

# First report of the genus *Cratera* (Platyhelminthes, Geoplanidae) in Argentina, with description of a new species and comments on the species of the genus

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## Abstract

A new species of land planarians of the genus *Cratera* is described. *Cratera viridimaculata* **sp. n.** was recorded in the Atlantic Forest Ecoregion, in north-eastern Argentina, and represents the first report of the genus *Cratera* outside Brazil. The new species is about 50 mm in length and externally characterized by a color pattern consisting of a light green olive pigmentation on the dorsum, stippled with dark gray fine spots, and dorsal eyes. Other features regarding the internal anatomy are the presence of a glandular margin, Cutaneous Muscular Index (CMI) of 10–13%, pharynx cylindrical, prostatic vesicle extrabulbar, tubular and C-shaped, with a proximal bifurcated portion, penis papilla protrusible with ejaculatory duct widened in its distal portion, and female atrium funnel-shaped. The new species is compared and discussed with its congeners.

## Keywords

*Cratera viridimaculata* sp. n., land planarians, Geoplaninae, Argentinian Atlantic Forest

## Introduction

The genus *Cratera* Carbayo et al., 2013 is one of the currently recognized genera of land flatworms of the subfamily Geoplaninae. It is characterized by a peculiarity of the male reproductive system which is a widening of the distal part of the ejaculatory duct that traverses the penis papilla, reminiscent of a volcano crater in sagittal section, hence the origin of its generic name. Other features of the genus include prostatic vesicle extrabulbar; male atrium not folded and not separated from the female atrium; common ovovitelline duct dorsal to the female atrium; and genital canal dorso-anteriorly flexed, opening dorsally in the posterior region of the female atrium (Carbayo et al. 2013). *Cratera* was erected to separate some Brazilian species formerly described into the genus *Geoplana* Stimpson, 1857 as they share the features above mentioned. Five species were transferred by Carbayo et al. (2013) to this new genus, namely *Cratera crioula* (Froehlich, 1955), *Cratera joia* (Froehlich, 1956), *Cratera pseudovaginuloides* (Riester, 1938), *Cratera tamoia* (Froehlich, 1955), and *Cratera yara* (Froehlich, 1955). Since then, four new species of *Cratera* have been described, all of them recorded in the Brazilian Atlantic Forest (Rossi et al. 2014; Carbayo and Almeida 2015; Rossi et al. 2016). The Atlantic Forest extends along the Atlantic coast of Brazil and inland in this country, eastern Paraguay and north-eastern Argentina, where it is known as Interior Atlantic Forest, being characterized by semi-deciduous diversified forests. Even though the original coverage of the Atlantic forest has decreased significantly by human activities, this ecoregion still exhibits a high diversity, including land flatworms (Sluys 1998; Galindo-Leal and Câmara 2003). Here, we describe a new species of *Cratera* from the Interior Atlantic Forest of Argentina, the first record of this genus outside Brazil, extending its geographic range.

## Methods

Specimens were manually collected during the day below fallen logs in two natural reserves from north-eastern Argentina (Misiones Province), both located in the southern portion of the Interior Atlantic Forest ecoregion: Esmeralda Provincial Park (26°53'S, 53°52'W) and San Antonio Strict Nature Reserve (26°03'S, 53°46'W).

The animals were photographed alive and their external morphology was recorded. Then, they were killed with boiling water, fixed in 10% formaldehyde and subsequently conserved in 70% ethanol. Body fragments of land flatworms were dehydrated in an ascending series of ethanol, cleared in n-Butanol, embedded in Paraplast®, and serially sectioned with a microtome. Slides were stained with Masson's trichrome method (Subarna et al. 2013). Type material was deposited in the Invertebrate Collection at Museo de La Plata (MLP), Argentina.

## Results

Order Tricladida Lang, 1884

Suborder Continenticola Carranza et al., 1998

Family Geoplanidae Stimpson, 1857

Subfamily Geoplaninae Stimpson, 1857

Genus *Cratera* Carbayo et al., 2013

*Cratera viridimaculata* sp. n.

<http://zoobank.org/A7CBCE5C-E265-46C3-83C7-F73DF0789675>

Figs 1–5, Tables 1, 2

*Geoplana* sp. 6 (Negrete et al., 2014 in part)

**Type material. Holotype** (Figs 1, 3–5). MLP–He 6944. Locality: Esmeralda Provincial Park (26°53'S, 53°52'W), Misiones Province, Argentina. 19 June 2013; cephalic region: transversal sections on 16 slides (6 µm thick); anterior region: sagittal sections on 30 slides (7 µm thick); anterior region at level of ovaries: sagittal sections on 20 slides (7 µm thick); pre-pharyngeal region: transverse sections on 6 slides (6 µm thick); pharynx: sagittal sections on 32 slides (7 µm thick); copulatory apparatus: sagittal sections on 32 slides (7 µm thick).

**Paratype** (Fig 2). MLP–He 6489. Locality: San Antonio Strict Nature Reserve (26°03'S, 53°46'W), Misiones Province, Argentina. 30 October 2008; cephalic region and anterior region at level of ovaries: sagittal sections on 28 slides (8 µm thick); pre-pharyngeal region: transverse sections on 12 slides (8 µm thick); pharynx: sagittal sections on 31 slides (8 µm thick); copulatory apparatus: sagittal sections on 31 slides (8 µm thick).

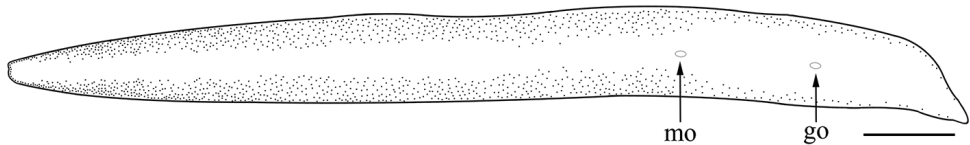
**Type locality.** Esmeralda Provincial Park (26°53'S, 53°52'W), in native subtropical forest. Misiones province, Argentina.

**Diagnosis.** Species of *Cratera* of 50 mm in length; dorsal surface stippled with dark gray fine spots on a light olive green background; eyes dorsal; glandular margin present; CMI, 10–13%; pharynx cylindrical; prostatic vesicle extrabulbar, tubular and C-shaped, with proximal bifurcated portion.

**Description. External morphology.** Body elongate with parallel margins. Anterior tip blunt and posterior end pointed (Figs 1, 2). Dorsal surface light olive green, stippled with dark gray fine spots, and body margins and cephalic region pigmented dark gray (Fig. 1). Ventral surface whitish with margins grayish. After fixation, the dorsal color pattern became paler with lighter gray fine spots. Eyes distributed from the anterior tip to the posterior end. They surround the cephalic region and extend uniseri-ally on body margins along 1–2 mm from the anterior tip, continuing pluriserially over the dorsal surface, being surrounded by clear halos. Eyes occupy about 30% of body width on each side of the dorsal surface at pre-pharyngeal region. Behind the pharynx, they decrease in number and at the level of the copulatory apparatus become uniserial



**Figure 1.** Dorsal view of a live specimen of *Cratera viridimaculata* sp. n. (holotype) (anterior end to the left). Scale bar: 10 mm.

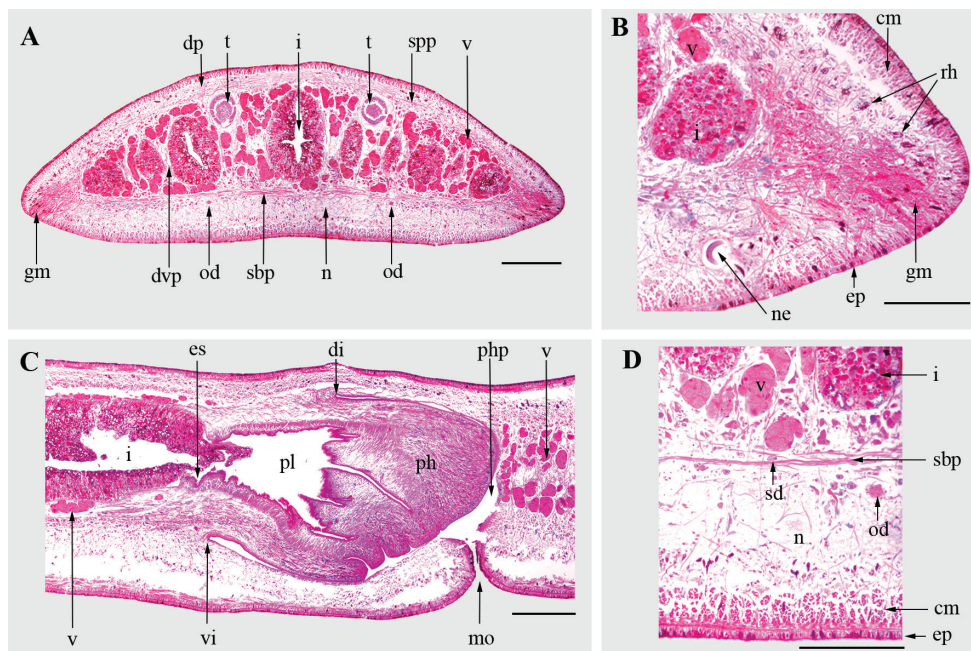


**Figure 2.** Schematic drawing of eyes pattern, in dorsal view, with position of mouth (**mo**) and gonopore (**go**) of *Cratera viridimaculata* sp. n. (paratype) (anterior end to the left). Scale bar: 5 mm.

and marginal (Fig. 2). After fixation, the length of specimens is about 50 mm, maximum width ~4.5 mm, and maximum height ~1.5 mm. Mouth and gonopore located at a distance of 66–75% and 83–89% from the anterior tip, respectively (Table 1).

