused. Segment VII with dorsal tubercles enlarged and fused. Segments VIII–IX each with dorsal and dorso-lateral tubercles enlarged and fused. Segment X with pygopod well developed.

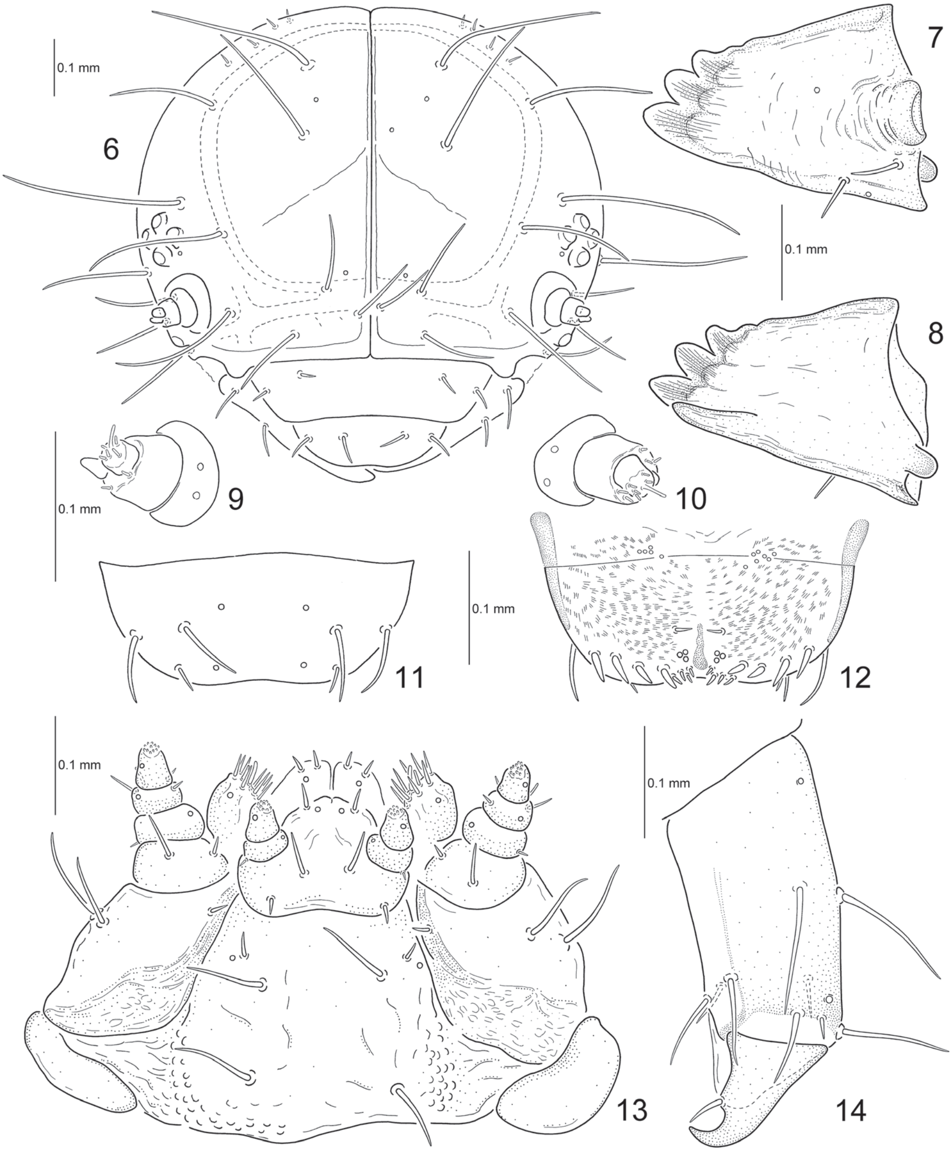
Third (last) instar larva. Body length 4.60–5.80 mm, width 1.50–1.90 mm, head width 0.85–0.90 mm (n = 7). Body elongate, rather broad, widest at meso- and metathorax, thence moderately narrowed posteriorly (Fig. 1) and moderately convex dorsally (Fig. 2). General coloration of integument yellowish-white in alcohol; dorsolateral region covered with dense platelets, forming a pair of longitudinal bands; head dark brown with anterior region and mouthparts largely yellowish-white; dorsal tubercles small, pale brown to dark brown, whereas ventral ones reduced (Fig. 3); legs pale yellow with apex of each segment brown. Defensive glands present on meso- and metathorax and abdominal segments I–VII.

Head. Hypognathous, rounded, strongly sclerotized (Fig. 6). Vertex with four pairs of minute setae; epicranium with six pairs of long setae; temporal side of head

Figures 4–5. *Phratora koreana*, live larva. **4** first and second instar larvae **5** third instar larva.

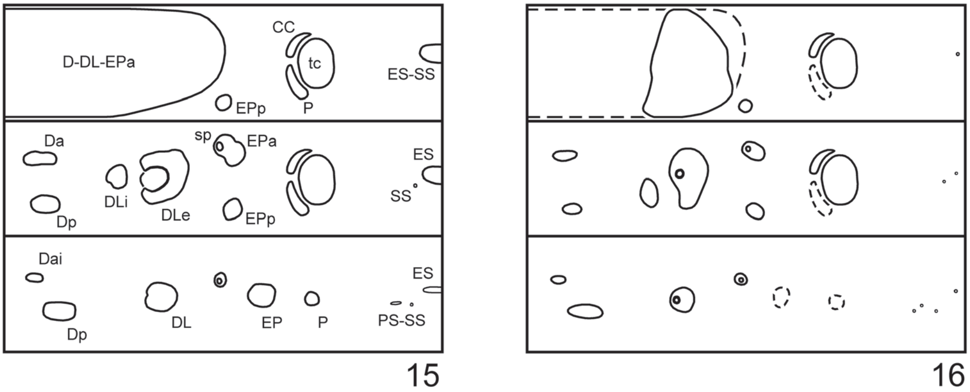
with three pairs of long setae. Epicranial suture distinct; frontal suture short, not reaching antennal socket; endocarina well developed. Frons with four pairs of long setae. Clypeus trapezoidal with two pairs of setae. Labrum slightly emarginate with two pairs of setae and two pairs of campaniform sensilla placed medially and one pair of setae placed at anterior border (Fig. 11); epipharynx with four pairs of stout and four pairs of small setae at anterior margin and one pair of small setae placed medially (Fig. 12). Mandible palmate, 4-toothed, with two setae and two campaniform sensilla (Figs 7–8). Maxillary palp 3-segmented; palpomere I transverse with one seta and one campaniform sensillum; II rectangular with two setae and one campaniform sensillum; III subconical with one seta, one digitiform sensillum and one campaniform sensillum on sides and a group of peg-like sensilla at the apex; palpifer distinct with two setae (Fig. 13). Mala rounded with eight pointed setae, two blunt setae and one campaniform sensillum; stipes longer than wide with three setae; cardo without setae. Labial palp 2-segmented; palpomere I rectangular with singe campaniform sensillum; II subconical with one campaniform sensillum below the apex and a group of peg-like sensilla at the apex. Hypopharyngeal area with three pairs of short setae and two pairs of campaniform sensilla. Prementum with two pairs of short setae and one pair of small setae – each of them placed at base of labial palp; postmentum with three pairs of setae. Stemmata six on each side, four of them located above antenna and two behind antenna. Antenna short, 3-segmented; antenomere I transverse with four campaniform sensilla; II stout, more or less as wide as long, with a conical sensorium and five small setae apically; III subconical with six small setae apically (Figs 9–10).

Thorax. Prothorax with D-DL-EPa (8–9L 2–3S) largest and pigmented only on dorso-lateral region; EPp (1S); P (1S) not sclerotized; ES-SS represented by a short seta (Fig. 16). Meso- and metathorax with Da (2S) small and transverse; Dp (1L) subequal to Da in size; DLi (1L 2S) larger than Da and Dp; DLe (2L 2–3S 1M) large and conical with a defensive gland; EPa (1L); EPp (1L); P (1S) not sclerotized; SS (1S) and ES (1S) represented by setae. Mesothoracic spiracles annuliform; peritreme fused with EPa. Legs rather stout; tibia with nine setae; tarsungulus large, strongly curved, basal tooth not developed, with 1 short seta (Fig. 14).



Figures 6–14. *Phratora koreana*, third instar larva. **6** head **7–8** mandibles **9–10** antennae **11** labrum **12** epipharynx **13** maxillae and labium **14** tibia and tarsungulus.

Abdomen. Segments I–VI with Dai (1S) very small; Dp (2L 1S) small, but larger than Dai; DL (2L 1M) conical with a defensive gland; EP (2L) and P (2S) not sclerotized; PS-SS (3S) and ES (1S) represented by setae. Segment VII with dorsal tubercles enlarged and fused; DL with a defensive gland. Segments VIII–IX each with dorsal and dorso-lateral tubercles fused. Segment X with pygopod well developed. Spiracles present on segments I–VIII.



Figures 15–16. Schematic presentation of tubercular patterns (top: prothorax, middle: mesothorax, bottom: abdominal segment II), *Phratora koreana*. **15** first instar larva **16** third instar larva.

Diagnosis. The larva of *Phratora koreana* is easily distinguished from all other known species of *Phratora* by the presence of small tubercles Dai and Dp on abdominal segments I–VI. In other species of *Phratora*, Dai and Dp are present only on abdominal segment I and a large tubercle D is present on II–VI. The larva of *Prasocuris glabra* (Herbst) is also similar to that of *Phratora koreana* in the presence of tubercles Dai and Dp on abdominal segments I–VI, but tubercles of *P. glabra* are much larger (Hennig 1938).

Distribution. South Korea: Gangwon, Gyeongnam, Jeju; Japan: Honshu (Takizawa 1985, 1990).

Notes on biology and larval morphology. Overwintered adults appear in late May, mate and lay 8–15 yellowish eggs per cluster on leaves of *Salix caprea* in early June. The larvae gregariously feed on leaves until the final instar. There are three larval instars and pupation takes place in the soil. Newly emerged adults appear in early July.

Morphological changes in the pigmentation, tubercular pattern and defensive glands occur during the larval development. The first instar larva has well developed and pigmented tubercles, but after molting to the second instar larva, ventral tubercles are reduced and median region of D-DL-EPa is unpigmented (Fig. 4). The defensive glands on abdominal segments I–VII are well developed in the second and third instar larvae, whereas they are almost invisible in the first instar larva. A pair of longitudinal bands on account of very dense and strongly sclerotized platelets appear only in the third instar larva (Fig. 5).

Key to the known third instar larvae of the Palaearctic species of the genus *Phratora*

(modified from Steinhausen 1994, Zaitzev and Medvedev 2009)

1 Claws with basal tooth (subgenus *Phratora* s.str.)..**2**
– Claws without basal tooth (subgenus *Phyllodecta* Kirby) **3**

2 Claws with large and quadrangular basal tooth; dorsal coloration mostly “pale” or “dark”, rarely “striped”. Forest belt of Palaearctic.......................... ***vulgatissima* (Linnaeus)**

– Claws with long, narrow and sharp basal tooth; dorsal coloration mostly “striped”. East Siberia, Far East............................ ***obtusicollis* Motschulsky**

3 The underside of the body with unpigmented and hardly visible tubercles....**4**

– The underside of the body with pigmented and distinct tubercles...............**6**

4 Tubercles Dai and Dp present on abdominal segments II–VI. Korea and Japan .... ***koreana* Takizawa**

– Tubercle D present on abdominal segments II–VI....................................**5**

5 Dorsal coloration mostly “dark”, rarely “pale” or “striped”; tubercle EP unpigmented. Forest belt of Palaearctic............................. ***laticollis* (Suffrian)**

– Dorsal coloration “dark”; tubercle EP pigmented. Taiwan... ***similis* (Chûjô)**

6 Body covered with black setae, which are usually darker than the rest of surface; dorsal side of the body covered unevenly with microsculpture, forming separate dark spots between tubercles; pronotum dark with 2 yellow spots near mid-line; body wide, narrowed posteriorly, depressed dorsally, with head distinctly narrower than thorax. Forest belt of Palaearctic.................... ***vitellinae* (Linnaeus)**

– Body covered with pale setae, which are usually not darker than the rest of surface, or setae paler than the rest of surface; dorsal side of the body covered with dense and even microsculpture, not forming separate spots; dorsal side giving dark impression; body elongate, cylindrical, with head indistinctly narrower than thorax **7**

7 Pronotum black with narrow pale medial stripe. Central Europe, European Russia, North Caucasus ....***tibialis*** (**Suffrian**)

– Pronotum pale medially...**8**

8 Pronotum black with wide pale stripe occupying medial 1/3. Central Europe, Northern Europe, North of European Russia, Siberia, Far East, Arctic......... ***polaris* (Schneider)**

– Pronotum pale with dark brown lateral sides. Forest belt of Palaearctic .... ***atrovirens* (Cornelius)**

Notes. *Phratora grandis* (Chûjô, 1956) occurring in Japan is not included in the key due to insufficient description. This species differs from other Japanese species in having black head and legs with all tubercles dark brown (Kimoto and Takizawa 1994).

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CHECKLIST

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Amphibians and reptiles of the state of Chihuahua, Mexico, with comparisons with adjoining states

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Abstract

Chihuahua is Mexico's largest state, and its physiographic complexity affects the distribution of its herpetofauna. We list amphibians and reptiles for the state of Chihuahua, with their conservation status. We also compare this list to those of six adjoining states in the United States and Mexico (New Mexico, Texas, Coahuila, Durango, Sinaloa, and Sonora). A total of 175 species of amphibians and reptiles is found in Chihuahua. Thirty-eight are amphibians, and 137 reptiles. Chihuahuan amphibians and reptiles represent just over 37% of such species from Chihuahua and neighboring states. Chihuahua shares the highest proportion of its herpetofauna with Sonora and Durango. Most of the herpetofauna of Chihuahua falls in IUCNs least concern category and is not listed by SEMARNAT. However, turtles in Chihuahua are a group of particular conservation concern.

Keywords

Checklist, Chihuahuan Desert, conservation status, herpetofauna, Sierra Madre Occidental

Introduction

Chihuahua is the largest state in Mexico. Its 245,612 km^2 (lying between 25°38'N to the south, 31°47'N to the north, and between 103°18'W to the east, and 109°7'W to the west) represent 12.6% of the total territory of the nation. Chihuahua is physiographically complex (Fig. 1), and this complexity affects the distribution of the herpetofauna.