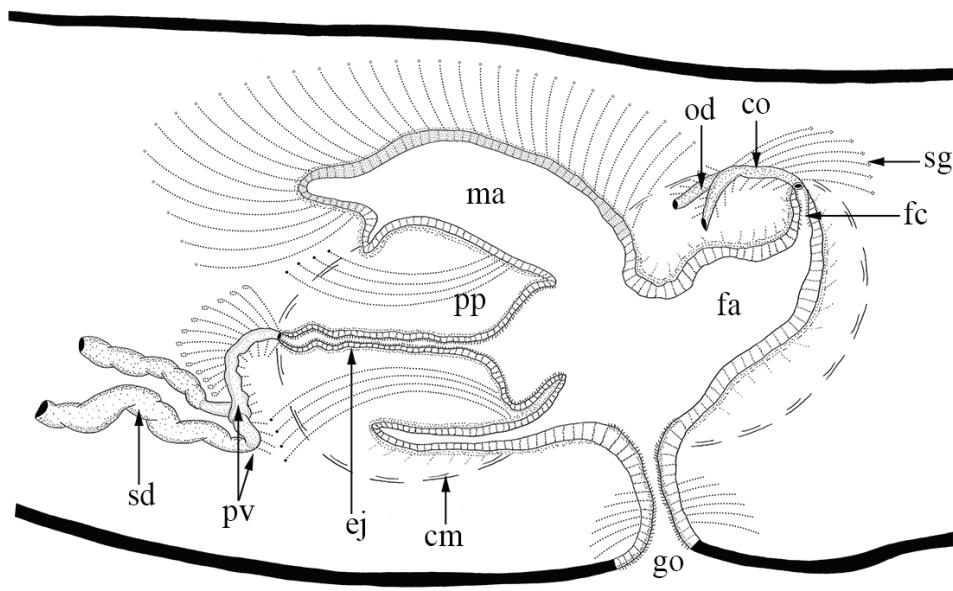
**Internal morphology.** Sensory pits, as simple invaginations ranging from 25  $\mu$ m to 40  $\mu$ m deep, contouring anterior tip and extending along body margins in a single irregular row. They occur at intervals of about 25–50  $\mu$ m, and posteriorly become gradually spaced until they disappear at 5–6 mm from anterior tip. Three types of secretory cells discharge through dorsal epidermis (15  $\mu$ m height) and body margins at pre-pharyngeal region: numerous rhabditogen cells with xanthophil secretion (rhammites), abundant cells with fine granular erythrophil secretion, and scarce cells with fine granular cyanophil secretion. Glandular margin composed of abundant fine gran-





**Figure 3.** *Cratera viridimaculata* sp. n. (holotype). **A** Transverse section at pre-pharyngeal region **B** Detail of the body margin of a transverse section at pre-pharyngeal region **C** Sagittal section of the pharynx **D** Detail of a transverse section at pre-pharyngeal region. Abbreviations: **cm**, cutaneous musculature; **di**, dorsal insertion of pharynx; **dp**, dorsal parenchymatic musculature; **dvp**, dorsoventral parenchymatic fibers; **ep**, epidermis; **es**, esophagus; **gm**, glandular margin; **i**, intestine; **mo**, mouth; **n**, nervous plate; **ne**, nematode larva; **od**, ovovitelline duct; **ph**, pharynx; **pl**, pharyngeal lumen; **php**, pharyngeal pouch; **rh**, rhabditogen cells; **sbp**, sub-intestinal parenchymatic musculature; **sd**, sperm duct; **spp**, supra-intestinal parenchymatic musculature; **t**, testes; **v**, vitellaria; **vi**, ventral insertion of pharynx. Scale bars: 500 µm (**A**, **C**), 200 µm (**B**, **D**).

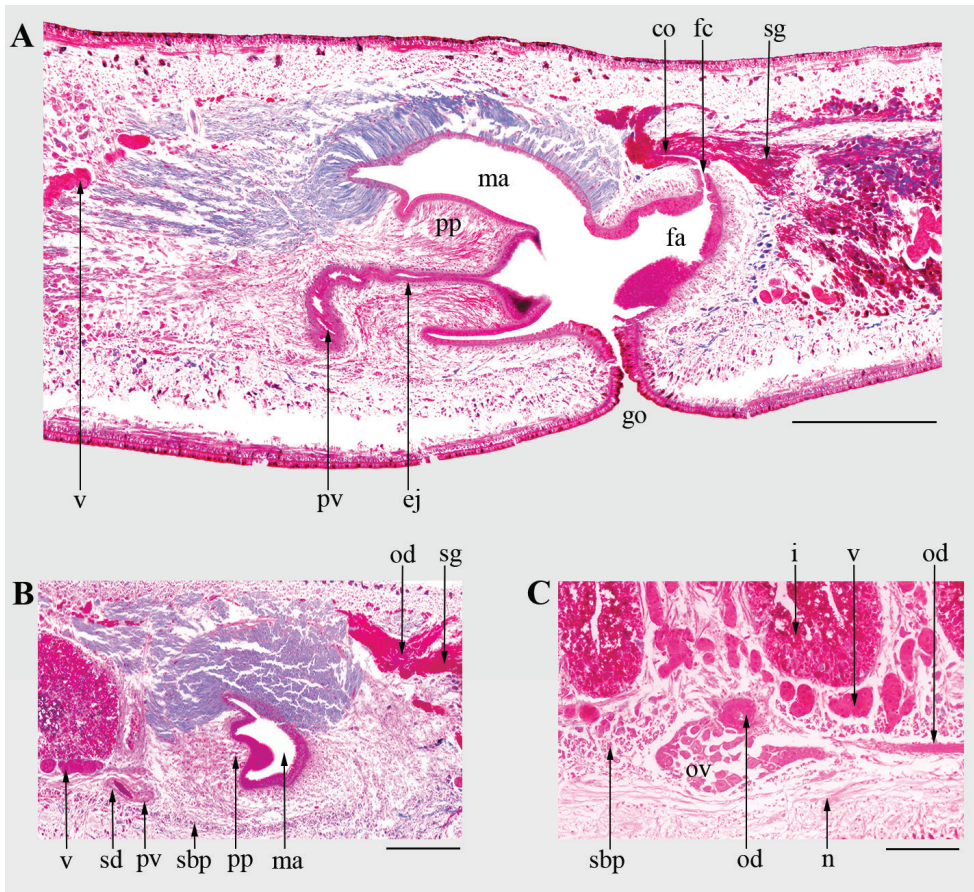
ular erythrophil secretion and scarce fine granular xanthophil and cyanophil secretion (Fig. 3A, B). Ventral epidermis (25 µm height) ciliated on the creeping sole (90% of body width). Three types of secretory cells discharge their secretion through the creeping sole: rhabditogen cells (with rhabdithes), and abundant cells with fine granular erythrophil and cyanophil secretion. Cephalic region with the same types of secretory cells, discharging through dorsal and ventral epidermis but in less quantity, except cells with fine granular xanthophil secretion which are highly abundant mainly on body margins. No musculo-glandular specializations. Cutaneous musculature with the usual three layers present in the subfamily Geoplaninae: circular, oblique and longitudinal, the latter arranged in bundles and is the thickest (Table 1). Cutaneous Muscular Index (CMI) ranging from 10% to 13%. Parenchymatic musculature composed of a dorsal layer with oblique fibers, a supra-intestinal and a sub-intestinal transverse layers (Table 1) (Fig. 3A, B, D). Additionally, dorsoventral fibers located among intestinal branches (Fig. 3A). Parenchymatic Muscular Index (PMI) ranging from 8% to 9% (Table 1).



**Figure 4.** Schematic reconstruction, in sagittal view, of the copulatory apparatus of *Cratera viridimaculata* sp. n. (holotype). Abbreviations: **cm**, common muscle coat; **co**, common ovovitelline duct; **ej**, ejaculatory duct; **fa**, female atrium; **fc**, female genital canal; **go**, gonopore; **ma**, male atrium; **od**, ovovitelline duct; **pp**, penis papilla; **pv**, prostatic vesicle; **sd**, sperm duct; **sg**, shell glands. Scale bar: 500  $\mu$ m.

Pharynx cylindrical, 1.5–2.3 mm in length (3–4% of body length), with dorsal insertion located at the proximal third of pharyngeal pouch (3–3.2 mm in length) (Fig. 3C). Pharynx lined by ciliated cuboidal epithelium. Pharyngeal musculature of the planariid type comprising an outer musculature arranged in two layers: longitudinal subepithelial layer (5  $\mu$ m thick) followed by a subjacent circular layer (5–10  $\mu$ m thick). Pharyngeal lumen lined by ciliated columnar epithelium. Pharyngeal inner musculature comprised of circular subepithelial layer (75–90  $\mu$ m thick) followed by a thinner longitudinal layer (10–20  $\mu$ m thick). Pharyngeal glands constituted by three secretory cell types: abundant cells with fine granular erythrophil secretion, less abundant cells with fine granular cyanophil secretion and scarce cells with amorphous cyanophil secretion (Fig. 3C). Cell bodies of pharyngeal glands located in the surrounding parenchyma, mainly anterior to pharynx. Short esophagus (250–300  $\mu$ m in length) lined by ciliated columnar epithelium, followed by a subepithelial circular layer (45–60  $\mu$ m thick) and a subjacent longitudinal layer (5–15  $\mu$ m thick). Esophagus: pharynx ratio, 13–17%.

Testes dorsal, mature, arranged in one irregular row on each side of the body, located between the suprainestinal parenchymatic muscle layer and intestinal branches (Fig. 3A). They extend immediately behind the ovaries to nearly the ventral root of pharynx (Table 2). Sperm ducts dorso-medial to ovovitelline ducts, located among fibers of sub-intestinal transverse layer (Fig. 3D). Near the copulatory system, the lumen of sperm ducts is dilated and full of spermatozoa. They curve to the sagittal plane



**Figure 5.** *Cratera viridimaculata* sp. n. (holotype). **A, B** Sagittal sections of the copulatory apparatus **C** Sagittal section of the anterior region, at the level of ovaries. Abbreviations: **co**, common ovovitelline duct; **ej**, ejaculatory duct; **fa**, female atrium; **fc**, female genital canal; **go**, gonopore; **i**, intestine; **ma**, male atrium; **n**, nervous plate; **od**, ovovitelline duct; **ov**, ovary; **pp**, penis papilla; **p****v**, prostatic vesicle; **sbp**, sub-intestinal parenchymatic musculature; **sd**, sperm duct; **sg**, shell glands; **v**, vitellaria. Scale bars: 500  $\mu$ m (**A**), 250  $\mu$ m (**B, C**).

and communicate with the proximal paired portions of the prostatic vesicle (150–170 in length each) (Figs 4, 5A, B). Prostatic vesicle, extrabulbar, unpaired, tubular and C-shaped, spaced 5.2 mm from the pharyngeal pouch (Figs 4, 5A). Ejaculatory duct almost straight, except its proximal portion which is sinuous, opening through an expansion into the tip of the penis papilla (Figs 4, 5A). Male atrium with unfolded walls, housing a cylindrical penis papilla which occupies most of the atrium (Figs 4, 5A). Male atrium with ample communication with female atrium, without folds separating both atria (Figs 4, 5A).

Sperm ducts lined with ciliated cuboidal epithelium, coated by circular fibers (5  $\mu$ m thick). Lining epithelium of prostatic vesicle columnar and ciliated, receiving abundant

**Table 1.** Measurements (mm) from fixed specimens of *Cratera viridimaculata* sp. n. CS, width of creeping sole; DG: distance from gonopore to anterior end; DM: distance from mouth to anterior end. The numbers given in parentheses represent the position relative to body length (%). Thickness (µm) of cutaneous (CM) and parenchymatic (PM) musculatures at pre-pharyngeal region. CMI (cutaneous muscular index): ratio between height of cutaneous musculature to body height. PMI (parenchymatic muscular index): ratio between height of parenchymatic musculature to body height. Both indices measured at pre-pharyngeal region. Abbreviations: cc, circular cutaneous musculature; dc, diagonal cutaneous musculature; dp, dorsal parenchymatic musculature; lc, longitudinal cutaneous musculature; sbp, sub-intestinal parenchymatic musculature; spp, supra-intestinal parenchymatic musculature.

Measurements	Holotype	Paratype	Measurements	Holotype	Paratype
Length	53	51	CM dorsal (cc–dc–lc)	2.5 – 10 – 45	2.5 – 10 – 50
Width	4.5	4.4	CM ventral (cc–dc –lc)	2.5 – 10 – 75	5 – 20 – 90
Height	1.5	1.4	CMI	10%	13%
DM	40 (75%)	33.8 (66%)	PM (dp–spp–sbp)	40 – 50 – 50	25 – 50 – 40
DG	47.3 (89%)	42.3 (83%)	PMI	9%	8%
CS (%)	90%	90%			

**Table 2.** Measurements (mm) of reproductive organs of *Cratera viridimaculata* sp. n. DPVP, distance between prostatic vesicle and pharyngeal pouch; LCGD, length of common glandular ovovitelline duct; LFA, length of female atrium; LFC, length of female canal; LMA, length of male atrium; LPP, length of penis papilla; LPV, length of prostatic vesicle. The numbers given in parentheses represent the position relative to body length (%).

	Holotype	Paratype
Anteriormost testes	16 (30%)	12 (23%)
Posteriormost testes	37.1 (70%)	30.6 (60%)
LPV	0.5	0.45
DPVP	5.2	5.2
LPP	0.55	0.45
LMA	0.95	0.7
Location of ovaries	14 (26%)	11 (22%)
LCGD	0.25	0.15
LFC	0.1	0.1
LFA	0.65	0.45

fine granular erythrophil secretion from glands with cells bodies located anterior to the prostatic vesicle. Muscularis of prostatic vesicle (15–20 µm thick) arranged in a circular layer interwoven with oblique fibers. Ejaculatory duct lined with ciliated columnar epithelium, which receives scarce fine granular erythrophil secretion, coated by circular fibers (2.5–5 µm thick). Penis papilla lined with non-ciliated columnar epithelium, strongly erythrophil (Fig. 5A). Epithelial lining of penis papilla receives abundant fine granular erythrophil secretion and less abundant amorphous erythrophil secretion (Fig.



5A). Cell bodies of penis glands located in the parenchyma, outside the penis bulb. Muscularis of the penis papilla (5–10  $\mu\text{m}$  thick) composed of circular fibers. Male atrium lined with non-ciliated columnar epithelium, followed by circular muscle layer (5–15  $\mu\text{m}$  thick). The epithelial lining of the dorsal wall of the male atrium receives large amount of fine granular cyanophil secretion, and less abundant fine granular erythrophil secretion (Fig. 5A, B). The ventral wall receives fine granular erythrophil secretion and scarce cyanophil granules. Cell bodies of glands which discharge their secretions into the male atrium located in the parenchyma, external to common muscle coat.

Ovaries ovoid and distally elongate, measuring 500–600  $\mu\text{m}$  in length, located just below the sub-intestinal parenchymatic muscle layer (Fig. 5C). Ovovitelline ducts emerge dorso-laterally from the middle third of ovaries, and run posteriorly between sub-intestinal parenchymatic muscle layer and nerve plate (Figs 3A, D, 5C). At the level of gonopore, ovovitelline ducts ascend, run to the sagittal plane and join in a short common glandular ovovitelline duct (Figs 4, 5A, B). The common ovovitelline duct is horizontal and located above the posterior region of the female atrium (Figs 4, 5A). Short female genital canal dorsoventrally oriented, connecting common glandular duct and female atrium (Figs 4, 5A). Female atrium funnel-shaped and without folded walls, shorter than the male atrium (Figs 4, 5A, Table 2).

Ovovitelline ducts lined with ciliated cuboidal epithelium, coated by circular fibers (2.5  $\mu\text{m}$  thick). Ascending portions of ovovitelline ducts receive secretion from shell glands (Fig. 5B). Lining epithelium of common glandular ovovitelline duct columnar and ciliated, receiving abundant secretion from shell glands and amorphous cyanophil secretion (Fig. 5A). Cell bodies of these glands located posterior to the copulatory apparatus (Figs 4, 5A). Female genital canal lined with ciliated columnar epithelium, coated by circular fibers (5–10  $\mu\text{m}$  thick). Female atrium lined by non-ciliated columnar epithelium, with nuclei located at different heights and giving a stratified aspect (Fig. 5A). Muscularis of female atrium composed of circular fibers mixed with some longitudinal fibers (10–15  $\mu\text{m}$  thick). Female genital canal and female atrium receive abundant fine granular erythrophil secretion, and fine granular cyanophil secretion in less quantity. Common muscle coat poorly organized, composed of longitudinal and oblique fibers (5–10  $\mu\text{m}$  thick) (Fig. 4).

Vitellaria well-developed in both specimens studied, located among intestinal branches (Figs 3A–D, 5A–C). Gonopore canal slightly anteriorly flexed, lined with ciliated columnar epithelium (Fig. 5A). Three types of secretory cells discharge their secretion through the gonopore canal: rhabditogen cells (with rhabdithes), abundant cells with fine granular erythrophil secretion and scarce cells with fine granular cyanophil secretion.

**Etymology.** The specific name refers to the dorsal pigmentation of body, stippled with dark gray dots on a light green olive background (from lat. *viridis* = green, greenish; *maculatus* = maculated, spotted, splattered with dots).

**Distribution.** Southern portion of the Interior Atlantic Forest ecoregion, Misiones Province, north-eastern Argentina. The new species was found in native sub-tropical forests, in two natural reserves: Esmeralda Provincial Park (26°53'S, 53°52'W) and San Antonio Strict Nature Reserve (26°03'S, 53°46'W).



## Discussion

As with other genera of the subfamily Geoplaninae, the diagnosis of the genus *Cratera* Carbayo et al., 2013 relies on a combination of non-exclusive features, which mainly include medium-sized body, pharynx cylindrical to bell-shaped, prostatic vesicle extrabulbar, penis papilla protrusible, common ovovitelline duct and female canal dorsal to female atrium, and female atrium funnel-shaped (Carbayo et al. 2013). However, an autapomorphy of this genus is the presence of a widening of the ejaculatory duct in its opening in the apex of the penis papilla. This peculiarity and the other features above mentioned were observed in the new species herein described, strongly supporting its inclusion into this genus. The finding of a new species of *Cratera* outside Brazil extends the geographic range of this genus.

Taking into account the external morphology, among the species currently known of *Cratera*, the majority of them exhibit a well-defined stripe pattern on the dorsum, namely: *Cratera anamariae* Carbayo, 2015, *Cratera cuarassu* Carbayo & Almeida, 2015, *Cratera joia*, *C. pseudovaginuloides*, *Cratera steffeni* Rossi et al., 2014, *C. tamoiia* and *C. yara*. Thus, they can be easily distinguished from *Cratera viridimaculata* sp. n. because the new species has scattered dots on the dorsal surface without forming stripe pattern. The remaining two species, *Cratera ochra* Rossi et al., 2016 and *C. crioula*, even though they have stripes, they also exhibit a stippled pattern on the dorsum. In *C. ochra* the dorsal color pattern is quite similar to that *C. viridimaculata* sp. n., with a yellow ochre pigment splashed with irregularly arranged grayish dots, except body margins which are free of dots. However, unlike the new species, in *C. ochra* the dots are concentrated forming two broad grayish bands (Rossi et al. 2016). Regarding *C. crioula*, this species can be distinguished from *C. viridimaculata* sp. n. because the stippled pattern follows a homogeneous arrangement on a dark gray background, only free of dots along of a thin median stripe and two para-marginal stripes, of whitish pigment (Froehlich 1955).

Regarding the copulatory apparatus, the new species shares with *C. anamariae*, *C. ochra*, *C. pseudovaginuloides*, *C. steffeni*, and *C. yara* the presence of highly abundant cyanophil secretion discharging onto the dorsal wall of the male atrium. Besides, *C. viridimaculata* sp. n. and the five species above mentioned have a tubular and sinuous extrabulbar prostatic vesicle, and similarly to *C. viridimaculata* sp. n., the prostatic vesicle of *C. anamariae*, *C. ochra* and *C. steffeni* has proximal bifurcated branches which connect with the sperm ducts. However, *C. viridimaculata* sp. n. differs from *C. ochra* and *C. steffeni* in the position of the prostatic vesicle. In these species, the proximal part of the unpaired portion is almost horizontal and dilated, with the bifurcated branches also expanded, giving a T shape (Rossi et al. 2014, 2016). In the new species, the unpaired portion is C-shaped and the proximal bifurcated branches are not expanded. In regard to *C. anamariae*, the unpaired portion of the prostatic vesicle is sinuous as in *C. viridimaculata* sp. n. but their paired proximal branches run dorso-anteriorly (Carbayo and Almeida 2015), while in the new species the bifurcated branches run almost horizontal in their course to the sagittal plane.

Some aspects about the internal anatomy of *C. crioula*, *C. cuarassu* and *C. joia* deserve comment. As previously noted, one of the most remarkable features of the genus *Cratera* is the presence of a widening of the ejaculatory duct in its distal portion. However, in the original descriptions of *C. crioula* and *C. joia* the authors did not mention this peculiarity, this being confirmed in the reconstructions of the copulatory apparatus (Froehlich 1955; Froehlich 1956). Moreover, in *C. joia* the prostatic vesicle is intrabulbar, in contrast to other species of *Cratera*, and the penis papilla extends beyond the gonopore and occupies half of the female atrium, which has not been observed in species of *Cratera*, and resembling more the species of the genus *Geoplana* Stimpson, 1857 (see Carbayo et al. 2013 for the emended diagnosis of *Geoplana*). However, the inclusion of *C. crioula* into the genus *Cratera* is supported by results of the molecular phylogeny of Geoplaninae accomplished by Carbayo et al. (2013), in which this genus was proposed. According these results, *C. crioula* form a clade with *C. tamoia*, *C. pseudovaginuloides*, *C. cuarassu* (= *Geoplana* sp. 5 in Carbayo et al. 2013), *Geoplana hina* Marcus, 1951, and some undescribed species. In contrast, *Geoplana hina* was not included in *Cratera* although molecular data appear to support it, but as in *C. joia*, the description of the anatomy of the copulatory apparatus (see Marcus 1951) seems to not fit with the diagnosis of the genus.