The western part of the state is primarily occupied by the Sierra Madre Occidental, which passes the Continental Divide, separating the Pacific and Atlantic drainages. In Chihuahua, the Sierra Madre varies in width from ~130–160 km in the south (west of Hidalgo de Parral) to ~65–80 km in the north (west of Casas Grandes) (Tanner 1985, Lemos-Espinal and H. Smith 2007). The topography of the Sierra Madre Occidental of Chihuahua is very heterogeneous. The highest altitude is on Cerro Mohinora, at 3,300 m, and the extreme southwestern Pacific slopes of this Sierra are characterized by deep canyons that drop down to ~250 m in the Barranca del Septentrión/Cañón de Chínipas, making diverse habitats for plants and animals. Copper Canyon is a 64,750 km^2 system of six interconnected canyons located in Southwestern Chihuahua. Four of these six canyons are deeper than the Grand Canyon, some by over 305 m. The deepest canyon is Urique Canyon, 1,870 m in depth; Batopilas Canyon is 1,830 m deep; Sinforosa Canyon is 1,800 m deep; and Copper Canyon is 1,759 m deep (Martin et al.1998, INEGI 2004, Wyndham 2004, Lemos-Espinal and H. Smith 2007, 2015a, Lemos-Espinal et al. 2013, http://www.earlham.edu/~garcier/Geology/coppercanyon.htm).

Over half of the state of Chihuahua, east of the Sierra Madre, is covered by high plains at ~1,200–1,700 m. From these plains arise a large number of small to medium-sized, isolated sierras, some of which reach altitudes of over 2,000 m. Some are high enough to support coniferous forests, constituting continental "islands" surrounded by a "sea" of semiarid plains, where differentiation among populations is enhanced by isolation.

In extreme northeastern Chihuahua, deep canyons, similar to those on the Pacific side of the Sierra Madre Occidental, cut into the edge of the high plains, and support their own distinct herpetofaunal assemblages. Among them is the great Cañón de Santa Elena, in the Zona de Protección de Flora y Fauna Silvestre Cañón de Santa Elena, an extension of the Big Bend National Park of the United States.

In recent years, there has been a considerable increase in the study of Mexican regional and state herpetofaunas such as Sinaloa (Hardy and McDiarmid 1969), Peninsula of Baja California (Grismer 2002), Peninsula of Yucatan (Lee 1996), the Valley of Mexico (Ramírez-Bautista et al. 2009), Aguascalientes (McCranie and Wilson 2001), Chihuahua and Coahuila (Lemos-Espinal and H. Smith 2007a, b, 2015a, b; Lemos-Espinal and G. Smith 2016), Querétaro (Dixon and Lemos-Espinal 2010), San Luis Potosí (Lemos-Espinal and Dixon 2013), Michoacán (Alvarado-Díaz et al. 2015), Chiapas (Johnson et al. 2015b), Oaxaca (Mata-Silva et al. 2015), Nayarit (Woolrich-Piña et al. 2016), Nuevo León (Lemos-Espinal et al. 2016), Sonora (Enderson et al. 2009, Lemos-Espinal and Rorabaugh 2015, Lemos-Espinal et al. 2015, Rorabaugh 2008, Rorabaugh and Lemos-Espinal 2016), and Tamaulipas (Farr 2015, Terán-Juárez et al. 2016).

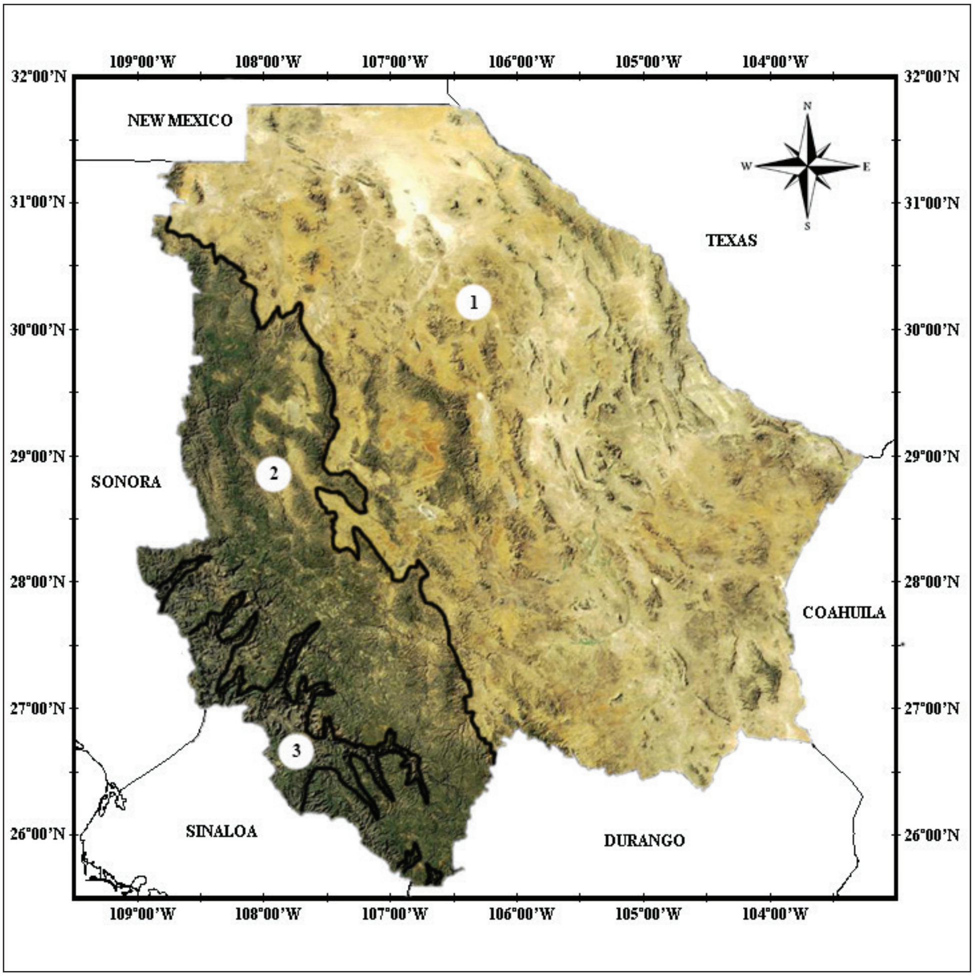

Figure 1. Topographical map of the state of Chihuahua, Mexico: **1** Chihuahuan Desert **2** Sierra Madre Occidental, and **3** Cooper Canyon (INEGI 2001).

Among these states Chihuahua has received a great deal of attention in the study of its herpetofauna. Lemos-Espinal and H. Smith (2015a) reviewed herpetological studies previously done in this state, reporting a total of 158 publications related to amphibian and reptile species since the description of *Axolotes maculata* (= *Ambystoma rosaceum*) by Owen (1844) through the description of *Incilius mccoyi* by Santos-Barrera and Flores-Villela (2011), adding the recent publications by Anderson and Greenbaum (2012), Villa et al. (2012), Uriarte-Garzón and García-Vázquez (2014), Lemos-Espinal and H. Smith (2015a), and Lemos-Espinal et al. (2015). The number of publications has increased to 163. The chronological distribution of these publications is the following: prior to 1850 (1); 1851–1875 (4); 1876–1900 (5); 1901–1925 (1); 1926–1950 (14); 1951–1975 (18); 1976–2000 (37); 2001–2015 (83), suggesting a surge in interest and knowledge about the herpetofauna of Chihuahua.

Although there has been a considerable interest in the herpetofauna of Chihuahua, as stated above, none of these 163 publications has focused on the conservation statuses of the documented species for this state. Here, we report the list of amphibians and reptiles that have been recorded so far for the state of Chihuahua. While checklists for Chihuahua are available (e.g., Lemos-Espinal and H. Smith 2007, 2015a), we expand on these earlier efforts by also collecting and summarizing the conservation statuses for each documented species. We also compare the list of the six adjoining states in the United States and Mexico for which recent checklists are available (New Mexico, Texas, Coahuila, Durango, Sinaloa, and Sonora). Our goal is to place this checklist into a regional and conservation context not available in previously published checklists.

Methods

We compiled the list of amphibians and reptiles of the state of Chihuahua from the following sources: (1) our own field work; (2) specimens from the Laboratorio de Ecología – UBIPRO (**LEUBIPRO**) collections; (3) databases from the Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (National Commission for the Understanding and Use of Biodiversity; **CONABIO**), including records from the following 22 collections Colección Herpetológica, Departamento de Zoología, Escuela Nacional de Ciencias Biológicas (**ENCB**); Colección Herpetológica, Museo de Zoología "Alfonso L. Herrera", Facultad de Ciencias UNAM (**MZFC-UNAM**); Colección Nacional de Anfibios y Reptiles, Instituto de Biología UNAM (**CNAR**); Amphibians and Reptiles Collection, University of Arizona (**UAZ**); Collection of Herpetology, Amphibians and Reptiles Section, Carnegie Museum of Natural History, Pittsburgh; Collection of Herpetology, Biology Department, Tulane University, New Orleans (**TU**); Collection of Herpetology, Department of Vertebrate Zoology, National Museum of Natural History, Smithsonian Institution (**USNM**); Collection of Herpetology, Herpetology Department, American Museum of Natural History (**AMNH**); Collection of Herpetology, Herpetology Department, California Academy of Sciences (**CAS**); Collection of Herpetology, Museum of Comparative Zoology, Harvard University Cambridge (**MCZ**); Collection of Herpetology, Museum of Vertebrate Zoology, Division of Biological Sciences, University of California Berkeley (**MVZ**); Collection of Herpetology, Museum of Zoology, University of Michigan Ann Arbor (**UMMZ**); Collection of Herpetology, Texas Cooperative Wildlife Collection, Texas A&M University (**TCWC**); Collection of Herpetology, Texas Natural History Collection, University of Texas Austin (**TNHC**); Collection of Herpetology, University of Colorado Museum (**UCM**); Collection of Herpetology, University of Illinois Museum of Natural History (**UIMNH**); Division of Amphibians and Reptiles, Field Museum of Natural History (**FMNH**); Fort Worth Museum of Sciences and History (**FWMSH**); Herpetology Section, Natural History Museum of Los Angeles County (**LACM**); Louisiana State University, Museum of Life Sciences; Merriam Museum, University of Texas Arlington (**UTAMM**); Museum of Natural History, Division of

Herpetology, Kansas University (**MNHUK**); and (4) a thorough examination of the available literature on amphibians and reptiles in the state. Species were included in the checklist only if we were able to confirm the record, either by direct observation or through documented museum records or vouchers in the state. In addition, we recorded the conservation status of each species based on three sources: 1) the IUCN Red List, 2) Environmental Viability Scores from Wilson et al. (2013a,b), and 3) listing in SEMARNAT (2010).

Scientific names used in this publication are based on the taxonomic list published in Lemos-Espinal (2015). The amphibian names follows Frost (2016) and the reptile names follows Uetz and Hošek (2016). State lists used to compare the species composition between Chihuahua and the adjoining states were: Dixon (2015) for Texas; Enderson et al. (2009) for Sinaloa; Lemos-Espinal and G. Smith (2016) for Coahuila; Painter and Stuart (2015) for New Mexico; Rorabaugh and Lemos-Espinal (2016) for Sonora; and Valdez-Lares et al. (2013) for Durango. We updated these lists for Coahuila (adding *Crotalus ornatus*, Nevárez De los Reyes et al. [2016]); Sonora and Sinaloa (adding *Gopherus evgoodei*, Edwards et al. [2016]); Texas (adding *Crotalus ornatus*, Anderson and Greenbaum [2012]); Durango (we regarded the population of *Barisia imbricata* [Wiegmann] as *Barisia ciliaris* [Smith]; *Sceloporus edbelli* Smith et al. as part of *Sceloporus consobrinus* Baird & Girard; *Sceloporus lineolateralis* Smith as part of *Sceloporus jarrovii* Cope; and *Aspidoscelis scalaris* [Baird & Girard] as part of *Aspidoscelis gularis* [Baird & Girard]). We also determined the number of overlapping species between each of these states and Chihuahua.

Results and discussion

A total of 175 (173 native, two introduced) species of amphibians and reptiles is found in Chihuahua. Thirty-eight of these species are amphibians (four salamanders, 34 anurans [one introduced]), and 137 are reptiles (13 turtles, 51 lizards [one introduced], and 73 snakes) (Tables 1, 2). These represent 32 families: nine amphibians (two salamanders; seven anurans), and 23 reptiles (five of turtles, 11 of lizards and seven of snakes), and 81 genera: 16 amphibians (two salamanders, 14 anurans), and 65 reptiles (seven of turtles, 20 of lizards and 38 of snakes). The introduced species are the American Bullfrog (*Lithobates catesbeianus*) and the Mediterranean House Gecko (*Hemidactylus turcicus*).

General distribution

Thirteen of the 38 species of amphibians that inhabit Chihuahua are endemic to Mexico, one of them (*Lithobates lemosespinali*) is restricted to a small area in the Sierra Madre Occidental of Chihuahua, and another (*Isthmura sierraoccidentalis*) is found only in an isolated population in the Sierra Madre Occidental of Sonora and Chihuahua. Eleven

Table 1. Checklist of amphibians and reptiles of Chihuahua providing the habitat type (CD = Chihuahuan Desert, SMO = Temperate Forests of the Sierra Madre Occidental, SBT = Subtropics – Canyons of the Sierra Madre Occidental; GEN = Generalist – occupies more than one habitat type), IUCN Status (DD = Data Deficient; LC = Least Concern, V = Vulnerable, NT = Neat Threatened; E = Endangered; CE = Critically Endangered) according to the IUCN Red List (The IUCN Red List of Threatened Species, Version 2016.1; www.iucnredlist.org; accessed 30 June 2016), Environmental Vulnerability Score (EVS; the higher the score the greater the vulnerability; NE = not evaluated) from Wilson et al. (2013a,b) and Johnson et al. (2015a), and conservation status in Mexico according to SEMARNAT (2010) (P = in danger of extinction, A = threatened; Pr = subject to special protection, NL – not listed). Source denotes whether the species was observed in the field by the authors (A), documented in the CONABIO data base and/or museum collections (C/M), or found in the literature (citation of source).

	Habitat type	IUCN	EVS	SEMARNAT	Source
CLASS AMPHIBIA					
ORDER CAUDATA					
Ambystomatidae					
Ambystoma mavortium Baird	CD	LC	10	NL	A
Ambystoma rosaceum Taylor	SMO	LC	14	Pr	A
Ambystoma silvense Webb	SMO	DD	14	NL	C/M
Plethodontidae					
Isthmura sierraoccidentalis (Gray)	SMO	V	12	A[1]	C/M
ORDER ANURA					
Bufonidae					
Anaxyrus cognatus (Say)	CD	LC	8	NL	A
Anaxyrus debilis (Girard)	CD	LC	7	Pr	A
Anaxyrus mexicanus (Brocchi)	SMO	NT	13	NL	A
Anaxyrus punctatus (Baird & Girard)	GEN	LC	5	NL	A
Anaxyrus speciosus (Girard)	CD	LC	12	NL	A
Anaxyrus woodhousii (Girard)	GEN	LC	10	NL	A
Incilius alvarius (Girard)	CD	LC	11	NL	Santos-Barrera et al. (2006)
Incilius mazatlanensis (Taylor)	SBT	LC	12	NL	A
Incilius mccoyi Santos-Barrera & Flores-Villela	SMO	NL	14	NL	A
Rhinella horribilis (Linnaeus)	SBT	LC	3	NL	A
Craugastoridae					
Craugastor augusti (Dugès)	SBT	LC	8	NL	C/M
Craugastor tarahumaraensis (Taylor)	SMO	V	17	Pr	A
Eleutherodactylidae					
Eleutherodactylus interorbitalis (Langebartel & Shannon)	SBT	DD	15	Pr	A
Eleutherodactylus marnockii (Cope)	CD	LC	NE	NL	A
Hylidae					
Hyla arenicolor Cope	SMO	LC	7	NL	A
Hyla wrightorum Taylor, 1939	SMO	LC	9	NL	A
Agalychnis dacnicolor (Cope)	SBT	LC	13	NL	A
Smilisca baudinii (Duméril & Bibron)	SBT	LC	3	NL	A
Tlalocohyla smithii (Boulenger)	SBT	LC	11	NL	A

	Habitat type	IUCN	EVS	SEMARNAT	Source
Microhylidae					
Gastrophryne mazatlanensis (Taylor)	SBT	NL	8	NL	A
Gastrophryne olivacea (Hallowell)	CD	LC	9	Pr	A
Hypopachus variolosus (Cope)	SBT	LC	4	NL	A
Ranidae					
Lithobates berlandieri (Baird)	CD	LC	7	Pr	A
Lithobates catesbeianus (Shaw) – **Introduced**	SMO	LC	10	NL	A
Lithobates chiricahuensis (Platz & Mecham)	SMO	V	11	A	A
Lithobates forreri (Boulenger)	SBT	LC	3	Pr	A
Lithobates lemosespinali (Smith & Chiszar) **Endemic**	SMO	DD	14	NL	A
Lithobates magnaocularis (Frost & Bagnara)	GEN	LC	12	NL	A
Lithobates pustulosus (Boulenger)	SBT	LC	9	Pr	C/M
Lithobates tarahumarae (Boulenger)	SMO	V	8	NL	A
Lithobates yavapaiensis (Platz & Frost)	SMO	LC	12	Pr	A
Scaphiopodidae					
Scaphiopus couchi Baird	GEN	LC	3	NL	A
Spea bombifrons (Cope)	CD	LC	10	NL	A
Spea multiplicata (Cope)	GEN	LC	6	NL	A
CLASS REPTILIA					
ORDER TESTUDINES					
Emydidae					
Chrysemys picta (Schneider)	GEN	LC	14	A	A
Terrapene nelsoni Stejneger	SMO	DD	18	Pr	A
Terrapene ornata (Agassiz)	CD	NT	15	Pr	A
Trachemys gaigeae (Hartweg)	CD	V	18	NL	A
Geoemydidae					
Rhinoclemmys pulcherrima (Gray)	SBT	NL	8	NL	A
Kinosternidae					
Kinosternon durangoense Iverson	CD	DD	16	NL	A
Kinosternon flavescens (Agassiz)	CD	LC	12	NL	A
Kinosternon hirtipes (Wagler)	GEN	LC	10	Pr	A
Kinosternon integrum LeConte	SBT	LC	11	Pr	A
Kinosternon sonoriense Le Conte	GEN	NT	14	P – subsp *longifemorale*	A
Testudinidae					
Gopherus flavomarginatus Legler	CD	V	19	P	A
Gopherus evgoodei Edwards, Karl, Vaughn, Rosen, Meléndez-Torres, & Murphy	SBT	NL	NE	A[2]	A
Trionychidae					
Apalone spinifera (Le Sueur)	CD	LC	15	Pr	A
ORDER SQUAMATA					
SUBORDER LACERTILIA					
Anguidae					
Barisia ciliaris (Smith)	SMO	NL	15	NL	A
Barisia levicollis Stejneger **Endemic**	SMO	DD	15	Pr	A

	Habitat type	IUCN	EVS	SEMARNAT	Source
Elgaria kingii Gray	SMO	LC	10	Pr	A
Gerrhonotus infernalis Baird	SMO	LC	13	NL	A
Crotaphytidae					
Crotaphytus collaris (Say)	GEN	LC	13	A	A
Gambelia wislizenii (Baird & Girard)	CD	LC	13	Pr	A
Dactyloidae					
Anolis nebulosus (Wiegmann)	SBT	LC	13	NL	A
Eublepharidae					
Coleonyx brevis Stejneger	CD	LC	14	Pr	A
Gekkonidae (INTRODUCED)					
Hemidactylus turcicus (Linnaeus) **Introduced**		N/A	N/A	N/A	A
Helodermatidae					
Heloderma horridum Wiegmann	SBT	LC	11	A	A
Iguanidae					
Ctenosaura macrolopha Smith	SBT	NL	19	Pr[1]	A
Phrynosomatidae					
Cophosaurus texanus Troschel	CD	LC	14	A	A
Holbrookia approximans Baird	CD	NL	14	NL	A
Holbrookia elegans Bocourt	GEN	LC	13	NL	A
Holbrookia maculata Girard	GEN	LC	10	NL	A
Phrynosoma cornutum (Harlan)	CD	LC	11	NL	A
Phrynosoma hernandesi Girard	SMO	LC	13	NL	A
Phrynosoma modestum Girard	CD	LC	12	NL	A
Phrynosoma orbiculare (Linnaeus)	SMO	LC	12	A	A
Sceloporus albiventris Smith	SBT	NL	16	NL	A
Sceloporus bimaculosus Phelan & Brattstrom	CD	NL	NE	NL	A
Sceloporus clarkii Baird & Girard	GEN	LC	10	NL	A
Sceloporus consobrinus Baird & Girard	CD	NL	NE	NL	A
Sceloporus cowlesi Lowe & Norris	CD	NL	13	NL	A
Sceloporus jarrovii Cope	SMO	LC	11	NL	A
Sceloporus lemosespinali Lara-Góngora	SMO	DD	16	NL	A
Sceloporus merriami Stejneger	CD	LC	13	NL	A
Sceloporus nelsoni Cochran	SBT	LC	13	NL	A
Sceloporus poinsettii Baird & Girard	CD	LC	12	NL	A
Sceloporus slevini Smith	SMO	LC	11	NL	A
Sceloporus virgatus Smith	SMO	LC	15	NL	A
Uma paraphygas Williams, Chrapliwy & Smith	CD	NT	17	P	A
Urosaurus bicarinatus (Duméril)	SBT	LC	12	NL	A
Urosaurus ornatus (Baird & Girard)	GEN	LC	10	NL	A
Uta stansburiana Baird & Girard	CD	LC	11	A	A
Phyllodactylidae					
Phyllodactylus tuberculosus Wiegmann	SBT	LC	8	NL	A
Scincidae					
Plestiodon bilineatus (Tanner)	SMO	NL	13	NL	A
Plestiodon callicephalus (Bocourt)	SMO	LC	12	NL	A

	Habitat type	IUCN	EVS	SEMARNAT	Source
Plestiodon multilineatus (Tanner) **Endemic**	SMO	DD	16	Pr	Van Devender and Van Devender (1975)
Plestiodon multivirgatus (Hallowell)	CD	LC	14	Pr	A
Plestiodon obsoletus (Baird & Girard)	CD	LC	11	NL	A
Plestiodon parviauriculatus (Taylor)	SMO	DD	15	Pr	A
Plestiodon tetragrammus (Baird)	CD	LC	12	NL	A
Teiidae					
Aspidoscelis costata (Cope)	SBT	NL	11	Pr	A
Aspidoscelis exsanguis (Lowe)	CD	LC	14	NL	A
Aspidoscelis gularis (Baird & Girard)	CD	LC	9	NL	A
Aspidoscelis inornata (Baird)	CD	LC	14	NL	A
Aspidoscelis marmorata (Baird & Girard)	CD	NL	14	NL	A
Aspidoscelis sonorae (Lowe & Wright)	SMO	LC	13	NL	A
Aspidoscelis tesselata (Say)	CD	LC	14	NL	A
Aspidoscelis uniparens (Wright & Lowe)	CD	LC	15	NL	A
ORDER SQUAMATA					
SUBORDER SERPENTES					
Boidae					
Boa sigma Daudin	SBT	NL	NE	A[3]	A
Colubridae					
Arizona elegans Kennicott	CD	LC	5	NL	A
Bogertophis subocularis (Brown)	CD	LC	14	NL	A
Conopsis nasus Günther	SMO	LC	11	NL	A
Drymarchon melanurus (Duméril, Bibron & Duméril)	SBT	LC	6	NL	A
Drymobius margaritiferus (Schlegel)	SBT	NL	6	NL	A
Gyalopion canum Cope	CD	LC	9	NL	A
Gyalopion quadrangulare (Günther)	SBT	LC	11	Pr	A
Lampropeltis getula (Linnaeus)	GEN	LC	NE	A	A
Lampropeltis knoblochi Taylor	SMO	NL	10	A[4]	A
Lampropeltis polyzona Cope	SBT	NL	11	NL	A
Leptophis diplotropis (Günther)	SBT	LC	14	A	A
Masticophis bilineatus Jan	GBN	LC	11	NL	A
Masticophis flagellum Shaw	CD	LC	8	A	A
Masticophis mentovarius (Duméril, Bibron & Duméril)	SBT	LC	6	A	A
Masticophis taeniatus (Hallowell)	GEN	LC	10	NL	A
Mastigodryas cliftoni (Hardy)	SBT	NL	14	NL	A
Opheodrys vernalis (Harlan)	SMO	LC	NE	NL	Van Devender and Lowe (1977)
Oxybelis aeneus (Wagler)	SBT	NL	5	NL	A
Pantherophis emoryi (Baird & Girard)	CD	LC	13	NL	A
Pituophis catenifer (Blainville)	GEN	LC	9	NL	A
Pituophis deppei (Duméril)	SMO	LC	14	A	A
Rhinocheilus lecontei Baird & Girard	CD	LC	8	NL	A
Salvadora bairdii Jan & Sordelli	SMO	LC	15	Pr	A

	Habitat type	IUCN	EVS	SEMARNAT	Source
Salvadora deserticola Schmidt	CD	NL	14	NL	A
Salvadora grahamiae Baird & Girard	GEN	LC	10	NL	A
Senticolis triaspis (Cope)	SBT	LC	6	NL	A
Sonora aemula (Cope)	SBT	NT	16	Pr	A
Sonora semiannulata Baird & Girard	GEN	LC	5	NL	A
Sympholis lippiens Cope	SBT	NL	14	NL	A
Tantilla hobartsmithi Taylor	CD	LC	11	NL	A
Tantilla nigriceps Kennicott	CD	LC	11	NL	A
Tantilla wilcoxi Stejneger	SMO	LC	10	NL	A
Tantilla yaquia Smith	SBT	LC	10	NL	A
Trimorphodon tau Cope	SBT	LC	13	NL	A
Trimorphodon vilkinsonii Cope	CD	LC	15	A	A
Dipsidae					
Diadophis punctatus (Linnaeus)	GEN	LC	4	NL	A
Geophis dugesii Bocourt	SMO	LC	13	NL	A
Heterodon kennerlyi Kennicott	CD	NL	11	Pr	A
Hypsiglena chlorophaea Cope	GEN	NL	8	NL	A
Hypsiglena jani (Dugès)	CD	NL	6	NL	A
Imantodes gemmistratus (Cope)	SBT	NL	6	Pr	A
Leptodeira splendida (Günther)	SBT	LC	14	NL	A
Rhadinaea hesperia Bailey	SMO	LC	10	Pr - subsp *baileyi*	A
Rhadinaea laureata (Günther)	SMO	LC	12	NL	Villa et al. (2012)
Tropidodipsas repleta Smith, Lemos-Espinal, Hartman & Chiszar	SBT	DD	17	NL	A
Elapidae					
Micruroides euryxanthus (Kennicott)	SON	NL	15	A	A
Micrurus distans (Kennicott)	SBT	LC	14	Pr	A
Leptotyphlopidae					
Rena dissecta (Cope)	CD	LC	11	NL	C/M
Rena humilis Baird & Girard	CD	LC	8	NL	A
Rena segrega (Klauber)	CD	NL	NE	NL	C/M
Natricidae					
Nerodia erythrogaster (Forster)	CD	LC	11	A	Uriarte-Garzón and García-Vázquez (2014)
Storeria storerioides (Cope)	SMO	LC	11	NL	A
Thamnophis cyrtopsis (Kennicott)	GEN	LC	7	A	A
Thamnophis elegans (Baird & Girard)	SMO	LC	14	A	A
Thamnophis eques (Reuss)	GEN	LC	8	A	A
Thamnophis errans Smith	SMO	LC	16	NL	A
Thamnophis marcianus (Baird & Girard)	GEN	LC	10	A	A
Thamnophis melanogaster (Peters)	SMO	E	15	A	A
Thamnophis sirtalis (Linnaeus)	SMO	LC	14	Pr	A
Thamnophis unilabialis Tanner	SMO	NL	NE	NL	A
Thamnophis validus (Kennicott)	SBT	NL	12	NL	A

	Habitat type	IUCN	EVS	SEMARNAT	Source
Viperidae					
Agkistrodon bilineatus (Günther)	SBT	NT	11	Pr	A
Agkistrodon contortrix (Linnaeus)	CD	LC	14	NL	C/M
Crotalus atrox Baird & Girard	CD	LC	9	Pr	A
Crotalus basiliscus (Cope)	SBT	LC	16	Pr	A
Crotalus lepidus (Kennicott)	SMO	LC	12	Pr	A
Crotalus molossus Baird & Girard	GEN	LC	8	Pr	A
Crotalus ornatus Hallowell	CD	NL	13	NL	Anderson and Greenbaum (2012)
Crotalus pricei Van Denburgh	SMO	LC	14	Pr	A
Crotalus scutulatus (Kennicott)	CD	LC	11	Pr	A
Crotalus viridis (Rafinesque)	CD	LC	12	Pr	A
Crotalus willardi Meek	SMO	LC	13	Pr	A

A^1 = Protected under the name *Pseudoeurycea bellii*; A^2 = Protected under the name *Gopherus agassizii*; A^3 = Protected under the name *Boa constrictor*; A^4 = Protected under the name *Lampropeltis pyromelana*; Pr^1 = Protected under the name *Ctenosaura hemilopha*.

more are distributed in western Mexico (*Ambystoma rosaceum, A. silvense, Anaxyrus mexicanus, Incilius mazatlanensis, I. mccoyi, Craugastor tarahumaraensis* [Fig. 2], *Eleutherodactylus interorbitalis, Agalychnis dacnicolor, Tlalocohyla smithii, Lithobates magnaocularis,* and *L. pustulosus*). Three more species are widely distributed from southern Canada to northern Mexico (*Ambystoma mavortium, Anaxyrus cognatus,* and *Spea bombifrons*). One species (*Lithobates forreri*) is widely distributed from northern Mexico to Central America, with a range that extends from central western Sonora through the Pacific Coast to Costa Rica. Another sixteen species occur from central or southern United States to northern, central or southern Mexico (*Anaxyrus debilis, A. punctatus, A. speciosus, A. woodhousii, Incilius alvarius, Craugastor augusti, Eleutherodactylus marnockii, Hyla arenicolor, H. wrightorum, Gastrophryne mazatlanensis, G. olivacea, Lithobates chiricahuensis, L. tarahumarae, L. yavapaiensis, Scaphiopus couchii,* and *Spea multiplicata*). Four more occur from eastern and/or southeastern United States to South America (*Rhinella horribilis, Smilisca baudinii, Hypopachus variolosus,* and *Lithobates berlandieri*), this last species with isolated populations in the Sierra Madre Occidental. Only one of the amphibian species that currently inhabit Chihuahua was introduced to the state (*Lithobates catesbeianus*).