Regarding *C. cuarassu*, this species possesses a very short and wide penis papilla which hangs from the roof of the male atrium and occupies the entire atrium, whose proximal and distal walls have numerous folds (Carbayo and Almeida 2015). The peculiar shape of the penis papilla is distinguished from the other species of *Cratera*, in which the papilla is nearly horizontal, and even from any other species of Geoplaninae (Carbayo and Almeida 2015). Furthermore, Carbayo and Almeida (2015) have stated that *C. cuarassu* has a large intra-penial cavity as a result of the extension of the widening in the ejaculatory duct. Nevertheless, the inclusion of *C. cuarassu* into this genus is supported by molecular data (Carbayo et al. 2013), even though the copulatory apparatus exhibits numerous dissimilarities with the rest of species of *Cratera*, as male atrium folded and separated from the female one, female atrium without funnel-shape, in addition with the features about the penis papilla above mentioned.

In light of this morphological heterogeneity, it would be interesting to confirm the presence or absence of the distal widening of the ejaculatory duct in *C. crioula* and *C. joia* as well as a reanalysis of the internal anatomy as a whole. In regard to *C. joia*, some justification based on morphological or molecular data is missing, so its inclusion in *Cratera* is at least doubtful according to the anatomical features above mentioned. As in *C. crioula* and *C. joia*, a re-evaluation of the morphology of *G. hina* could clarify this matter.

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# Redescription of two species of *Oplitis* Berlese (Acari, Mesostigmata, Oplitidae) from Iran

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## Abstract

Two new species records of Oplitidae, *Oplitis exopodi* Hunter & Farrier, 1975 and *Oplitis sarcinulus* Hunter & Farrier, 1976 are redescribed based on Iranian specimens from leaf-litter forest in Mazandaran province, northern Iran. A key to the Iranian species of *Oplitis* is presented.

## Keywords

Acari, Iran, new species, Parasitiformes, taxonomy, Uropodina

## Introduction

The suborder Uropodina is the most morphologically and ecologically diverse group of mesostigmatic mites. They are free-living or associated with arthropods, mammals, or birds. Worldwide, this suborder comprises approximately 300 genus-group names and 2000 described species (Wiśniewski and Hirschmann 1993, Halliday 2015). *Oplitis* is one of the largest genera of uropodine mites, with nearly 150 described species worldwide. The genus was proposed by Berlese (1884) with *Uropoda paradoxa* Canestrini & Berlese, 1884 as the type species. It has been considered by some authors to be a member of the family Uropodidae (Berlese 1903, 1904, Sellnick 1926, Vitzthum 1942,

Hirschmann 1961, Hirschmann and Zirngiebl-Nicol 1964, 1967, Zirngiebl-Nicol 1973a, 1973b, 1973c, Hunter and Farrier 1975, 1976, Hiramatsu 1979, Wiśniewski 1979, Hirschmann 1991), Trachyuropodidae (Karg 1989, Mařán 2001, Kontschán 2013) or Oplitidae (Kontschán 2014, Lopes et al. 2015, Pereira et al. 2016). They are mostly associated with ants but some species were collected from soil and litter. The most recent review of the genus was by Hirschmann (1991), who used a broad concept of the genus and divided *Oplitis* into 16 species-groups, mostly on the basis of features such as presence or absence of a perigenital ring, pre-anal and post anal lines, and the shape of the peritremes and dorsal setae. To date, two species of *Oplitis*, *O. paradoxa* (Canestrini & Berlese, 1884) and *O. iranicus* Kazemi & Kontschán, 2007 have been reported from soil and litter in Iran (Kazemi and Rajaei 2013).

In the present work, two new records of *Oplitis* are reported on the basis of material collected in Mazandaran province, northern Iran, during a survey on Uropodina mites. Also, an identification key to the Iranian species of this genus is presented.

## Material and methods

Mites were extracted from soil detritus and leaf-litter using Berlese-Tullgren funnels, and picked out under a stereomicroscope. After clearing in Nesbitt's fluid, all specimens were mounted in Faure's medium on permanent microscope slides. Morphological observations, measurements, and illustrations were made using a BX51 phase contrast Olympus microscope equipped with a drawing tube. Measurements were made from slide-mounted specimens, and are presented as ranges (minimum–maximum) in micrometers ( $\mu\text{m}$ ). Length of shields and legs were measured along their midlines, and widths at their widest point (if not otherwise specified in the description). Legs I–IV were measured from the bases of coxa to their tips but without the pretarsal ambulacra.

## Taonomy

### Family Oplitidae Hirschmann & Zirngiebl-Nicol, 1964

### Genus *Oplitis* Berlese, 1884

**Type species.** *Uropoda paradoxa* Canestrini and Berlese, 1884 by monotypy.

**Diagnosis.** The most detailed diagnosis of *Oplitis* was provided by Hunter and Farrier (1975, 1976). Species of this genus have dorsal setae spatulate, cuneiform, scimitar-shaped and setiform, but usually have one (sometimes more) basal asymmetric protuberance. Corniculi relatively short; female genital shield free, oval and without setae, located between coxae II–IV; usually with perigenital ring; palp apotele three-tined. Cheliceral digits nearly of similar length; ventral shield with 4–10 pairs of setae; with or without pre-anal line, anal shield bearing two pairs of circumanal setae (*Ad1*,



*Ad2*) and a post-anal seta; epistome 3–5 partite and with denticulate margins. Deutosternum moderately wide, smooth and delimited posteriorly, bearing 3–4 transverse lines of fine denticles between hypostomal setae *h3* and *pc* and behind *pc*.

### ***Oplitis exopodi* Hunter & Farrier, 1975**

Figs 1–7, 10–13

**Description of females (n = 2).** *Idiosoma*. Length 560–570, width 438–458.

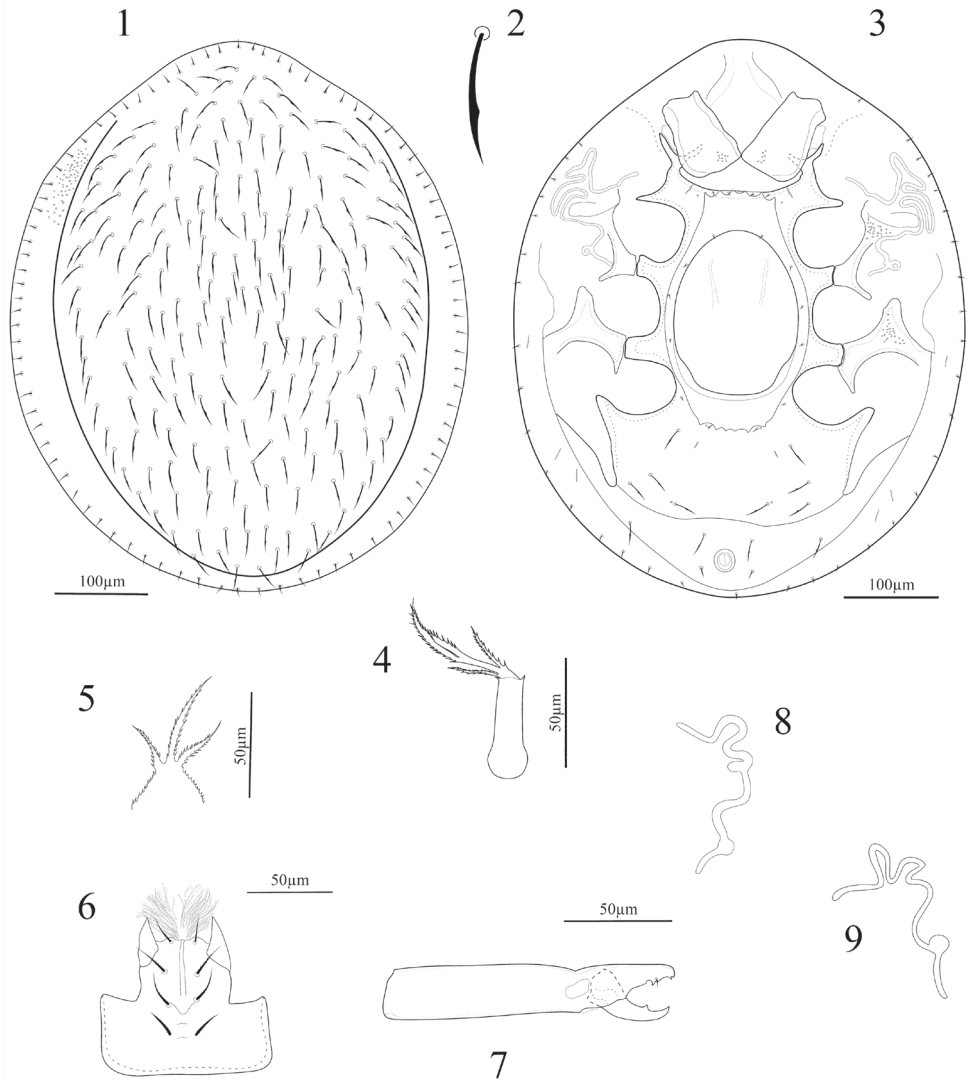
*Dorsum* (Fig. 1). Dorsal shield oval, slightly narrowed at both anterior and posterior regions, smooth on whole surface. Dorso-central region with complement of 105 pairs of scimitar-shaped setae (Fig. 2). Marginal shield united anteriorly with dorso-central region, with 42 pairs of smooth and needle-like setae.

*Venter* (Fig. 3). Tritosternal base narrow, c. 43 long, lacinia three-branched and pilose, lateral branches shorter than bifurcate median branch (Fig. 4). Sternal, endopodal and ventral shields smooth, exopodals with small puncta. Genital shield smooth, 157–162 long and 128–133 wide, ratio length/width = 1.21–1.23, situated between coxae II–IV, anterior margin convex and posterior margin straight. Perigenital ring oblong, 235–243 long and 136–143 wide, ratio length/width = 1.69–1.73, extending slightly beyond posterior level of coxae IV, with five crenulations on both anterior and posterior margins; lateral margins smooth and entire, perigenital area with four pairs of very short setae, lateral to genital shield, with two pairs of setae near anterior crenulation, one pair near to posterior crenulation and one pair inserted between coxae IV on inguinal region. Pre-anal line present. Ventral shield smooth, with 4–5 pairs of scimitar-shaped setae, 25–27 in length, *Ad1* scimitar-shaped and 25–26 long, *Ad2* smooth, needle-like and 12–13 long. Peritremes with three subequal convoluted branches. Pedofossae II–IV well developed, pedofossae III foot-shaped and pointed, pedofossae IV narrowing posteriorly and with a rounded tip.

*Gnathosoma* (Figs 5–7). Epistome three-branched and with serrate margins, median branch longer than laterals (Fig. 5). Corniculi short and horn-like; internal malae numerous and brushy, gnathosomal setae *h1* smooth, *h2* with a few barbs, *h3* and *pc* thickened and denticulated (Fig. 6). Cheliceral digits normal for the genus; movable digit 35–38 long, with one subdistal teeth and a terminal hook; fixed digit 47–50 long (from tip to the base of movable digit), with two teeth and a terminal hook; pilus dentilis setiform and minute (Fig. 7). Palptarsus with three-tined apotele.

*Legs* (Figs 10–13). Leg chaetotaxy agree with Evans, 1972. Leg lengths: leg I 251–263, leg II 240–255, leg III 214–225, and leg IV 224–238 long.

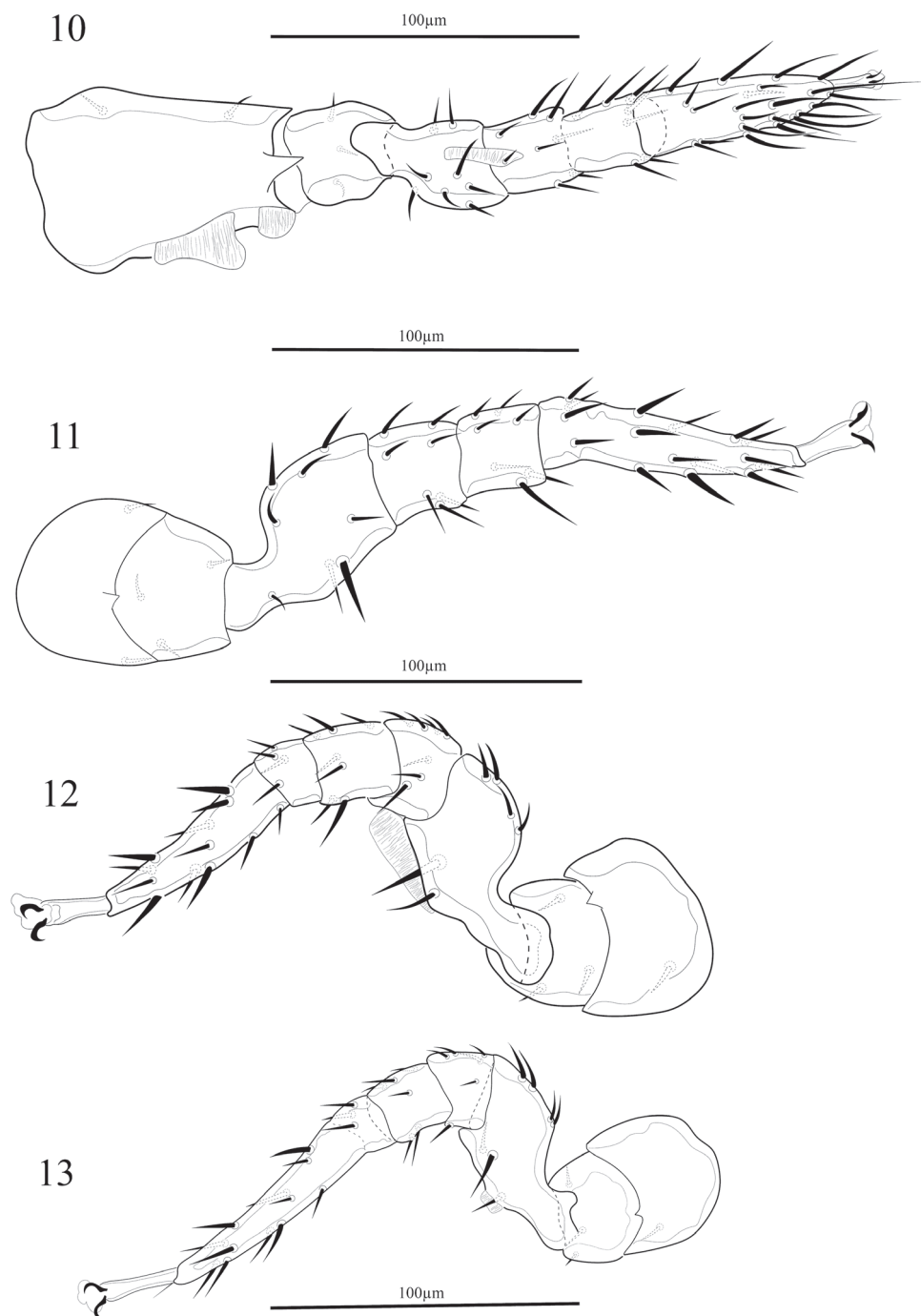
**Remarks.** *Oplitis exopodi* was originally found by Hunter and Farrier (1975) from North Carolina (USA) in association with *Solenopsis xyloni* and *Brachyponera solitaria* (Formicidae). It can be distinguished from other known species by dorsal shield smooth and with 105 pairs of scimitar-shaped setae; ventral regions (excluding exopodals) smooth; genital shield elongate, ratio length/width = 1.21–1.23; perigenital ring oblong, with 5



**Figures 1–9.** *Oplitis exopodi* (female): **1** Dorsal view of idiosoma **2** Dorsal seta **3** Ventral view of idiosoma **4** Tritosternum **5** Epistome **6** Hypostome **7** Chelicera. *O. pennsylvanica* (female): **8** Peritreme. *O. leonardiana* (female) **9** Peritreme.

crenulations, ratio length/width = 1.69–1.73; peritremes long and three-convoluted; pre-anal line present; *Ad2* shorter than *Ad1*; pedofossae IV narrow and with rounded tip.

Our specimens of *O. exopodi* show some variations with illustration given by Hunter and Farrier (1975), especially shape of anterior section of peritreme (notched in our specimens, but smooth in with Hunter and Farrier's illustration), shape of pedofossae III (foot-shaped in our specimens, but wide and pointed in Hunter and Farrier's



**Figures 10–13.** *Oplitis exopodi* (female): **10** Leg I; **11** Leg II; **12** Leg III **13** Leg IV.

illustration) and the number of scimitar-shaped setae on ventral region (4–5 pairs in our specimens, but 6–8 pairs in Hunter and Farrier's illustration).

**Material examined.** 2 females, Iran, Mazandaran Province, Nowshahr, Kheyrood-Kenar forest, 36°34'N, 50°34'E, altitude 741 m a.s.l., 27 May, 2015, E. Babaeian coll., in leaf-litter. The type specimens are deposited in the Acarological Collection, Jalal Afshar Zoological Museum, Department of Plant Protection, Faculty of Agriculture, University of Tehran, Karaj, Iran.

### *Oplitis sarcinulus* Hunter & Farrier, 1976

Figs 14–21

**Description. Female (n = 9).** *Idiosoma*. Length 473–507, width 400–438.

*Dorsum* (Fig. 14). Dorsal shield oval, smooth on whole surface except on anterior part. Dorso-central region with complement of 106 pairs of scimitar-shaped setae, 25–30 long (Fig. 15). Marginal shield united anteriorly with dorso-central region, with about 29 pairs of smooth and needle-like setae.

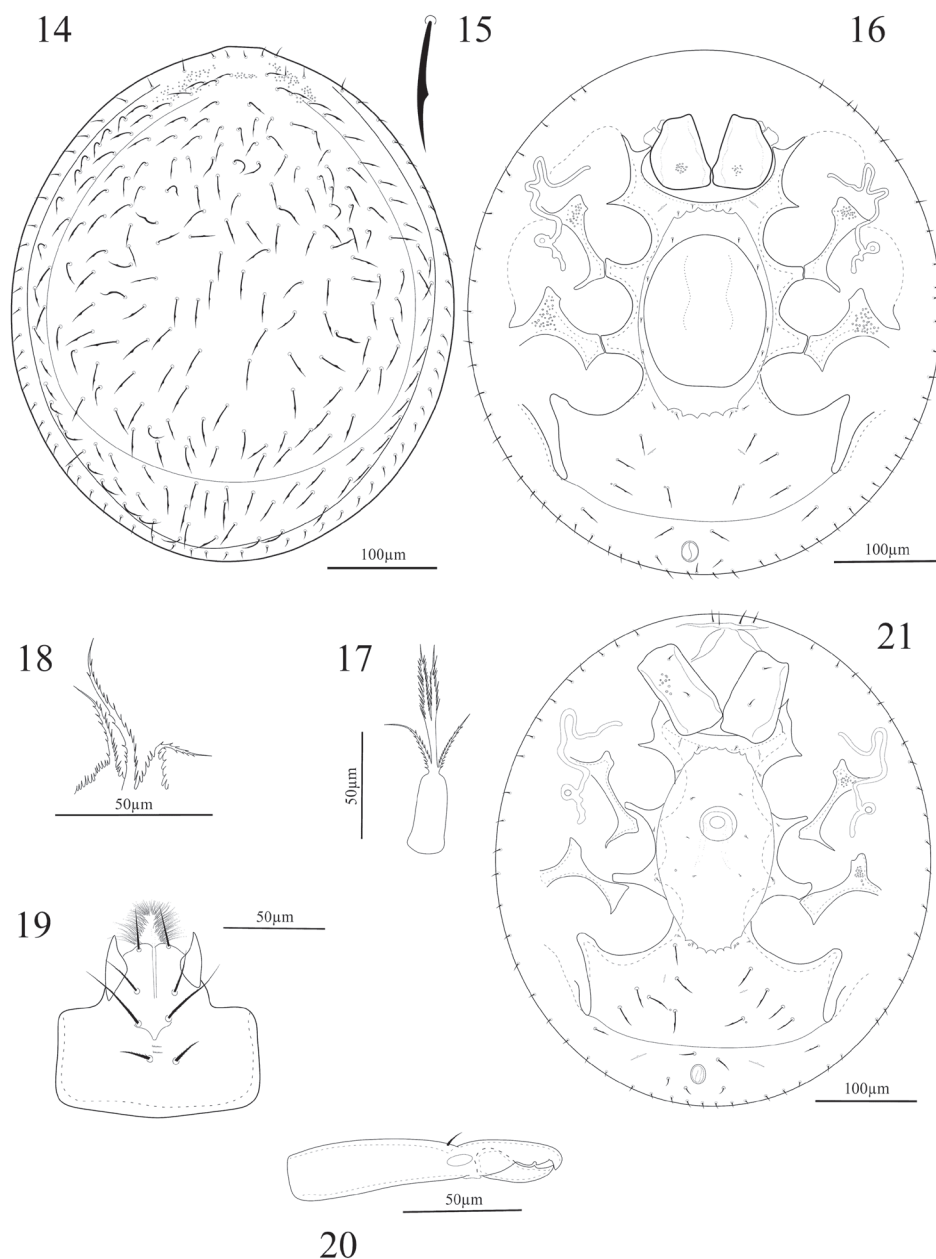
*Venter* (Fig. 16). Tritosternal base narrow, lacinia pilose, and three branched, lateral branches shorter than bifurcate median branch (Fig. 17). Sternal region smooth, united with endopodal shields. Genital shield smooth, 135–150 long and 108–128 wide, ratio length/width = 1.20–1.23, situated between coxae II–IV, anterior margin convex and posterior margin straight. Perigenital ring oblong, 175–200 long and 125–145 wide, ratio length/width = 1.40–1.53, extending slightly beyond posterior level of coxae IV, with 5 crenulations on both anterior and posterior margins; lateral margins smooth and continuous. Perigenital area with four pairs of short setae, lateral to genital shield; with two pairs of short setae near anterior margin, one pair near to posterior margin and one pair inserted between coxae IV on inguinal region. Pre-anal line present. Ventral shields with 4–5 pairs of scimitar-shaped setae, adanal setae *Ad1* scimitar-shaped and 20–22 long, *Ad2* smooth, needle-like, and 12–14 long. Peritremes with three subequal convolute branches. Pedofossae II–IV well developed. Pedofossae IV narrowing posteriorly and with a rounded tip.