Five of the 13 species of turtles that inhabit Chihuahua are endemic to Mexico, two of them to the Bolsón de Mapimí, a small area in southeastern Chihuahua, southwestern Coahuila, and northeastern Durango (*Kinosternon durangoense* and *Gopherus flavomarginatus*), two more to western Mexico (*Terrapene nelsoni* and *Kinosternon integrum*), and one more to the subtropics of southeastern Sonora, southwestern Chihuahua, and northern Sinaloa (*Gopherus evgoodei*). Six more species occur from central or southern United States to northern (*Terrapene ornata* [Fig. 3], *Trachemys gaigeae, Kinosternon flavescens,* and *K. sonoriense*) or central or southern Mexico (*Kinosternon hirtipes*

Table 2. Summary of species present in Chihuahua by family, order or suborder, and class. Status summary indicates the number of species found in each IUCN conservation status in the Order DD, LC, V, NT, E, CE (see Table 1 for abbreviations; in some cases species have not been assigned a status by the IUCN and therefore these may not add up to the total number of species in a taxon). Mean EVS is the mean Environmental Vulnerability Score, scores ≥ 14 are considered high vulnerability (Wilson et al. 2013a,b) and conservation status in Mexico according to SEMARNAT (2010) in the Order NL, Pr, A, P (see Table 1 for abbreviations).

Class	**Order/ Suborder**	**Family**	**Genera**	**Species**	**Status Summary**	**Mean EVS**	**SEMARNAT**
Amphibia	Caudata		**2**	**4**	**1,2,1,0,0,0**	**12.5**	**2,1,1,0**
		Ambystomatidae	1	3	1,2,0,0,0,0	12.7	2,1,0,0
		Plethodontidae	1	1	0,0,1,0,0,0	12	0,0,1,0
	Anura		**14**	**34**	**2,26,3,1,0,0**	**9.8**	**25,8,1,0**
		Bufonidae	3	10	0,8,0,1,0,0	9.5	9,1,0,0
		Craugastoridae	1	2	0,1,1,0,0,0	12.5	1,1,0,0
		Eleutherodactylidae	1	2	1,1,0,0,0,0	15	1,1,0,0
		Hylidae	4	5	0,5,0,0,0,0	8.6	5,0,0,0
		Microhylidae	2	3	0,2,0,0,0,0	7	2,1,0,0
		Ranidae	1	9	1,6,2,0,0,0	9.6	4,4,1,0
		Scaphiopodidae	2	3	0,3,0,0,0,0	6.3	3,0,0,0
	Subtotal		**16**	**38**	**3,28,4,1,0,0**	**9.96**	**27,9,2,0**
Reptilia	Testudines		**7**	**13**	**2,5,2,2,0,0**	**14.16**	**5,6,2,0**
		Emydidae	3	4	1,1,1,1,0,0	16.25	1,2,1,0
		Geoemydidae	1	1	0,0,0,0,0,0	8	1,0,0,0
		Kinosternidae	1	5	1,3,0,1,0,0	12.6	3,2,0,0
		Testudinidae	1	2	0,0,1,0,0,0	19	0,1,1,0
		Trionychidae	1	1	0,1,0,0,0,0	15	0,1,0,0
	Squamata						
	Lacertilia		**20**	**51**	**4,34,0,1,0,0**	**12.91**	**35,9,5,1**
		Anguidae	3	4	1,2,0,0,0,0	13.25	2,2,0,0
		Crotaphytidae	2	2	0,2,0,0,0,0	13	0,1,1,0
		Dactyloidae	1	1	0,1,0,0,0,0	13	1,0,0,0
		Eublepharidae	1	1	0,1,0,0,0,0	14	0,1,0,0
		Gekkonidae	1	1			
		Helodermatidae	1	1	0,1,0,0,0,0	11	0,0,1,0
		Iguanidae	1	1	0,0,0,0,0,0	19	0,1,0,0
		Phrynosomatidae	7	24	1,16,0,1,0,0	12.7	20,0,3,1
		Phyllodactylidae	1	1	0,1,0,0,0,0	8	1,0,0,0
		Scincidae	1	7	2,4,0,0,0,0	13.3	4,3,0,0
		Teiidae	1	8	0,6,0,0,0,0	13	7,1,0,0
	Serpentes		**38**	**73**	**1,52,0,2,1,0**	**10.95**	**38,17,16,0**
		Boidae	1	1	0,0,0,0,0,0	?	0,0,1,0
		Colubridae	21	35	0,27,0,1,0,0	10.5	23,3,7,0
		Dipsidae	8	10	1,5,0,0,0,0	10.1	7,3,0,0
		Elapidae	2	2	0,1,0,0,0,0	14.5	0,1,1,0
		Leptotyphlopidae	1	3	0,2,0,0,0,0	9.5	3,0,0,0
		Natricidae	3	11	0,8,0,0,1,0	11.8	4,1,6.0
		Viperidae	2	11	0,9,0,1,0,0	12.1	1,9,0,0
	Subtotal		**65**	**137**	**7,91,2,5,1,0**	**11.99**	**78,32,23,1**
TOTAL			**81**	**175**	**10,119,6,6,1,0**	**11.45**	**105,41,25,1**

Figure 2. *Craugastor tarahumaraensis*. Ocampo, Chihuahua. Photo courtesy of Peter Heimes.

Figure 3. *Terrapene ornata*. Rancho de Flores Magón, Buenaventura, Chihuahua. Photo by Julio Lemos Espinal.

Figure 4. *Barisia levicollis* (female). Sierra del Nido, Chihuahua. Photo courtesy of Marisa Ishimatsu.

and *Apalone spinifera*). The remaining two species of turtles are widely distributed from southern Canada to northern Mexico (*Chrysemys picta*) and from southeastern Sonora, through the Pacific Coast, to Costa Rica (*Rhinoclemmys pulcherrima*).

Fifteen of the 51 species of lizards that occur in Chihuahua are endemic to Mexico, two of them to the state of Chihuahua (*Barisia levicollis* [Fig. 4] and *Plestiodon multilineatus*), one of the remaining 13 endemics is limited to the Bolsón de Mapimí (*Uma paraphygas*), one more to a small area in eastern Sonora and western Chihuahua (*Sceloporus lemosespinali*), another one to the temperate forests of western Chihuahua and northern Durango (*Plestiodon bilineatus*), one more to the Chihuahua Desert from northern Chihuahua to central Mexico (*Holbrookia approximans*), two others occupy areas in the Sierra Madre Occidental and the Sierra Madre Oriental (*Barisia ciliaris*), and even the Transvolcanic Belt (*Phrynosoma orbiculare*). The remaining seven endemic species are distributed mainly along the Pacific Coast of Mexico (*Anolis nebulosus, Ctenosaura macrolopha, Sceloporus albiventris, S. nelsoni, Urosaurus bicarinatus, Plestiodon parviauriculatus,* and *Aspidoscelis costata*).

The remaining 36 lizard species are not endemic to Mexico, one of them is distributed from southern Canada to northern Mexico (*Phrynosoma hernandesi*), and two more range from Mexico to northern Guatemala (*Heloderma horridum*) or to Costa Rica (*Phyllodactylus tuberculosus*) mainly on the Pacific Coast. Another 32 are distributed in the United States and Mexico, most of them are species characteristic of the Chihuahua Desert or woodlands of the Sierra Madre Occidental (*Elgaria kingii, Gerrhonotus infernalis, Crotaphytus collaris, Gambelia wislizenii, Coleonyx brevis, Cophosaurus texanus,*

Figure 5. *Crotalus willardi*. Sierra del Nido, Chihuahua. Photo courtesy of Robert Bryson.

Holbrookia elegans, H. maculata, Phrynosoma cornutum, P. modestum, Sceloporus bimaculosus, S. clarkii, S. consobrinus, S. cowlesi, S. jarrovii, S. merriami, S. poinsettii, S. slevini, S. virgatus, Urosaurus ornatus, Uta stansburiana, Plestiodon callicephalus, P. multivirgatus, P. obsoletus, P. tetragrammus, Aspidoscelis exsanguis, A. gularis, A. inornata, A. marmorata, A. sonorae, A. tesselata, and *A. uniparens*). Only one of the 51 lizard species that occur in Chihuahua is an introduced species (*Hemidactylus turcicus*).

Twenty-one of the 73 species of snakes are endemic to Mexico (*Conopsis nasus, Leptophis diplotropis, Mastigodryas cliftoni, Pituophis deppei, Salvadora bairdii, Sonora aemula, Sympholis lippiens, Trimorphodon tau, Geophis dugesii, Lampropeltis polyzona, Leptodeira splendida, Rhadinaea hesperia, R. laureata, Tropidodipsas repleta, Micrurus distans, Storeria storerioides, Thamnophis errans, T. melanogaster, T. unilabialis, T. validus,* and *Crotalus basiliscus*). Thirty-seven snake species that are found in Chihuahua are distributed from the United States to Mexico (*Arizona elegans, Bogertophis subocularis, Gyalopion canum, G. quadrangulare, Lampropeltis getula, L. knoblochi, Masticophis bilineatus, M. flagellum, M. taeniatus, Pantherophis emoryi, Rhinocheilus lecontei, Salvadora deserticola, S. grahamiae, Sonora semiannulata, Tantilla hobartsmithi, T. nigriceps, T. wilcoxi, T. yaquia, Trimorphodon vilkinsonii, Heterodon kennerlyi, Hypsiglena chlorophaea, H. jani, Micruroides euryxanthus, Rena dissecta, R. humilis, R. segrega, Nerodia erythrogaster, Thamnophis eques, Agkistrodon contortrix, Crotalus atrox, C. lepidus, C. molossus, C. ornatus, C. pricei, C. scutulatus, C. viridis,* and *C. willardi* [Fig. 5]). Another four species range from northern Mexico to Central or even South America

(*Boa sigma, Masticophis mentovarius*, *Imantodes gemmistratus,* and *Agkistrodon bilineatus*). Six more species are found from central or southern United States to Central or South America (*Drymarchon melanurus, Drymobius margaritiferus, Oxybelis aeneus, Senticolis triaspis, Thamnophis cyrtopsis,* and *T. marcianus*). Five more range from Canada to northern or central Mexico (*Opheodrys vernalis, Pituophis catenifer, Diadophis punctatus, Thamnophis elegans,* and *T. sirtalis*).

In terms of habitat types, 47 species are found in the temperate forests of the Sierra Madre Occidental. Forty-four are found in the subtropical canyons of the Sierra Madre Occidental. Fifty-eight species are found in the Chihuahuan Desert. One species is found in SON. Twenty-five species occupy more than one habitat type (i.e., are generalists).

Likely species and poorly documented species

There are several additional species that are likely to occur in Chihuahua, but that have not been recorded within the state. Three species of anurans might occur in the deep canyons and lowlands of the extreme southwestern part of the state. The Pacific Stream Frog (*Craugastor vocalis*) was recorded by Hardy and McDiarmid (1969) in extreme northeastern Sinaloa, 16 km NNE Choix, 520 m, near the state line with Chihuahua. The Sabinal Frog (*Leptodactylus melanonotus*) was recorded by Bogert and Oliver (1945) from Güirocoba and Álamos, Sonora, only about 25 and 35km respectively from the Chihuahua border, and by Smith et al. (2005) from the Río Mayo at the gates of Presa Mocuzari, Sonora. Hardy and McDiarmid (1969) mapped localities for this species (as *L. occidentalis*, a junior synonym) from throughout the lowlands of Sinaloa, including a locality in the extreme northeastern corner. The Lowland Burrowing Treefrog (*Smilisca fodiens*) has been recorded close to Chihuahua by Hardy and McDiarmid (1969) for Sinaloa, Bogert and Oliver (1945) for Sonora, and Trueb (1969) and Duellman (2001) for both states. Another anuran species likely to occur in extreme northeastern Chihuahua is the Gulf Coast Toad (*Incilius nebulifer*). This species of toad is represented by isolated populations at the southern extremity of the Big Bend region of Texas, adjacent to Coahuila (Conant and Collins 1998).

It is likely that at least four other turtle species occur in Chihuahua. Three species have been taken close to the state line with Sonora and Sinaloa, in the extreme southwestern part of the state. *Kinosternon alamosae* has been taken in the vicinity of Álamos, Sonora, about 35 km from the Chihuahua border. *Trachemys hiltoni* has been recorded from Güirocoba, ~25 km from Chihuahua, and from extreme northern Sinaloa (Hardy and McDiarmid 1969). Seidel (2002) mapped its range into Chihuahua, but only conjecturally. Legler and Webb (1970) stated that the species is limited to the Río El Fuerte drainage. These last authors stated that *Trachemys yaquia* is limited to the drainages of the Río Mayo, Río Sonora and Río Yaqui, however, Seidel (2002) conjectured that the range of this species extended into Chihuahua. In addition, the Common Snapping Turtle (*Chelydra serpentina*) occurs in the Río Grande at least in

New Mexico (Degenhardt et al. 1996), and may well occur farther south in extreme northeastern Chihuahua, where little turtle trapping has been done.

There are at least nine lizard species not yet recorded in the state of Chihuahua that are likely to occur in it; four of them in the deep canyons and lowlands of extreme southwestern Chihuahua; three in the extreme northeastern part of the state; and two in the extreme northwestern part. The Zebra-tailed Lizard (*Callisaurus draconoides*) was recorded by Bogert and Oliver (1945) from Güirocoba and Álamos, Sonora (~25 and 35 km respectively from the Chihuahua border), and Hardy and McDiarmid (1969) spotted it at several localities in extreme northeastern Sinaloa. The Black Banded Gecko (*Coleonyx fasciatus*) has been recorded from five localities along the foothills of the Sierra Madre Occidental of eastern Sonora, three of these localities are in the Álamos region, one fairly close to Chihuahua. Its habitat suggests that it might occur in some of the deep canyons of southwestern Chihuahua. The Regal Horned Lizard (*Phrynosoma solare*) ranges from southern Arizona through almost all of Sonora, into northern Sinaloa. Hardy and McDiamid (1969) and Bogert and Oliver (1945) recorded it near Chihuahua in both Sinaloa and Sonora. It is a species of arid and semiarid habitats on plains, hills, and low mountain slopes. The Desert Spiny Lizard (*Sceloporus magister*) shows a range similar to that of the preceding species. East of the Sea of Cortés, it is the western representative of the eastern *S. bimaculosus*.

In northeastern Chihuahua the presence of three additional lizard species is likely. Wright (1971) indicated that the New Mexico Whiptail (*Aspidoscelis neomexicana*) is known from only central New Mexico and extreme southwestern Texas; almost all records are from near the Río Grande. He projected its range into Chihuahua along the Río Grande; although there are no records, its occurrence is highly likely there. Conant and Collins (1998) depicted the southern part of the Big Bend region of Texas as part of the range of the Reticulate Banded Gecko (*Coleonyx reticulatus*). It may be expected in adjacent parts of Chihuahua. Also Conant and Collins (1998) projected the range of the Texas Alligator Lizard (*Gerrhonotus infernalis*) to include the southern part of the Big Bend region of Texas, southward through eastern Chihuahua, most of Coahuila and other states to the south. In northwestern Chihuahua the presence of the Western Banded Gecko (*Coleonyx variegatus*) is expected. As indicated in Stebbins (2003) and Degenhardt et al. (1996), this species occurs in extreme southwestern New Mexico, and probably also in adjacent northwestern Chihuahua. The Gila Monster (*Heloderma suspectum*) is also expected to occur in this part of the state. The known occurrence of this species in Sonora, Arizona, and New Mexico close to the Chihuahua border indicates that occurrence in Chihuahua is likely.

It is highly likely that nine more snake species occur within the state of Chihuahua. Two of them in southwestern Chihuahua (*Phyllorhynchus browni* and *Pseudoficimia frontalis*); four in northeastern Chihuahua (*Coluber constrictor, Lampropeltis alterna, Pantherophis bairdi, Tantilla cucullata*); two in the northwestern part of the state (*Crotalus tigris, Sistrurus catenatus*); and one in extreme southeastern Chihuahua (*Tantilla atriceps*). The Saddled Leaf-nosed Snake (*Phyllorhynchus browni*) was recorded by Bogert and Oliver (1945) from Alamos, ~35 km from the Chihuahua border; Hardy

(1972) reviewed the distribution of The False Ficimia (*Pseudoficimia frontalis*), citing specimens from near Álamos and Güirocoba, Sonora, ~35 and 25 km from the Chihuahua border, respectively. The North American Racer (*Coluber constrictor*) is rare in Mexico, with only three records. Two are from Coahuila, including one from the extreme northwestern corner, in the Sierra del Carmen (Wilson 1966). Occurrence in Chihuahua seems likely. The Gray-banded Kingsnake (*Lampropeltis alterna*) is well known in the Big Bend of Texas, and elsewhere in that state, as well as in Coahuila and other adjacent states in Mexico, but it has never been found in Chihuahua, although it almost certainly occurs there. Baird´s Ratsnake (*Pantherophis bairdi*) occurs in western Texas, including the Big Bend region, as well as northern Coahuila (Conant and Collins 1998); it is highly likely to occur in adjacent Chihuahua. The Trans-Pecos Black-headed Snake (*Tantilla cucullata*) is known only in Texas, in the Big Bend and immediate vicinity (Dixon et al. 2000); occurrence in adjacent Coahuila and Chihuahua is to be expected. In northwestern Chihuahua the occurrence of the Tiger Rattlesnake (*Crotalus tigris*) is expected. Stebbins (2003) indicates occurrence of this species in the extreme southeastern corner of Arizona, and in eastern Sonora near the Chihuahua border. An inhabitant of arid and semiarid foothills deserts, it may enter the latter state in some of its semiarid valleys. Another rattlesnake, the Massasagua (*Sistrurus catenatus*), is known from southern New Mexico (Degenhardt et al. 1996) and southeastern Arizona (Brennan and Holycross 2006); it likely occurs in adjacent Chihuahua. In extreme southeastern Chihuahua the occurrence of the Mexican Black-headed Snake (*Tantilla atriceps*) is expected. The known range of this species comes close to the southeastern corner of the state (Cole and Hardy 1981, Conant and Collins 1998).

Some amphibian and reptile species are known to occur in Chihuahua from only a few records, including the Sonoran Desert Toad (*Incilius alvarius*) recorded by Santos-Barrera et al. (2006) in the municipality of Janos; the Spectacled Chirping Frog (*Eleutherodactylus interorbitalis*) recorded by Lemos-Espinal et al. (2006) in Cumbre del Caballo, Chínipas; the Cliff Chirping Frog (*Eleutherodactylus marnockii*) recorded by Lemos-Espinal et al. (2001) in the Grutas de Coyame; the Many-lined Skink (*Plestiodon multivirgatus*) recorded only by Van Devender and Van Devender (1975) at Ojo de Galeana; the Smooth Green Snake (*Opheodrys vernalis*) recorded only by Van Devender and Lowe (1977) at 38.4 km SE of Guerrero; the Crowned Graceful Brown Snake (*Rhadinaea laureata*) recorded by Villa et al. (2012) near km 86 on Hwy 25 N of Creel, Bocoyna, and 1 km N of Baborigame, Guadalupe y Calvo; the Banded Blacksnake (*Tropidodipsas repleta*) recorded by H. Smith and Lemos-Espinal (2006) at km 36 road Temoris-Chínipas, Guazapares; and the Plain-bellied Watersnake (*Nerodia erythrogaster*) recorded by Uriarte-Garzón and García-Vázquez (2014) in the municipality of Ojinaga.

Comparisons with neighboring states

Overall, the species of amphibians and reptiles in Chihuahua represent just over 37% of the total pool of species from Chihuahua and its neighboring states (Tables 3, 4).

Table 3. Total number of native amphibian and reptile species in each state arranged according to taxonomic order/suborder. Superscripts indicate number of introduced species to the state.

Order/Suborder	Chihuahua	New Mexico	Texas	Sonora	Sinaloa	Durango	Coahuila
Caudata	4	3	28	3	1	3	4
Anura	33^1	23^1	41^1	33^2	35	30^1	20
Crocodilia			1	1	1		
Testudina	13	10	30^1	16^1	12	5	11
Squamata/Lacertilia	50^1	46^1	45^6	66^3	35	49^1	49^1
Squamata/Serpentes	73	52	75^2	71^1	62	59^1	49
TOTAL	**173^2**	**134^2**	**220^{10}**	**190^7**	**146***	**146^3**	**133^1**

*Introduced species for the state of Sinaloa are not documented in Enderson et al. (2009).

Species of reptiles from Chihuahua make up even more of the total pool of species, especially the Squamata, and more specifically Anguids and Snakes. Chihuahuan amphibians make up less of the species pool, especially salamanders. Chihuahua has a good proportion of the region's Ambystomatid salamanders, but is very depauperate in Plethodontids.

Overall, Chihuahua shares the highest proportion of its species with Sonora followed by Durango (Table 4). This is particularly evident in amphibians, with over 80% of Chihuahuan amphibians shared with Sonora. For reptiles, Chihuahua shares nearly 77% of its species with Durango and 66% with Sonora. Chihuahua generally shares the least number of species with Coahuila, Sinaloa, and Texas. These patterns of shared species are likely a function of the extent to which these states share habitat types. For example, Chihuahua, Sonora, and Durango all have extensive desert habitats whereas Texas, for example, has a much more diverse range of habitats than Chihuahua. In addition, Sonora and Chihuahua share the habitats and species found in the Sierra Madre Occidental. Our results considering Chihuahua and all of its neighboring states parallels the results of an analysis of the states along the US-Mexico border using Jaccard hierarchical clustering analyses (Smith and Lemos-Espinal 2015).

Conservation status

Most of the herpetofauna of Chihuahua falls in the IUCNs least concern category (119 of 132 [does not include DD species]; 90%), and as not listed by SEMARNAT (105 of 172; 61%) (Table 2). These percentages are similar to those from other recently compiled tallies of conservation statuses for Mexican states (Coahuila: Lemos-Espinal and G. Smith 2016, Hidalgo: Lemos-Espinal and G. Smith 2015, Nayarit: Woolrich-Piña et al. 2016, Nuevo León: Lemos-Espinal et al. 2016). However, there are species of conservation concern in Chihuahua. For example, turtles and tortoises in Chihuahua appear to be a group of particular conservation concern with nearly half considered Vulnerable or Near Threatened by IUCN and more than half listed as Pr

Table 4. Summary of the numbers of species shared between Chihuahua and neighboring Mexican and American states (not including introduced species). The percent of Chihuahuan species shared by a neighboring state are given in parentheses. Total refers to the total number of species found in Chihuahua and all the neighboring states (i.e., regional species pool) and the number in parentheses in this column is the percent of the regional species pool found in Chihuahua. -- indicates either Chihuahua or the neighboring state has no species in the taxonomic group, thus no value for shared species is provided.

	Chihuahua	New Mexico	Texas	Sonora	Sinaloa	Durango	Coahuila	Total
Class Amphibia	37	17 (45.9)	17 (45.9)	30 (81.1)	20 (54.0)	23 (62.2)	15 (40.5)	122 (30.1)
Order Caudata	4	1 (25)	1 (25)	3 (75)	1 (25)	3 (75)	1 (25)	36 (11.1)
Ambystomatidae	3	1 (33.3)	1 (33.3)	2 (66.7)	1 (33.3)	3 (100)	1 (33.3)	8 (37.5)
Amphiumidae	0	–	–	–	–	–	–	1 (0)
Plethodontidae	1	0 (0)	0 (0)	1 (100)	–	–	–	22 (4.5)
Proteidae	0	–	–	–	–	–	–	1 (0)
Salamandridae	0	–	–	–	–	–	–	2 (0)
Sirenidae	0	–	–	–	–	–	–	2 (0)
Order Anura	33	16 (48.5)	16 (48.5)	27 (81.8)	19 (57.6)	20 (60.6)	14 (42.4)	86 (38.4)
Bufonidae	10	6 (60)	6 (60)	9 (90)	6 (60)	8 (80)	6 (60)	21 (47.6)
Craugastoridae	2	1 (50)	1 (50)	2 (100)	1 (50)	2 (100)	1 (50)	5 (40)
Eleutherodactylidae	2	–	1 (50)	1 (50)	1 (50)	0 (0)	1 (50)	10 (20)
Hylidae	5	2 (40)	2 (40)	5 (100)	4 (80)	3 (60)	2 (40)	22 (22.7)
Leptodactylidae	0	–	–	–	–	–	–	2 (0)
Microhylidae	3	1 (33.3)	2 (66.7)	2 (66.7)	2 (66.7)	1 (33.3)	1 (33.3)	5 (60)
Ranidae	8	3 (37.5)	1 (12.5)	6 (75)	4 (50)	4 (50)	1 (12.5)	16 (50)
Rhinophrynidae	0	–	–	–	–	–	–	1 (0)
Scaphiopodidae	3	3 (100)	3 (100)	2 (66.7)	1 (33.3)	2 (66.7)	2 (66.7)	4 (75)
Class Reptilia	136	76 (55.9)	66 (48.5)	90 (66.2)	61 (44.8)	86 (76.8)	62 (59.6)	343 (39.6)
Order Crocodylia	0	–	–	–	–	–	–	2 (0)
Crocodylidae	0	–	–	–	–	–	–	2 (0)
Order Testudines	13	6 (46.2)	6 (46.2)	6 (46.2)	4 (30.8)	5 (38.5)	6 (46.2)	47 (27.6)
Chelonidae	0	–	–	–	–	–	–	5 (0)
Chelydridae	0	–	–	–	–	–	–	2 (0)
Dermochelyidae	0	–	–	–	–	–	–	1 (0)
Emydidae	4	3 (75)	3 (75)	2 (50)	1 (25)	1 (25)	1 (25)	22 (18.2)
Geomydidae	1	–	–	1 (100)	1 (100)	–	–	1 (100)
Kinosternidae	5	2 (40)	2 (40)	2 (40)	1 (20)	3 (60)	3 (60)	10 (50)
Testudinidae	2	–	0 (0)	1 (50)	1 (50)	1 (50)	1 (50)	4 (5)
Trionychidae	1	1 (100)	1 (100)	–	–	–	1 (100)	2 (50)
Order Squamata	123	70 (56.9)	60 (48.8)	84 (68.3)	57 (46.3)	81 (65.8)	56 (45.5)	294 (41.8)
Suborder Lacertilia	50	30 (60)	25 (50)	33 (66)	17 (34)	34 (68)	23 (46)	143 (35)
Anguidae	4	1 (25)	1 (25)	1 (25)	1 (25)	3 (75)	2 (50)	7 (57.1)
Crotaphytidae	2	2 (100)	2 (100)	2 (100)	–	2 (100)	2 (100)	6 (33.3)
Dactyloidae	1	–	0 (0)	1 (100)	1 (100)	1 (100)	–	4 (25)
Eublepharidae	1	1 (100)	1 (100)	0 (0)	0 (0)	1 (100)	1 (100)	4 (25)
Helodermatidae	1	0 (0)	–	1 (100)	1 (100)	1 (100)	–	2 (50)
Iguanidae	1	–	–	1 (100)	1 (100)	0 (0)	–	9 (11.1)
Phrynosomatidae	24	16 (66.7)	12 (50)	19 (79.2)	9 (37.5)	18 (75)	12 (50)	61 (39.3)

	Chihuahua	New Mexico	Texas	Sonora	Sinaloa	Durango	Coahuila	Total
Phyllodactylidae	1	–	–	1 (100)	1 (100)	1 (100)	–	5 (20)
Scincidae	7	3 (42.8)	3 (42.8)	3 (42.8)	2 (28.6)	3 (42.8)	2 (28.6)	18 (39.9)
Teiidae	8	7 (87.5)	6 (75)	4 (50)	1 (12.5)	4 (50)	4 (50)	23 (34.8)
Xantusidae	0	–	–	–	–	–	–	4 (0)
Suborder Serpentes	73	40 (54.8)	35 (47.9)	51 (69.9)	40 (54.8)	47 (64.4)	33 (45.2)	151 (48.3)
Boidae	1	–	–	1 (100)	1 (100)	1 (100)	–	2 (50)
Colubridae	35	21 (60)	19 (54.3)	24 (68.6)	22 (62.8)	25 (71.4)	17 (48.6)	66 (53)
Dipsidae	10	4 (40)	3 (30)	7 (70)	6 (60)	6 (60)	3 (30)	22 (45.4)
Elapidae	2	1 (50)	0 (0)	2 (100)	2 (100)	–	0 (0)	4 (50)
Leptotyphlopidae	3	2 (66.7)	2 (66.7)	1 (33.3)	1 (33.3)	1 (33.3)	2 (66.7)	4 (75)
Natricidae	11	6 (54.5)	4 (36.4)	7 (63.6)	3 (27.3)	9 (81.8)	3 (27.3)	32 (34.4)
Viperidae	11	6 (54.5)	7 (63.6)	9 (81.8)	5 (45.4)	5 (745.4)	8 (72.7)	21 (52.4)
TOTAL	**173**	**93 (53.8)**	**83 (48.0)**	**120 (69.4)**	**81 (46.8)**	**109 (63.0)**	**77 (44.5)**	**465 (37.2)**

or A by SEMARNAT. Emydidae and Testudinae are the families of most conservation concern. Indeed, turtles account for 4 of the 13 species (31%) of the Chihuahuan herpetofauna that are categorized as Vulnerable, Near Threatened, or Endangered by the IUCN, even though they make up only 7% of the species in Chihuahua. We also found that turtles as a group also have the highest mean Environmental Vulnerability Score (EVS), especially Emydidae, Testudinidae, and Trionychidae. We therefore encourage additional emphasis be placed on better understanding the ecology and conservation status of turtle and tortoise populations in Chihuahua.