*Gnathosoma* (Figs 18–20). Epistome three-branched and with serrated margin, median branch longer than laterals (Fig. 18). Corniculi short and horn-like; internal malae numerous and brushy, gnathosomal setae *h1* smooth, *h2* with a few barbs, *h3* and *pc* thickened and denticulated (Fig. 19). Cheliceral digits normal for the genus; movable digit 37 long, with one subdistal tooth and a terminal hook; fixed digit 40 long (from tip to the base of movable digit), with two teeth and a terminal hook; pilus dentilis setiform and minute (Fig. 20). Palptarsus with three-tined apotele. Leg lengths: legs I 245–250, legs II 210–220, legs III 175–188, and legs IV 213–225 long.

**Male (n = 3).** *Idiosoma*. Length 438–450, width 385–395.

*Dorsum*. Dorsal setae, shields and puncta as female.

*Venter* (Fig. 21). Ventral region (excluding exopodal shields) smooth, genital aperture rounded and located between coxae II–III. Perigenital ring 188–200 long,



**Figures 14–21.** *Oplitis sarcinulus* (female); **14** Dorsal view of idiosoma **15** Dorsal seta **16** Ventral view of idiosoma **17** Tritosternum **18** Epistome **19** Hypostome **20** Chelicera **21** Ventral view of idiosoma (Male).

110–125 wide. Peritreme uni-convoluted, U-shaped in central part and without medial extension. *Legs.* Leg I 215–225, leg II 185–205, leg III 165–179, and leg IV 190–201 long.



**Remarks.** *Oplitis sarcinulus* was described from North Carolina (USA) by Hunter and Farrier (1976) in association with *Tetramorium caespitum* Linnaeus, and is now recorded in Iran for the first time, from leaf-litter. Herein, we provide the complete description and illustration of this species based on adult female and male. *Oplitis sarcinulus* is similar to *O. leonardiana* (Berlese, 1903) and *O. pennsylvanica* (Berlese, 1903). On the basis of some photomicrographs from three very good quality slides (No. 2/16, 2/17 and 2/19) kindly supplied by Dr. Nannelli (Istituto Sperimentale per la Zoologia Agraria, Florence, Italy), we found that these two species are clearly different from *O. sarcinulus*. It differs from *O. leonardiana* (Berlese, 1903) and *O. pennsylvanica* (Berlese, 1903) by the shape of the peritreme (M-shaped in *O. sarcinulus*, but U-shaped and with a small extension as Fig. 8 in *O. pennsylvanica*, but with this U-shaped bend more compressed, posteriorly curved and directed posteriorly as Fig. 9 in *O. leonardiana*), ventral shield (with 4–5 pairs of setae in *O. sarcinulus* and *O. pennsylvanica*, but 8–9 pairs in *O. leonardiana*), adanal setae *Ad*2 (shorter than *Ad*1 in *O. sarcinulus*, but as long as *Ad*1 in both *O. leonardiana* and *O. pennsylvanica*), shape of genital shield (narrowly oval and elliptical in *O. sarcinulus* and *O. leonardiana*, but widely oval and beehive-shape in *O. pennsylvanica*), width and the number of posterior crenulations (narrow and with 5–6 crenulations in *O. sarcinulus*, but wide and with 9 crenulations in *O. pennsylvanica* and *O. leonardiana*), and pedofossae IV (narrow and with rounded distal end in *O. sarcinulus*, but wide, with pointed and rounded distal end in *O. leonardiana* and *O. pennsylvanica*).

The Iranian specimens agree well with the original description, however, Hunter and Farrier (1976) mentioned 6–7 crenulations on anterior and posterior margins of perigenital ring, respectively, and sternal region of perigenital ring with small punctuation, but with 5–6 crenulations and sternal region smooth in Iranian specimens.

**Material examined.** 6 females and 3 males, Iran, Mazandaran province, Nowshahr, Kheyrood-Kenar forest, 36°34'N, 051°33'E, altitude 636 m a.s.l., 5 July 2014, E. Babaeian coll., in leaf-litter. The type specimens are deposited in the Acarological Collection, Jalal Afshar Zoological Museum, Department of Plant Protection, Faculty of Agriculture, University of Tehran, Karaj, Iran.

### Key to the Iranian species of *Oplitis* (females)

1. Distance between anterior margin of genital shield to anterior margin of perigenital ring is longer than posterior distance, peritremes mushroom-like ..... *Oplitis exopodi* Hunter & Farrier, 1975
- Distance between anterior margin of genital shield to anterior margin of perigenital ring is equal or shorter than posterior distance, peritremes M- or U-shaped ..... 2
- 2 Dorsal and ventral shield setae smooth and needle-like, peritremes M-shaped and anterior loop of prestigmatic section shorter than posterior one ..... *O. iranicus* Kazemi & Kontschán, 2007
- Dorsal and ventral shield setae scimitar-shaped, anterior loop of prestigmatic section longer than posterior ..... 3

- 3 Prestigmatic part U-shaped, marginal and ventral shields completely with small punctations, ratio length/width of genital shield  $\approx 1.45$ , ratio length/width of perigenital ring  $\approx 1.90$  ..... ***O. paradoxa* (Canestrini & Berlese, 1884)**
- Peritremes more M-shaped and prestigmatic part longer than posterior part, only anterior part of marginal and dorsal shields with small punctations, ratio length/width of genital shield  $\approx 1.20$ – $1.23$ , ratio length/width of perigenital ring  $\approx 1.40$ – $1.53$  ..... ***O. sarcinulus* Hunter & Farrier, 1976**

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We would like to express our sincere thanks to Dr. Roberto Nannelli (Istituto Sperimentale per la Zoologia Agraria, Florence, Italy) for information concerning specimens in the Berlese collection. The authors would like to acknowledge the financial support of University of Tehran for this research under grant number 7110018/6/21.

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# A reassessment of the phylogenetic utility of genus-level morphological characters in the family Bogidiellidae (Crustacea, Amphipoda), with description of a new species of *Eobogidiella* Karaman, 1981

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## Abstract

Bogidiellidae is the most diverse and cosmopolitan family of stygobiotic amphipods, and inhabits a variety of subterranean biotopes, especially interstitial habitats. While the family is characterized by considerable sexual dimorphism, this dimorphism has adversely affected our understanding of the systematics of the group. Most species have restricted geographic ranges and occur in difficult to sample habitats, so it is common for individual species descriptions to be based on a single sex. In this work we revisit an analysis of morphological characters in an attempt to clarify their phylogenetic utility in resolving taxonomic relationships among genera by introducing a new species, two additional characters, and phylogenetic statistical support values. *Eobogidiella venkataramani* **sp. n.**, from a spring fed brook in the Shirawati River basin along the escarpment of the Western Ghats (Karnataka, India) differs from the only known congener, *Eobogidiella purmamarcensis*, from Argentina, in the structure of mouthparts, the shape and ornamentation on gnathopods and characters of the telson. Our phylogenetic analyses indicate that the available morphological characters are not sufficient to resolve phylogenetic relationships within Bogidiellidae, thus these characters alone cannot be used to determine the phylogenetic placement of *E. venkata-*

*ramani* **sp. n.** within the family. Nevertheless, *E. venkataramani* **sp. n.** shares diagnostic characters with *Eobogidiella*, supporting placement of the new species in this genus. Our findings point towards a critical need to resolve relationships within the family using molecular approaches, along with the development of a suite of additional morphological characters for Bogidiellidae. This is the third species of Bogidiellidae from southern India.

## Keywords

Biodiversity, Subterranean fauna, Karnataka, Taxonomy, Phylogenetic analysis

## Introduction

The family Bogidiellidae Hertzog, 1936 has an intriguing history of study that shaped the systematics of the group (e.g., Hertzog 1933; Holsinger and Longley 1980; Karaman 1981; Stock 1981; Ruffo 1973; Koenemann et al. 1998; Koenemann and Holsinger 1999; Iannilli et al. 2006; Jaume et al. 2007; Vonk and Jaume 2010; Leijes et al. 2011; Senna et al. 2014), but this work has not led to a coherent understanding of relationships within the family (Lowry and Myers 2013). The Bogidiellidae includes 37 genera and 113 described species, with the phylogenetic relationships among the genera discussed by Stock (1981) and a phylogenetic tree produced by Koenemann and Holsinger (1999).

Only two Bogidiellidae species are known from India: *Bogidiella indica* Holsinger et al. 2006, recorded from bore wells in Andra Pradesh, and the minute species *Bogidiella totakura* Senna et al. 2013, from a nearby locality Andhra Pradesh, southern India. The only other stygobiotic amphipod species of India are the gammaroid *Indoniphargus indicus* (Chilton 1923) (Mesogammaridae), reported from various groundwater habitats (e.g., springs, well water, and a mine pit) in the north-eastern states of Bihar, West Bengal and Odisha (formerly Orissa) (Stephensen 1931; Straškraba 1967), and the crangonyctoid *Kotumsaria bastarensis* Messouli et al. 2007 (Kotumsaridae), from Kotumsar Cave, in the east-central state of Chhattisgarh (Messouli et al. 2007; Senna et al. 2013).

Below we describe *Eobogidiella venkataramani* **sp. n.** from a spring-fed freshwater habitat in southwest India and evaluate the phylogenetic utility of the available morphological characters (Koenemann and Holsinger 1999, and two characters added in the present study) in hopes of gaining insights into the placement of our new species within the family.

## Methods

### Specimen sampling

A sample containing the stygobiont (one specimen) was collected in December 2008 from a spring-fed brook in the state of Karnataka in southwest India (Figs 1, 2) using a hand-made hemispherical scraper and preserved in a 4% solution of formaldehyde.





**Figure 1.** Geographic distribution of *Eobogidiella venkataramani* sp. n. (circle) and *Eobogidiella purmamarcaensis* (Grosso & Ringuelet, 1979) (square).



**Figure 2.** “Wet-spot” biotope in the Shirawati River basin, Western Ghats, India.

## Morphology and taxonomic terms

Body length was recorded while holding the specimen straight and measuring the distance along the dorsal side of the body from the base of the first antenna to the base of the telson using an ocular micrometer in a Lomo MBS-9 dissecting microscope. Appendages were drawn using a Carl Zeiss NU-2 compound microscope equipped with a drawing device as described in Gorodkov (1961).