In addition, even though there are relatively few reptiles and amphibians placed on conservation lists in Chihuahua, this does not mean they are safe. Indeed, there are species, such as *Craugastor tarahumaraensis*, *Ctenosaura macrolopha*, *Uma paraphygas*, and *Tropidodipsas repleta* that are of great conservation concern based on their EVS values (Wilson et al. 2013a, b). In addition, the more locally appropriate EVS assessments (see Wilson et al. 2013a,b) also suggest that conservation concern should exist for the amphibian families Ambystomatidae, Craugastoridae, and Eleutherodactylidae; and the non-turtle reptile families Anguidae, Eublepharidae, Iguanidae, Scincidae, Teiidae, and Elapidae.

Even beyond these species and families, the environment and habitats of Chihuahua are subject to anthropogenic change, such as construction of border fences (Lasky et al. 2011), increased urbanization (Biggs et al. 2010), and changes in precipitation and increased drying associated with climate change (Seager and Vecchi 2010). Indeed, the distribution of species at high risk according to the EVS assessment (≥ 14; Wilson et al. 2013a,b) is not the same across habitat types. Nearly 40% of species (18/47) in the temperate forests of the Sierra Madre Occidental is at risk according to the EVS, and nearly a third of species in the Chihuahuan Desert (19/58). Just over 20% (10/44) of species in subtropical canyons of the Sierra Madre Occidental are at high risk. Generalist species (those that use more than one habitat type) are the least at risk (2 of 25 species). These results suggest that particular conservation attention should be paid to the Sierra Madre Occidental and the Chihuahuan Desert habitat types in Chihuahua. We thus again emphasize that continued and increased study of the herpetofauna of Chihuahua is needed to monitor the possible effects of any environmental changes.

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Taxonomy of the *Cryptopygus* complex. II. Affinity of austral *Cryptopygus* s.s. and *Folsomia*, with the description of two new *Folsomia* species (Collembola, Isotomidae)

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Abstract

Folsomia minorae **sp. n.** and *F. australica* **sp. n.** are described from New Zealand and Australia, respectively. Their possible affinity to two different groups of *Cryptopygus sensu stricto* is discussed. Attention is paid to the variability of sensillary patterns of the genital segment in *Cryptopygus*: mainly, all s-chaetae are subequal, but in more advanced forms the dorsal triplet, lateral duplet or either of them become macrochaeta-like in length. *Cryptopygus ulrikeae* (= *Folsomia ulrikeae* Najt & Thibaud, 1987), **comb. n.** is given a new generic position.

Keywords

Australia, New Zealand, taxonomy

Introduction

The genus *Cryptopygus* Willem, 1902 *sensu stricto* has not received its modern generic diagnosis and most of its "austral" species need to be revised (Rusek 2002, Deharveng et al. 2005, Jordana et al. 2009, Potapov et al. 2013, Greenslade 2015). Several species related to *C. antarcticus* Willem, 1902 (the type species of *Cryptopygus*) are common in the high latitudes of the Southern Hemisphere and form a clear taxonomic group. They clearly differ from other genera of the *Cryptopygus* complex that are found in more northern areas (tropical and further into the Northern Hemisphere). In this paper we temporarily define *Cryptopygus s.s.* as having 3 and 5 s-chaetae on Abd IV and V respectively, s-chaetae in mid-tergal position on body tergites, and having no differentiated foil-chaetae at the end of the abdomen. Whilst hemispheric distribution patterns of certain Collembola genera have been well documented (e.g. Holarctic for *Tetracanthella* Schött, 1891, see Deharveng 1987), this group of "austral" *Cryptopygus* (*Cryptopygus s.s.* below) can be considered a geographical equivalent of the mostly Holarctic genus *Folsomia* Willem, 1902. Although occurring in different hemispheres, both genera show an increasing diversity towards the poles, a similar set of life forms and play similar ecological roles in collembolan communities, which are more evident in polar zones. This geographical segregation is even further complicated by the movement of a few *Cryptopygus s.s.* and *Folsomia* to the opposite hemisphere. Until now, at least two "apparent" members of *Cryptopygus s.s.*, *C. clavatus* (Schött, 1893) and *C. roberti* (Fjellberg, 1991) are known from areas of the North Atlantic. Despite the strong similarity between these two forms and the main group of "austral" *Cryptopygus* the final generic position of *clavatus* and *roberti* remains unresolved. The state of a few native "austral" members of *Folsomia* is more obscure as important characters are lacking. Here we present two apparently native and new species from the Australian region. They are described and compared with "austral" *Cryptopygus s.s.*, the potential ancestors of "austral" *Folsomia*. These two species indicate that the latter genus possibly resulted from the convergent evolution of several species of the *Cryptopygus s.s.*

Materials and methods

The notation system accp-as-al (Szeptycki 1972) was used to describe the set of s-chaetae. To establish the links between s-chaetae the approach by Potapov and Greenslade (2010) was applied to the genus *Folsomia*

Abbreviations

Abd. I–VI	abdominal segments I–VI
accp	accessory p-row s-chaeta
Ant. I–IV	antennal segments I–IV
as	anterosubmedial s-chaeta

a.s.l.	above sea level
bms	basal micro s-chaeta on antennal segments
e7	‘guard’ of labial papilla E
Leg I, II, III	first, second and third pairs of legs
M	macrochaeta
ms	micro s-chaeta(e) (=microsensillum(a) auct.)
s	macro s-chaeta or s-chaetae (=macrosensillum(a) or sensillum(a) auct.)
s.s.	*sensu stricto*
PAO	postantennal organ
Th.II–III	thoracic segments II and III
U3	inner edge of unguis

Institutional acronyms

MNZTPT	Museum of New Zealand Te Papa Tongarewa, Wellington
SAMA	South Australian Museum, Adelaide
MSPU	Moscow State Pedagogical University, Russia.

Results

Descriptions of new species

Folsomia minorae sp. n.

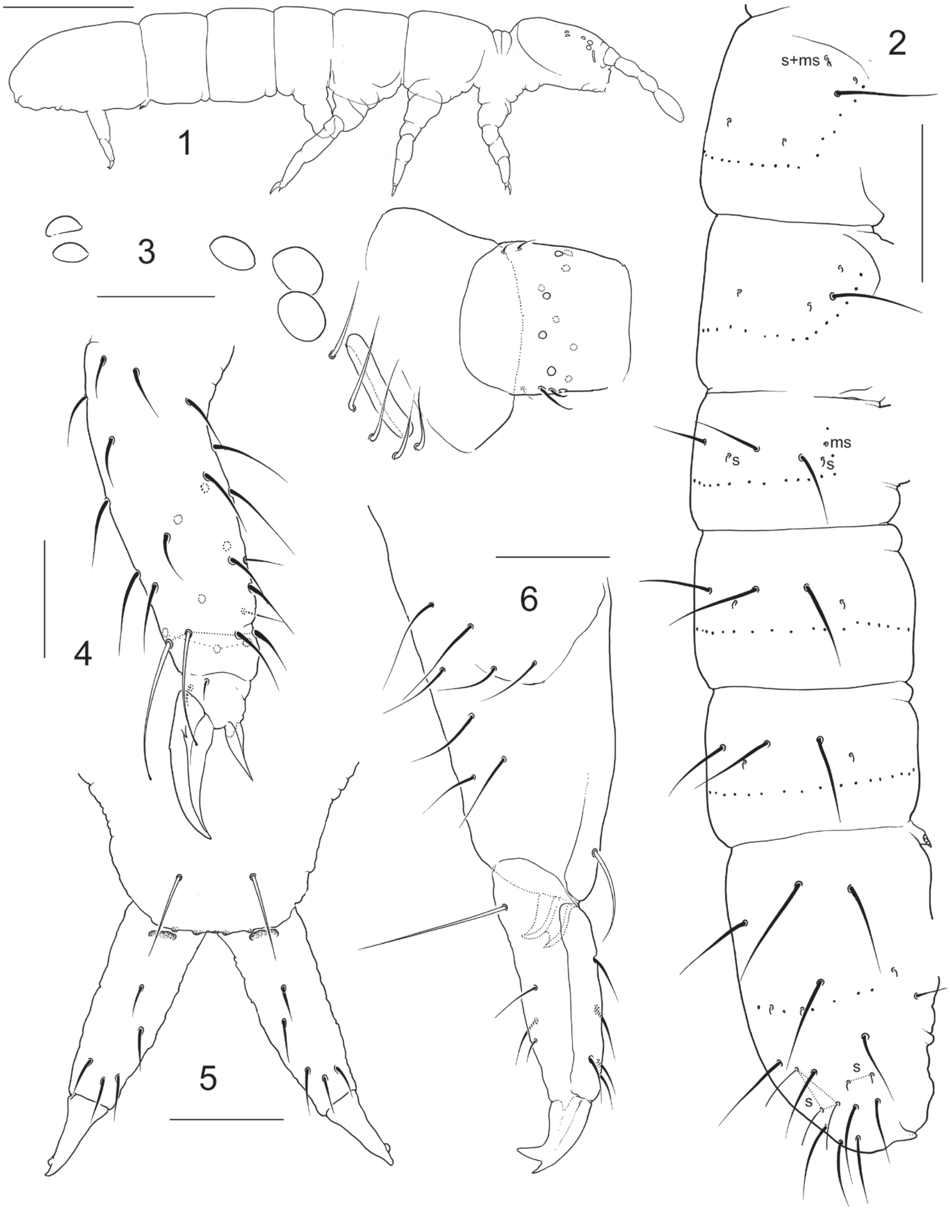
http://zoobank.org/08169B5D-CB65-4F2C-9C35-93A8EE6F0C63
Figs 1–13

Type material. Holotype: adult ♀. New Zealand, southern South Island, Central Otago, Pisa Range, 44°52'03"S, 169°9'33"E, 1700 m a.s.l., in soil and debris under *Dracophyllum muscoides* cushion, 18.ii.2014, coll. M. Minor (on slide). Paratypes. 10 paratypes, subadult ♀♀ and ♂♂of similar size with holotype, 7 of which from the same locality (and in close proximity), and 3 from Central Otago, The Remarkables Mts, 45°3'42"S, 168°48'40"E, 1829 m a.s.l., herbaceous snowbank, in soil, 19.ii.2014, coll. M. Minor (all on slides). Holotype and 4 paratypes kept in MNZTPT; 5 paratypes in MSPU.

Other material. One ♀ identified in all details as *F. minorae* sp. n. by A. Fjellberg (not seen by us): New Zealand, South Island (northern part), Avalanche Peak trail above Arthur Pass, 42°56'26"S, 171°33'29"E, forest litter, 23.i.2004, coll. A. Fjellberg.

Diagnosis. *Folsomia* species with 5+5 ocelli; slender subapical organite of Ant.IV; clavate tibiotarsal hairs; outer teeth on claws; stout dens with few chaetae and a large mucro; and characteristic ‘3+2’ sensillary pattern of s-chaetae on Abd.V.

Description. Body size of the only adult female 1.75 mm. Dark blue, appendages paler. Body cylindrical (Fig. 1). Abd.IV, V and VI clearly fused dorsally, Abd.IV and

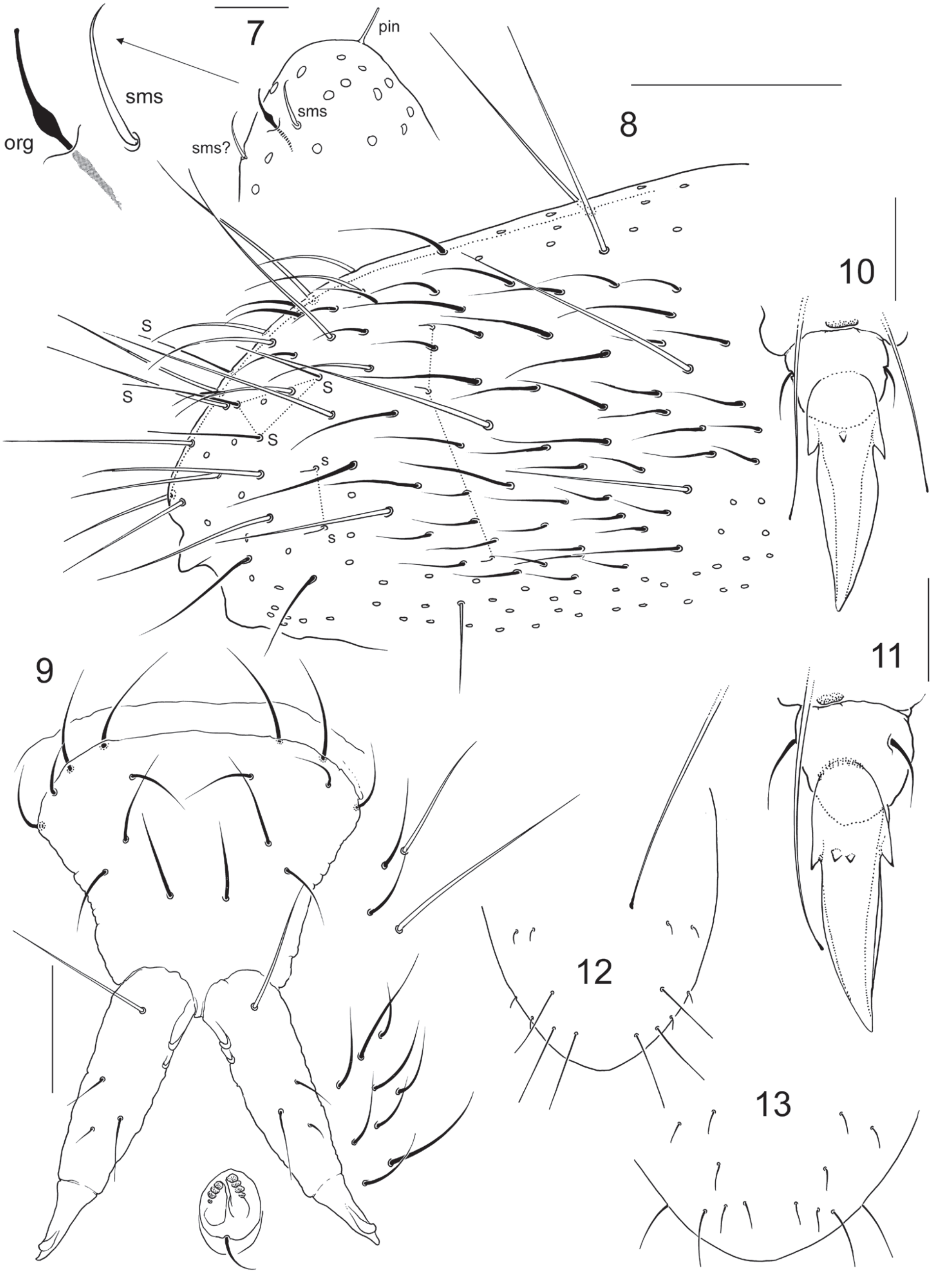


Figures 1–6. *Folsomia minorae* sp. n. **1** habitus **2** macrochaetae and s and ms-chaetae on body **3** anterior part of head **4** distal part of Leg III **5–6** furca, anterior (**5**) and lateral (**6**) view. Scale bar 0.3 mm in **1**; 0.15 mm in **2**, 0.03 mm in others.