Due to improper storage, the specimen was entirely dry upon initial examination. We followed the method described by Namiotko et al. (2011) to rehydrate the specimen. A permanent preparation was made using polyvinyl lactophenol (PVL) and a methylene blue staining solution was used as mounting medium.

The term “palmar angle” of the gnathopod propodi refers to the angle formed at the end of the palm and beginning of the posterior margin or the point at which the tip of the dactylus closes on the propodus (Birstein 1941). The fore-gut lateralia comprise a potentially useful morphological character in the phylogenetic analysis (Coleman 1991). We use the term “sternal humps” (Holsinger 1989; Sidorov 2010) to refer to the “pulvinate sternal epithelium” of Kikuchi et al. (1993) and Kikuchi and Matsumasa (1997), which is homologous to the “mediosternal processes” of Koenemann and Holsinger (1999) and Pérez-Schultheiss (2013). Koenemann and Holsinger (1999) took the view that the mediosternal gills of *Paracrangonyx* Stebbing, 1899 are autapomorphous, with a different physiological function and morphological structure, but they do not cite the works of Kikuchi. Fenwick’s (2001) diagnoses of the genus *Paracrangonyx* includes the presences of “Single, simple, elongate sternal gills medially on pereonites 2–7.” Bousfield (1977) observed that sternal gills are present in several families of amphipods which are not closely related – including Crangonyctidae (e.g., Holsinger 1977), Hyalellidae, and Pontogeneiidae – and suggests that these structures arose independently in the different groups. Homologies of mediosternal gills and sternal humps within and across families of freshwater amphipods remains problematic, and effective use of these characters in phylogenetic analyses requires further study.

## Phylogenetic analysis

To investigate the phylogenetic utility of the available morphological characters we used a revised version of the morphological data matrix used by Koenemann and Holsinger (1999) and incorporated phylogenetic methods that provide measures of statistical support (See Suppl. material 1 for morphological character matrix). Our updated data set includes additional genera described by various authors since Koenemann and Holsinger’s (1999) analyses (*Fidelidiella* Jaume, Gràcia & Boxshall, 2007; *Glyptogidiella* Vonk & Jaume, 2010; *Omangidiella* Iannilli, Holsinger, Ruffo & Vonk, 2006, *Racovella* Jaume, Gràcia & Boxshall, 2007), three additional species (*Patagongidiella wefkoi* Pérez-Schultheiss, 2013; *Xystriogidiella juliani* Coleman, 2009; *Eobogidiella venkataramani* sp. n.), two additional morphological characters, and published taxonomic updates made by Koenemann and

Holsinger (1999) as follows: *Medigidiella* (was *Medigidiella* A), *Indogidiella* (was *Medigidiella* C), *Arganogidiella* (was *Medigidiella* B), *Bogidiella* (*niphargoides* group) (was *Bogidiella* C), *Bogidiella* (*skopljensis* group) (was *Bogidiella* B), *Bogidiella* (*albertimagni* group) (was *Bogidiella* A), *Stygogidiella* (was *Stygogidiella* A), and *Argentinogidiella* (was *Stygogidiella* B). The new morphological characters address the hypertrophied coxa 5 in *Glyptogidiella* and the unique position of the coxal gills on pereonite 7 in *Xystriogidiella juliani* (Coleman 2009). Iannilli et al. (2005) discussed another character, “coxal endite on maxilliped (or third coxal lobe)”. We were unable to code the coxal endite character of Iannilli et al. (2005) for most genera, as this character is not included in earlier descriptions.

We used the Bogidiellidae *sensu lato* in our analysis, including Artesiidae, as its acceptance as a distinct family has been questioned (Stock 1981; Botosaneanu and Stock 1989), as well as the genus *Kergueleniola* Ruffo, 1974 which is sometimes placed in a separate family Kergueleniolidae (Lowry and Myers 2013). We were unable to test the validity of the inclusion of the Salentinellidae in Bogidielloidea within the Senticaudata: the uniramous uropod 3 in *Parasalentinella* Bou, 1971 does not fit with core bogidiellid features, and *Salentinella* Ruffo, 1947 species lack apical robust setae on uropods 1–2 (cf., *Salentinella anae* Messouli et al. 2002). *Bogidiella indica* Holsinger (2006), the sole member of the *indica*-group *sensu* Holsinger et al. (2006), recently has been attributed to the *niphargoides*-group based on the shared absence of rami on pleopods 1–3 (Senna et al. 2013). Therefore, the *indica*-group was not considered in our analysis, as it is instead included in our analysis within the *niphargodes*-group. The genera *Paracrangonyx* Stebbing, 1899 (Paracrangonyctidae), *Pseudingolfiella* Noodt, 1965 (Pseudingolfiellidae) and *Dussartiella* Ruffo, 1979 (Dussartiellidae) were excluded from the analysis. The recent placement of these genera in different families (see Koenemann and Holsinger 1999; Iannilli et al. 2011; Lowry and Myers 2012), supports a higher-level analysis of the Senticaudata, in which the Pseudingolfiellidae is not considered even to be a member of the suborder Senticaudata (Lowry and Myers 2013), whereas the Paracrangonyctidae and Dussartiellidae fall into the Gammarida instead of the Bogidiellida in the analysis of Lowry and Myers (2013).

Following Koenemann and Holsinger (1999), we conducted two phylogenetic analyses, treating all characters as unweighted: first with unordered character states and an ‘alternative’ analysis with ordered character states. The parsimony analyses (unordered and ordered) of 46 taxa, including 37 genera of Bogidiellidae, 2 genera of Artesiidae, and 1 genus of Kergueleniolidae, and the hypothetical ancestor outgroup used by Koenemann and Holsinger (1999), were based on 29 morphological characters (Suppl. material 1). Both analyses were conducted in PAUP\*4.0a146 (Swofford 2002) using a heuristic search, random stepwise addition with 1000 replicates and TBR branch swapping. Advances in computer power and processor speeds and have allowed us to reevaluate Koenemann and Holsinger’s (1999) original cladistic analysis with modern and more rigorous methods that incorporate statistical measures of branch support. Bootstrap and Jackknife resampling methods for branch support were performed with PAUP\*4.0a146 using the “Fast” stepwise-addition search (1,000,000 replicates). PAUP\* command files for Decay/Bremer support indices were generated

with TreeRot. v3 (Sorenson and Franzosa 2007), input with strict consensus trees, edited to run each heuristic search for 500 replicates with TBR branch swapping, and executed in PAUP\*4.0a146.

### Acronym used for the collection

FEFU Zoological Museum of the Far East Federal University, Vladivostok.

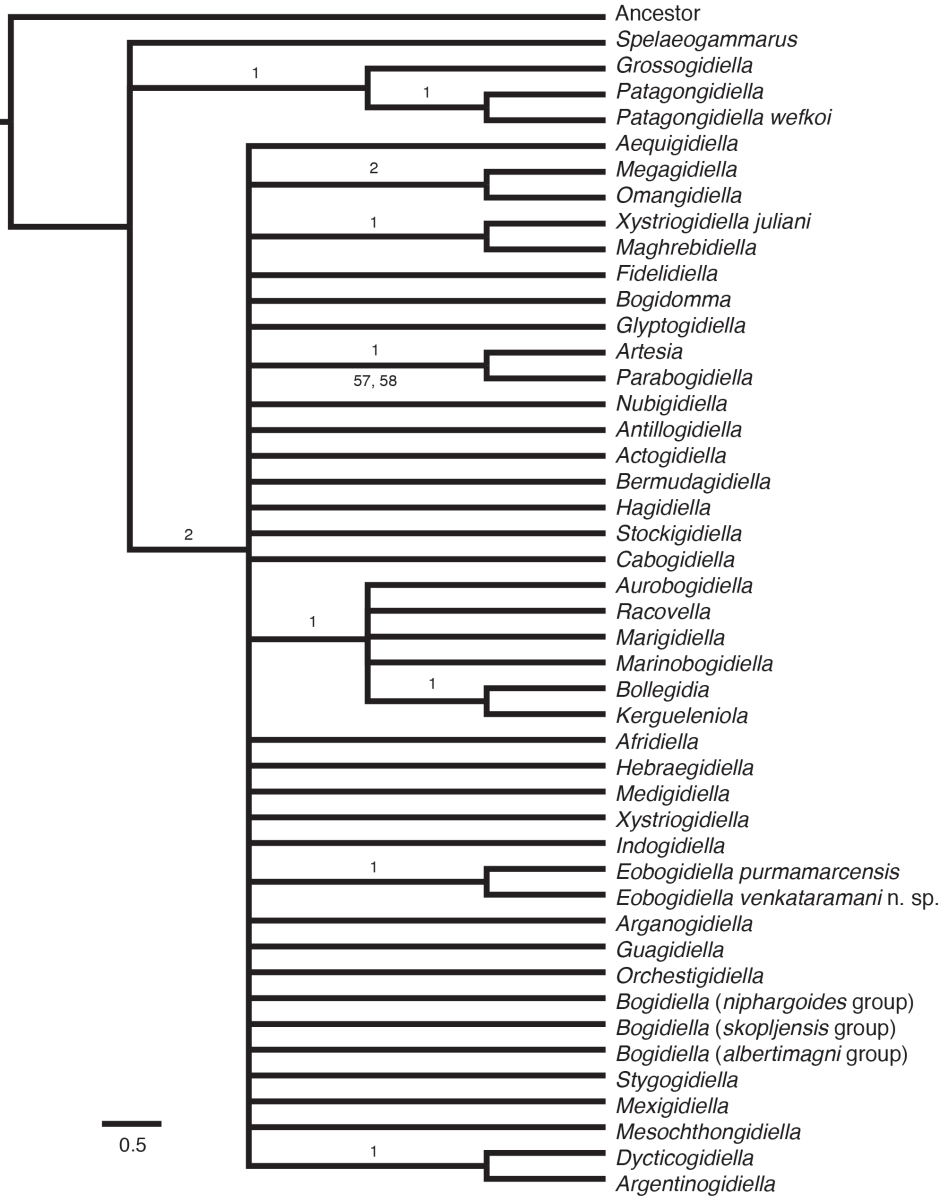
## Results

### Phylogenetic analysis of Bogidiellidae *sensu lato*

To investigate the phylogenetic utility of the available morphological characters and to determine the placement of our new species among the bogidiellids, we reevaluated the relationships within the family, adding new taxa and characters to the morphology matrix of Koenemann and Holsinger (1999). Our phylogenetic analysis of 29 morphological characters supports two equally parsimonious trees (length = 170) and 3235 equally parsimonious trees (length = 243) in the unordered and ordered analyses, respectively. Although the strict consensus trees (Figs 3, 4) resolved some relationships, they lack support from bootstrap (Suppl. material 2, 3), jackknife (Suppl. material 2, 3), and Bremer/decay indices (Figs 3, 4), due, at least in part, to the low character to taxa ratio (29 to 46, respectively). The strict consensus tree for the ordered analysis places the new species within the genus *Eobogidiella* Karaman, 1981 (Fig. 3), without significant statistical support. The unordered analysis (Fig. 4) instead places these two taxa in association with other genera (the new species with *Kergueleniola*; *Eobogidiella purmamarcensis* (Grosso & Ringuet, 1979) with *Bogidiella* and other genera), also without significant statistical support.