III well separated. Cuticle reticulated, with roundish polygons, the largest of which almost as large as chaetae bases. Ocelli 5+5, arranged in two groups: three anterior and two posterior. PAO slender, not constricted, almost as long as width of Ant I (0.8–1.0) and 1.1–1.4 as long as inner unguis length (Fig. 3). Maxillary outer lobe with four sublobal hairs, maxillary palp bifurcate. Labral formula as 4/5,5,4. Labium with five papillae (A–E) and full set of 'guards', 'guard' e7 present, with three proximal, four basomedian, and five basolateral chaetae. Ventral side of head with 4+4 postlabial chaetae. Ant.I with two ventral s-chaetae (s) and three small basal ms-chaetae (bms), two dorsal and one ventral (Fig. 3), Ant.II with three bms and a latero-distal s, one of bms enlarged, Ant.III with one bms and with six distal s (including two lateral), without additional s-chaetae. S-chaetae on Ant.IV weakly differentiated. Apex of Ant. IV with two subapical ms (sms) both set at a distance from very long organite (org). Both sms of normal shape, organite with swelling in proximal part chili-shaped. The second subapical ms subequal to the first one, located more dorsally (Fig. 7). S-chaetae formula as common for the genus, 4,3/2,2,2,3,5 (s) and 1,0/1,0,0 (ms) (Fig. 2). Tergal s-chaetae much shorter than common chaetae and distinct. Medial s-chaetae on Th.II–Abd.III in mid-tergal position, on Abd.I–III between Mac1 and Mac2 (Fig. 2). Abd.V with five s-chaetae: three dorsal ones (al, accp1, accp2) long and slender, and two lateral short ('3+2' pattern) (Figs 2, 8,12). Macrochaetae very long, stout and smooth, 1,1/3,3,3 in number, medial ones on Abd.V more than twice as long as dens (2.0–2.4) and 4.7–5.5 times longer than mucro. Foil chaetae at the tip of abdomen absent. Axial chaetotaxy of Th.II–Abd.III as 6–8,6–7/4,4,4. Thorax without ventral chaetae. Unguis stout, without inner teeth, with one (two on Leg III) outer and two large lateral teeth (Figs 4, 10, 11). The doubling of outer tooth on Unguis 3 well visible only in anterior position (Fig. 11). Empodial appendage about half as long as unguis (empodial appendage length: U3 = 0.46–0.53). Upper and lower subcoxae of Leg I, II, III with 1,1; 2–3,6; 4–5,6–9 chaetae. Tibiotarsi without additional chaetae on Leg I and II (21 chaetae), and with several additional chaetae on Leg III (more than 26 at whole). Tibiotarsal tenent chaetae clavate, long (1.3–1.6 longer than inner edge of U3), in number 1, 2, 2 on Leg I, II, III. VT with 4+4 laterodistal and 6 posterior chaetae, anteriorly without chaetae. Laterodistal chaetae arranged almost in a line, posterior chaetae in two rows, proximal (2) and distal (4). Tenaculum with 4+4 teeth and one chaeta. Basal tooth smaller than others (Fig. 9). Anterior furcal subcoxae with 8–9 chaetae, posterior one with four chaetae. Anterior side of manubrium with a pair of chaetae (Fig. 5). Posterior side of manubrium with 4+4 laterobasal and 4+4 on main part, without apical and lateral chaetae. To describe chaetae on main part the notation system of Fjellberg (2007) can be somewhat applied: chaetae M1, M2, pr and ml1 present (Fig. 9). Dens stout, with five anterior chaetae arranged as 1,1,3, the second single chaeta positioned more medially than the first (Figs 5, 6). Posterior side of dens almost smooth, with four chaetae of which one strong basal and three in central part (two of normal size and one small) (Fig. 9). Very large, chitinized, bidentate (Figs 6, 9). Ratio of manubrium : dens : mucro = 3.6–4.2 : 2.0–2.4 : 1.

Etymology. The name is given after Maria Minor, who kindly provided some of the material on the new species.

Discussion. To date eight species of *Folsomia* are known from New Zealand (Greenslade 1994; 2012). In addition, three species, *F. parasitica* Salmon, 1942, *F. novaezealandiae* Salmon, 1943, and *F. lunata* Salmon, 1943, were removed from the list



Figures 7–13. *Folsomia minorae* sp. n. (**7–12**) and *F. australica* sp. n. (**13**) **7** apex of Ant.IV, lateral view **8** chaetotaxy of posterior part of Abd.IV, Abd.V and VI **9** furca, tenaculum, and furcal subcoxae, posterior view **10–11** apical part of Leg II (**10**) and III (**11**) **12–13** s-patterns chaetae of Abd.IV–V (lateral s of Abd.IV not shown). org—organite, sms—subapical ms, pin—pin-chaeta. Scal bar 0.1 mm in **8**, 0.03 mm in **9**, others, 0.01 mm.

as synonyms or were moved to the genus *Cryptopygus* (Bellinger et al. 2016). Among the valid species, five are blind, while others show different number of ocelli (8, 2 and 1, vs. 5 in *F. minorae* sp. n.). Very little morphological data are available for endemic New Zealand *Folsomia* species (*F. miradentata* Salmon, 1943, *F. pusilla* Salmon, 1944, *F. salmoni* Stach, 1947, and *F. sedecimoculata* Salmon, 1943). Particularly, figures of the furca are known only for *F. sedecimoculata* and *F. pusilla*. Both species show a more common structure of the dens (typical of the genus), which is slender and continuously narrowed, unlike in *F. minorae* sp. n. Clavate tibiotarsal hairs were not figured or mentioned in descriptions of New Zealand forms (present in the new species*)*. A comparison between *F. minorae* sp. n. and *Cryptopygus s.s.* is given below.

Differentiating characters of the new species are: five ocelli, unique subapical organite of Ant.IV, clavate tibiotarsal hairs, presence of outer teeth on claws, stout dens with few chaetae, and a very large mucro. Well differentiated '3+2' sensillary pattern of s-chaetae on Abd.V is also characteristic (see below). Three long and slender dorsal s-chaetae of Abd.V are found in species of several groups of *Folsomia* of the Holarctic (i.e. *F. penicula* Bagnall, 1939*, F. quadrioculata* (Tullberg, 1871) and *F. sensibilis* Kseneman, 1936), which belong to either '3+2' or '3+1+1' patterns.

Distribution and ecology. *F. minorae* sp. n. is known from three localities in South Island, New Zealand. It is probably a species restricted to mountainous areas.

Folsomia australica sp. n.

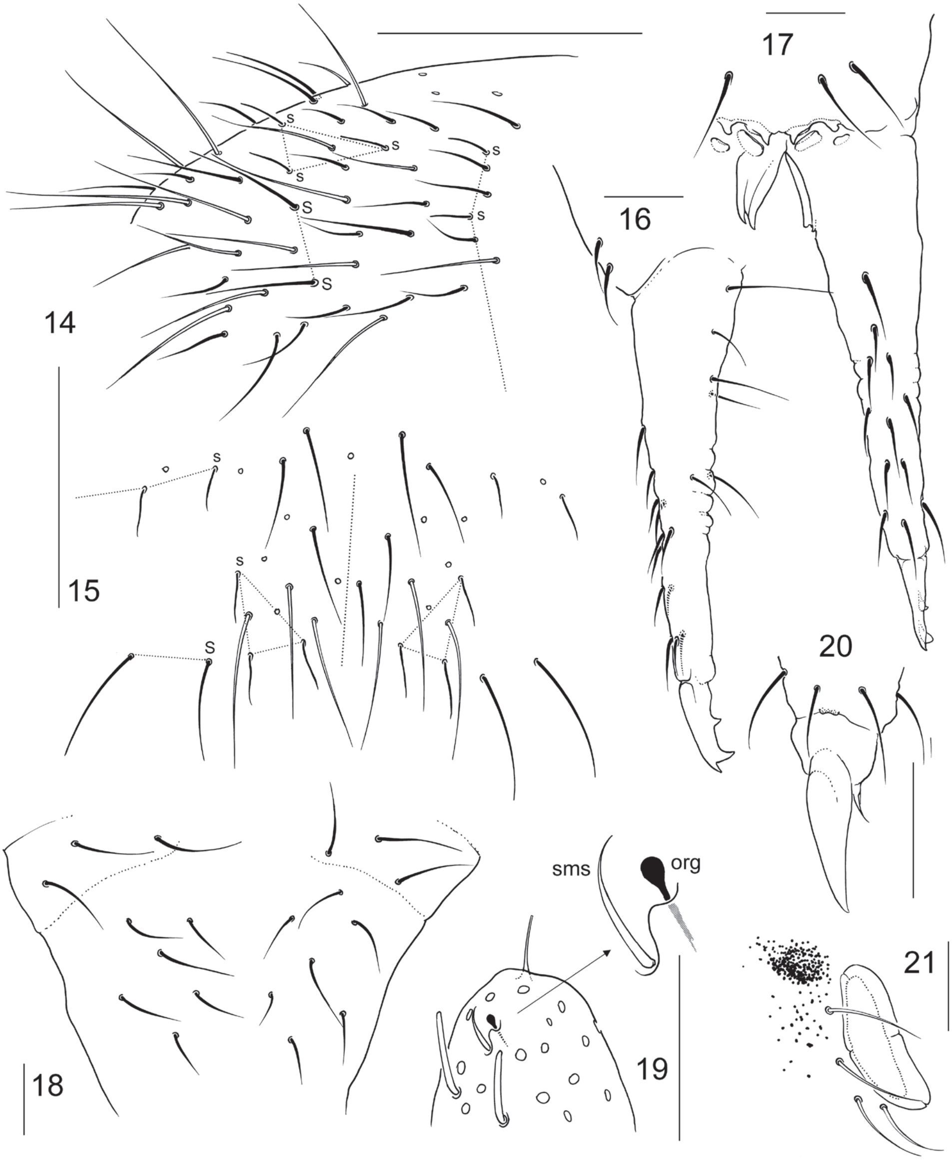
http://zoobank.org/C9C7BCD0-5200-4701-A90A-7F2763C9A550
Figs 14–21

Type material. Holotype: adult ♀. Australia, Chiltern National Park, Victoria, heathy dry forest, mostly native, 36°7'53"S, 146°36'20"E, 12.iv.2015, M. Lythe leg. Four paratypes, one adult ♀, one adult ♂and two sub-adult ♀♀ of the same size as adults. Holotype and two paratypes in SAMA, two paratypes in MSPU.

Other material. 10 specimens in ethanol (SAMA). Australia, Victoria, Mt Pilot National Park, 36°18'45"S, 146°33'16"E. 20.vii.2015, M. Lythe leg.

Diagnosis. *Folsomia* species with 1+1 ocelli; chaetotaxy of dens 12/6; tridentate mucro; 2 lateral s-chaetae on Abd.V clearly longer than 3 dorsal ones; 2+2 chaetae on anterior side of manubrium.

Description. Body size from 0.60 (adult male) to 0.75 mm (one of sub-adult females). White, with one black ocellus on each side of the head (Fig. 21). Body of normal shape for the genus. Abd IV, V and VI clearly fused dorsally, Abd.IV and III well separated. Cuticle "smooth", with fine orthogonal granulation, granules much smaller than chaetae bases. Ocelli 1+1, well-marked only by pigmentation, cuticular cornea weak. PAO wide, constricted, smaller (ca. 0.8) than width of Ant I, about 1.5 as long as inner unguis length (Fig. 21). Maxillary outer lobe with four sublobal hairs, maxillary palp bifurcate. Labral formula as 4/5,5,4. Labium with five papillae (A–E), 'guard' e7 present (whole number of 'guards' hard to estimate), with three proximal,



Figures 14–21. *Folsomia australica* sp. n. **14–15** chaetotaxy of posterior part of abdomen, lateral (**14**) and dorsal (**15**) views **16–17** furca, lateral (**16**) and anterior (**17**) view **18** manubrium, posterior view **19** apex of Ant.IV, dorsal view, left antenna **20** distal part of Leg III **21** ocellus and PAO. org—organite, sms—subapical ms. Scale bar 0.05 mm in **14, 15**, others, 0.01 mm.

four basomedian, and five basolateral chaetae. Ventral side of head with 4+4 postlabial chaetae. Ant.I with three ventral s-chaetae (s) and two small basal ms-chaetae (bms), dorsal and ventral, Ant.II with three bms and one latero-distal s. Ant.III with one bms and with five distal s (including one lateral), without additional s-chaetae. Ant.IV with several tubular s-chaetae. Subapical organite large and roundish, set together with subapical ms, as common for family (Fig. 19). S-chaetae formula 4,3/2,2,2,3,5 (s) and 1,0/0,0,0 (ms). Tergal s-chaetae shorter than common chaetae. Medial s-chaetae on Th.II–Abd.III in mid-tergal position, on Abd.I–III between Mac1 and Mac2. Abd.V with five s-chaetae with three dorsal ones (al, accp1, accp2), almost as long as common chaetae, and two lateral long, macrochaetae-like ('3+2' pattern) (Figs 14–15). Two lateral s-chaetae often slightly thickened on proximal 2/3 that makes them more distinct. Macrochaetae smooth, 1,1/3,3,3 in number, medial ones on Abd.V shorter than dens (0.6–0.8) and 2.6–3.0 times longer than mucro. Foil chaetae at the tip of abdomen absent. Axial chaetotaxy of Th.II–Abd.III as 9–10,6–8/4–5,4–5,4. Th.III with 1+1 ventral chaetae. Unguis without teeth (Fig 20). Empodial appendage about 0.6 as long as U3. Upper and lower subcoxae of Leg I, II, III with 1,1; 3,6; 5–6,6–7 chaetae. Tibiotarsi without additional chaetae on Leg I and II (21 chaetae), and with several additional chaetae on Leg III. Tibiotarsal tenent chaetae pointed, shorter than U3 (0.8–1.0). VT with 3+3 laterodistal and five posterior chaetae, of which four in transversal row, anteriorly without chaetae. Tenaculum with 4+4 teeth and a chaeta. Anterior furcal subcoxae with 8–12, posterior one with five chaetae. Anterior side of manubrium with two pair of chaetae, 2+2 (rarely 1+2) (Figs 16, 17). Posterior side of manubrium with 3+3 laterobasal, 6-7+6-7 on main part, without apical and lateral chaetae (Fig. 18) (shown in the only variant seen). Dens slender, with 12 anterior chaetae arranged as 1,1,2,3,2,3 (Figs 16, 17). Posterior side of dens with few distinct crenulations at the middle, four chaetae on proximal half and two medially. Mucro tridentate. Ratio of manubrium : dens : mucro = 2.9–3.4 : 3.6–4.2 : 1.

Etymology. The name is given after the geographical distribution of the new species.

Discussion. *Folsomia australica* sp. n. resembles the only other native Australian species of the genus, i.e. *F. loftyensis* (Womersley, 1934) (after the redescription of Potapov and Greenslade 2010) by chaetotaxy of dens 12/6, tridentate mucro, 1+1 ocelli, ms-formula of body 10/000, differentiation of s-chaetae on Abd.V, and other characters. It differs in having 2+2 chaetae (vs. 4–5+4–5 in *F. loftyensis*) on the anterior side of manubrium. Juvenile specimens of the two species are probably hard to distinguish. The new species was recorded by Potapov and Greenslade (2010) as "*Folsomia* sp. aff. *loftyensis*". *Folsomia australica* sp. n. and *F. minorae* sp. n. are dissimilar indicating that the "austral " members of the genus *Folsomia* can also be heterogeneous, as in the Northern Hemisphere.

Morphological features of the furca of *F. australica* and *F. loftyensis*, especially the tridentate mucro, are shared with several species of *Cryptopygus: C. tricuspis* Enderlein, 1909 (sub-Antarctic), *C. insignis* Massoud and Rapoport, 1968 (South America), *C. patagonicus* Izarra, 1972 (South America), and three unnamed species from South Africa (*Cryptopygus* sp. 5, *C.* sp. 6, and *C.* sp. 7, see below). These species probably represent another group of *Cryptopygus s.s.*, dissimilar to *C. antarcticus*, which could be ancestral to the "Australian" species of Folsomia.

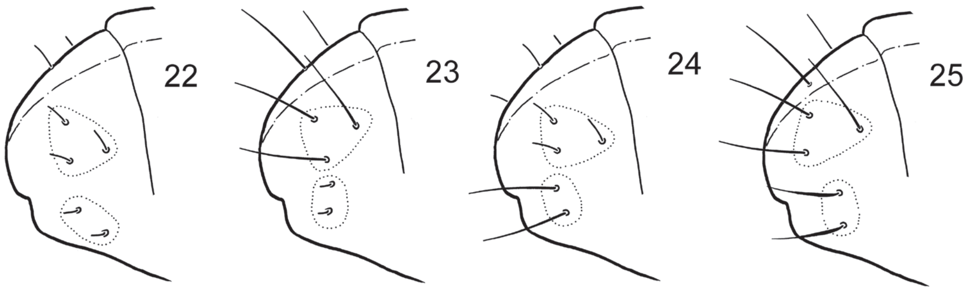
Distribution. *Folsomia australica* sp. n. is known from two localities in south-eastern part of Australia (Victoria and New South Wales).

General discussion

The fifth abdominal segment of all species of the genus *Cryptopygus*, as in *Folsomia*, has five s-chaetae on each side: accp1, accp2, accp3, accp4 and as. The s-pattern of *C. antarcticus* and several other species is probably the most primitive as it consists of regularly scattered sub-equal short and thin s-chaetae (Fig. 26). Weak differentiation is observed: s-chaetae of dorsal triplet (as+accp1+accp2) slightly longer and sometimes thinner than s-chaetae of lateral duplet (accp1+accp2) (Figs 22, 26). Such arrangement and differentiation of s-chaetae can be called as a weak '3+2' pattern (for terminology, see Potapov and Greenslade 2010). Most species of *Cryptopygus s.s.* show this pattern, sometimes the difference between the length of "triplet" and "duplet" s-chaetae is hardly evident. Subsequent evolution is expressed by stronger differentiation: s-chaetae of dorsal triplet, lateral duplet or either of them become macrochaeta-like (Figs 23–25). Only one species for each of these three apomorphic conditions was found in the material studied here, all only currently known from South Africa. The representation of s-patterns in *Cryptopygus s.s.* for Abd.V is as follows:

1. Weakly differentiated "3+2" pattern (Figs 22, 26). S-chaetae shorter than common chaetae. In a few short-haired species, (*C. badasa* Greenslade, 1995, *C. binoculatus* Deharveng, 1981, *C. lawrencei* Deharveng, 1981, *C.* sp.4) s-chaetae are almost as long as common chaetae.

Representatives:
- – *C. antarcticus antarcticus* Willem, 1902. Material: several locations in Antarctic Peninsula (King George Isl., Deception Isl., Devil Isl.) leg. D. Russell.
- – *C. antarcticus maximus* Deharveng, 1981. S-chaetae as in nominate subspecies. Material: Kerguelen Isl. leg. J. Travé.
- – *C. antarcticus reagens* (Enderlein, 1909). S-chaetae of dorsal triplet almost twice longer than s-chaetae of duplet. Material: Crozet Isl. (sub-Antarctic), leg. J. Travé.
- – *C. antarcticus travei* Deharveng, 1981. S-chaetae of dorsal triplet almost as long as those of duplet. Material: Marion Isl. (sub-Antarctic), leg. J. Travé.
- – *C. araucanus* Massoud & Rapoport, 1968. S-chaetae of dorsal triplet slightly longer than s-chaetae of duplet. Material: syntypes, several locations in Argentina (Futalaufquen, Lago Curruhé, Lago Menendez). Collections of the Museum national d'Histoire naturelle (Paris, France).
- – *C. badasa* Greenslade, 1995. All s-chaetae very short, "triplet" s-chaetae slightly longer. Material: Antarctic Peninsula (Devils Isl.), leg. D. Russell; South Georgia (sub-Antarctic), leg. V. Bulavintsev.
- – *C. binoculatus* Deharveng, 1981. S-chaetae subequal. Material: holotype, Crozet Isl. (sub-Antarctic).
- – *C. insignis* Massoud & Rapoport, 1968. S-chaetae subequal. Material: syntypes, Lago Menendez (Argentina). Collections of the Museum national d'Histoire naturelle (Paris, France).

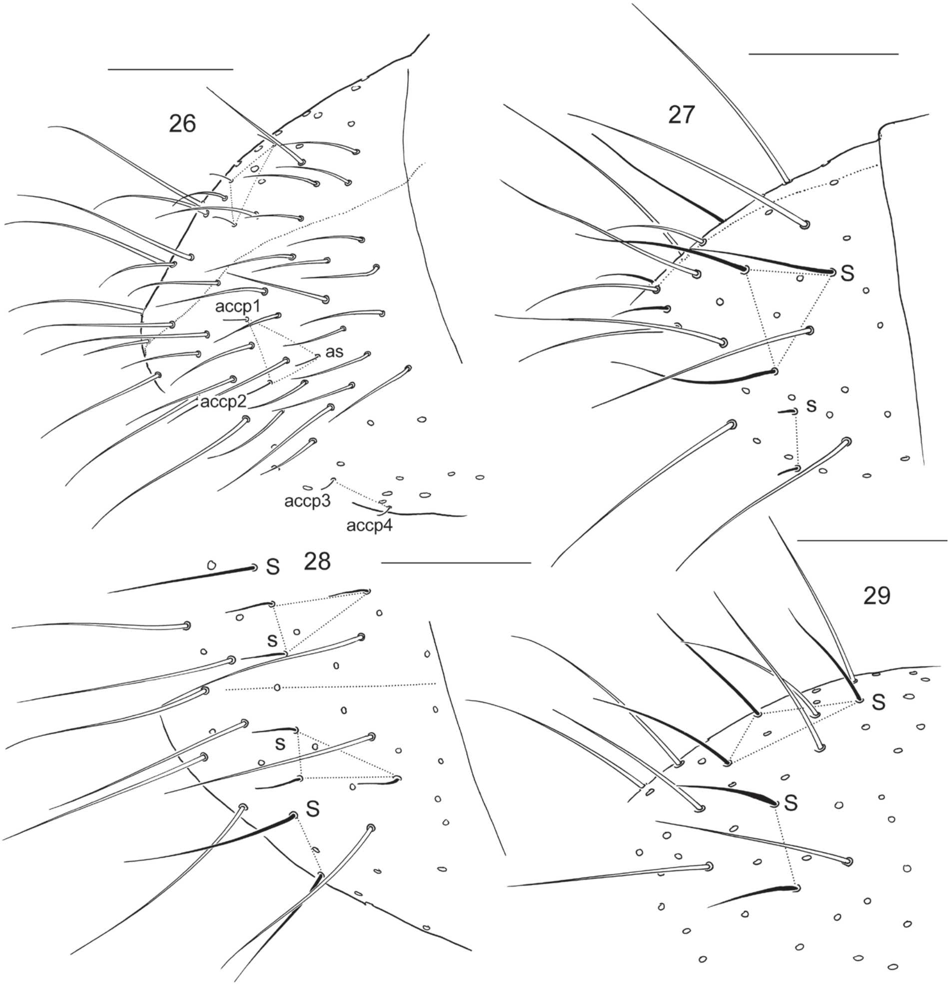


Figures 22–25. "3+2" s-patterns of austral *Cryptopygus*. **22** *C. antarcticus* **23–25** *Cryptopygus*: sp. 5 (**23**) sp. 6 (**24**) sp. 7 (**25**) (all three species from South Africa).

- *C. hirsutus* (Denis, 1931). S-chaetae subequal. Material: possible syntypes, Costa Rica. Collections of the Museum national d'Histoire naturelle (Paris, France).
- *C. lawrencei* Deharveng, 1981. "Triplet" s-chaetae slightly longer. Material: Kerguelen Isl. (sub-Antarctic), leg. J. Travé.
- *C. pilosus* (Womersley, 1934). S-chaetae as in *C. antarcticus*. Material: South Australia, Lofty Ranges, leg. P. Greenslade.
- *C. tricuspis* Enderlein, 1909. S-chaetae as in *C. antarcticus*. Material: Kerguelen Isl. (sub-Antarctic), leg. J. Travé.
- *C. ulrikeae* (Najt & Thibaud, 1987), **comb. n.** S-chaetae sub-equal. Separation of Abd.IV and V as in other species of the genus *Cryptopygus*. Primarily, it was described as *Folsomia ulrikeae* (Najt and Thibaud, 1987). Material: holotype, Ecuador. Collections of the Museum national d'Histoire naturelle (Paris, France).
- *Cryptopygus* sp. 1 (complex 'antarcticus'). S-chaetae as in *C. antarcticus*. Characters common with the nominotypic subspecies of *C. antarcticus* but body more slender. Material: New Zealand (South Island), leg. M. Minor.
- *Cryptopygus* sp. 2 (complex 'antarcticus'). S-chaetae as in *C. antarcticus*. With the characters of *C. antarcticus* but ms formula of body tergites as 10/000. Material: New Zealand (North Island).
- *Cryptopygus* sp. 3. S-chaetae as in *C. antarcticus*. With 6+6 ocelli. Manubrium without anterior chaetae Dens with one anterior chaeta, mucro bidentate. Material: South Africa (Jonkershoek), leg. C. Janion-Scheepers.
- *Cryptopygus* sp. 4. S-chaetae as in *C. antarcticus*. With 8+8 ocelli. Dens rather long, with nine anterior and 5 posterior chaetae, mucro bidentate. Common chaetae and macrochaetae on body short. Material: South Africa, (Sutherland), leg. C. Janion-Scheepers.

2. "3+2" pattern with development of dorsal triplet (Figs 23, 27). Three dorsal s-chaetae (as, accp1, accp2) almost as long as macrochaetae, two lateral (accp3, accp4) short.

- *Cryptopygus* sp. 5. Dens with 9-10 anterior and 6 posterior chaeta, mucro tridentate. Material: South Africa (Table Mountain), leg. L. Deharveng and A. Bedos.



Figures 26–29. S-chaetae on Abd.V in austral *Cryptopygus*. **26** *C. antarcticus* **27–29** *Cryptopygus*: sp.5 (**27**) sp.6 (**28**) sp.7 (**29**) (all three species from South Africa). Scale bar 0.05 mm.

3. "3+2" pattern with development of lateral duplet (Figs 24, 28). Three dorsal s-chaetae (as, accp1, accp2) short, two lateral (accp3, accp4) long.

– *Cryptopygus* sp.6. With 4+4 or 5+5 ocelli. PAO with strong inner denticles. Dens with ten anterior chaetae, mucro tridentate. Material: South Africa (Little Switzerland), leg. E. Krzemińska.

4. "3+2" pattern with development of all s-chaetae (Figs 25, 29). Three dorsal s-chaetae (as, accp1, accp2) thin, two lateral (accp3, accp4) also long, somewhat shorter than dorsal, somewhat flame-shaped.

– *Cryptopygus* sp.7. With 4+4 ocelli. Dens with 11-12 anterior and five posterior chaeta, mucro tridentate. Material: South Africa (Sutherland), leg. C. Janion-Scheepers.

S-chaetae patterns of *Cryptopygus* are probably more diverse than shown above: *Cryptopygus yosii* Izarra, 1965 (Argentina, after our study of a syntype) shows "3+1+1" pattern in which accp3 is thick and tubular and accp4 is short and moved to the latero-ventral position. More material on less primitive species needs to be studied to complete the generic overview. Nevertheless, s-patterns of Abd.V in *Cryptopygus* seem to be less divergent than in the larger genus *Folsomia* (Potapov and Greenslade 2010), while "austral" variant 4 (see above) has not been discovered in the latter genus.

The dorsal fusion or separation of genital (Abd.V) and pre-genital segment (Abd.IV) is traditionally considered to be of great taxonomic value in the classification of the subfamily Anurophorinae *s.l.*, and the genus *Folsomia* is defined by the apomorphic condition of this character (fusion). Based on the available literature and our own observations, the s-chaetotaxy of "austral" *Cryptopygus s.s.* shows principally the same characteristics as in *Folsomia*, particularly 4,3/2,2,2,3,5 set and arrangement of s-chaetae on Abd.V. The more adaptive characters (furca, ocelli, etc.) vary considerably within both genera. Therefore Abd.IV–V fusion seems to be the only apomorphic character that separates *Folsomia* from *Cryptopygus* and the former genus can be easily derived from the latter. This key character can potentially show a high level of homoplasy and *Folsomia* is probably a polyphyletic or paraphyletic group. In the Northern Hemisphere, the high diversity of *Folsomia* makes it difficult to find an appropriate ancestor or even ancestors among known taxa. In contrast, at least three "austral" native *Folsomia* mentioned above show much in common with certain species of *Cryptopygus s.s.* Thus, all the main characters of *F. minorae* sp. n. (ocelli, clavate tibiotarsal hairs, outer teeth on claws, dens and mucro) indicate its close relationship to a group of species similar to *Cryptopygus antarcticus* (Wise 1967; Massoud and Rapoport 1968, Deharveng 1981), while the characters of *F. australica* sp. n. are shared with several *Cryptopygus* species with a slender dens and tridentate mucro (see the remarks to the species). S-chaetae patterns of Abd. V in *F. minorae* is the same as in *Cryptopygus* sp. 5 from South Africa (Figs 12, 23), to which this new species is, however, less similar than to the "antarcticus" group. S-pattern of *F. australica* and *F. loftyensis* is identical to *Cryptopygus* sp. 6 from South Africa (Figs 14, 24).

The generic position of both lineages, *F. minorae* and *F. australica-loftyensis*, can be modified in the future, depending on the increase of knowledge on the generic groups "*Cryptopygus*" and "*Folsomia*". The genus *Folsomia* is also very diverse in the Holarctic and consists of several species groups of which several differ in characters of great taxonomical value and may justify the status of new separate genera.

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