The two additional characters (i.e., the presence or absence of a coxal endite on the maxilliped, and the morphology of coxa 5) were added to the matrix of Koenemann and Holsinger (1999), but provide little additional phylogenetic support. Although the “maxilliped, coxal endite” is an informative character as it is present for a number of genera, the morphology of coxa 5 is normal for all genera except for *Glyptogidiella* (for which it is hypertrophied), therefore, this autapomorphy is phylogenetically uninformative.

The above analyses revealed that the available morphological characters provide no phylogenetic utility in resolving generic relationships within the Bogidiellidae *sensu lato*, thus the available morphological characters do not allow us to establish the phylogenetic placement of the new species. Therefore, the resulting phylogenies (Figs 3, 4) cannot be used to inform generic placement of the new species or direct choices for generic comparisons. Instead, generic placement of the new species must rely exclusively on shared generic-level diagnostic characters. Generic-level diagnostic characters



**Figure 3.** Maximum parsimony strict consensus tree of genera and selected species of Bogidiellidae, ordered analysis. Numbers above branches are Decay/Bremer indices and numbers below branches are bootstrap followed by jackknife support values. Support values less than 50% not displayed. Scale bars indicate number of character state changes. See Suppl. material 2 for original bootstrap and jackknife consensus trees.

(i.e., 3 outer ramus segments in pleopods 1–3, uniarticulate and reduced inner rami of pleopods 1–3, and 1 segmented palp of maxilla 1) of the new species are shared with the South American genus *Eobogidiella*, suggesting a possible close relationship with





**Figure 4.** Maximum parsimony strict consensus tree of genera and selected species of Bogidiellidae, unordered analysis. Numbers above branches are Decay/Bremer indices and numbers below branches are bootstrap followed by jackknife support values. Support values less than 50% not displayed. Scale bars indicate number of character state changes. See Suppl. material 3 for original bootstrap and jackknife consensus trees.

*E. purmamarcensis*. Other bogidiellid genera were considered based on the shared presence and absence of male sexual modifications (*Indogidiella*) and similar geographical distributions (*Bogidiella*) (Table 1). Although both *Indogidiella* and the new species



**Table 1.** Species distributions and selected morphological characters from for *E. purmamarcensis*, *I. daccordii*, *I. sarawacensis*, *B. indica*, *B. totakura*, and the new species. Characters listed in the table represent all morphological characters from Koenemann & Holsinger (1999) that are variable among presented taxa. Bold character states indicate that the state is shared with the new species.

Characters	<i>Eobogidiella venkataramani</i> sp. n.	<i>Eobogidiella purmamarcensis</i> (Grosso & Ringuet, 1979)	<i>Indogidiella daccordii</i> (Ruffo, 1994)	<i>Indogidiella sarawacensis</i> (Stock, 1983)	<i>Bogidiella indica</i> Holsinger et al., 2006	<i>Bogidiella totakura</i> Senna et al., 2013
Distribution	India	Argentina	Philippines	Borneo	India	India
Modifications of the outer ramus in male pleopod 1	absent	?	absent	absent	absent	?
Modifications of the outer ramus in male pleopod 2	absent	?	absent	absent	absent	?
Number of outer ramus segments in pleopods 1-3	3	3	3	3	3	3 or 4
Inner rami of pleopods 1-3	unarticulate, reduced	unarticulate, reduced	unarticulate, reduced	unarticulate, reduced	absent	absent
Modifications in male uropod 1	present	?	present	present	present	?
Modifications in male uropod 2	present	?	present	present	absent	?
Dagger-shaped rami in male uropod 1	absent	?	absent	absent	absent	?
Dagger-shaped rami in male uropod 2	absent	?	absent	absent	absent	?
Gills	pleopods 3-6	?	?	pleopods 4-6	pleopods 2-6	pleopods 4-6
Number of segments in flagellum of antenna 2	5	5	5	6	5	5
Number of segments in accessory flagellum	1	2	3	3	1	3
Number of palp segments in maxilla 1	1	1	2	2	2	2
Number of setae on inner lobe of maxilla 1	2	3	2	2	4	0
Number of spines on outer lobe of maxilla 1	7	7	7	7	6	6
Mandibular molar	non-tritritative	tritritative	tritritative	tritritative	non-tritritative	“semi-tritritative”
Number of apical spines of telson	0	1	1	2	1	0
Number of subapical spines of telson	2	3	0	0	0	1

lack modifications of the outer ramus in male pleopods 1 and 2 and have modified spines on rami of male uropods 1 and 2 (Table 1), the nature of the modifications of the spines on the rami of male uropods 1 and 2 of *Indogidiella* (Ruffo 1994, fig. 4g, h; Stock 1983, figs 23, 24) differ from the new species, possibly indicating independent origins. Furthermore, species in *Indogidiella* have a 2 segmented palp on maxilla 1, whereas the new species has a 1 segmented palp. The geographically proximate species, *Bogidiella indica* and *Bogidiella totakura*, do not share the same male sexual modifications and also have a 2 segmented palp on maxilla 1. Therefore, based on the diagnostic characters shared with *Eobogidiella* and morphological dissimilarity from *Indogidiella* and the more geographically proximate genus, *Bogidiella*, we tentatively place the new species in the genus *Eobogidiella* recognizing further study is required to understand generic boundaries and relationships within the family.

### Species description and taxonomy

#### Order Amphipoda Latreille, 1816

#### Family Bogidiellidae Hertzog, 1936

#### Genus *Eobogidiella* G. Karaman, 1981

syn.: *Bogidiella* (*Eobogidiella*) G. Karaman 1981: 34. —*Eobogidiella* G. Karaman 1982: 50. —Koenemann and Holsinger 1999: 797, 810. —Lowry and Myers 2012: 43. —*Mexigidiella* (part.) Stock 1981: 354.

**Type species of the genus.** *Bogidiella* (*Eobogidiella*) *purmamarcensis* Grosso & Ringuelet, 1979, (by original designation).

#### *Eobogidiella venkataramani* sp. n.

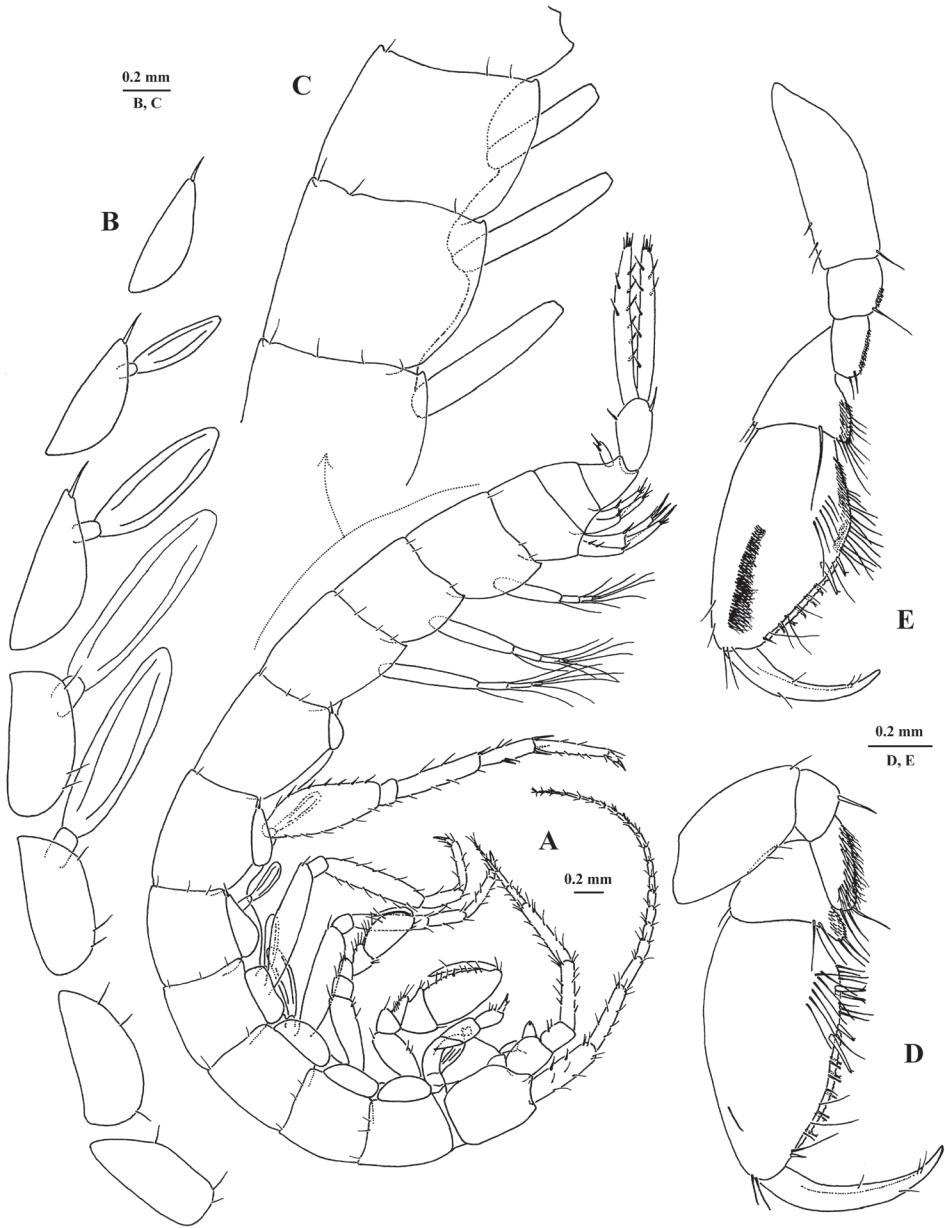
<http://zoobank.org/B0EE2445-3C65-45D0-B7C6-8ECF6ECE701A>

Figs 5–7

**Diagnosis.** Habitus typical of a stygomorphic bogidiellid, combining a number of features found in other genera of this family.

Primary characters: maxilla 1 with vestigial, single-segmented, symmetrical palps; pleopods 1–3 with single-segmented, reduced inner rami.

Secondary characteristics: ventral surface of pereonites 2–7 bearing sternal humps; coxal gills on pereopods 3–6; antenna 1 with reduced, single-segmented, minute accessory flagellum; mandibles with tiny, vestigial molars with 2 short spines and 1 plumose seta; maxilliped lacking coxal endite; apparent sexual dimorphism (spines on uropods 1 and 2 modified).



**Figure 5.** *Eobogidiella venkataramani* sp. n., ♂ (?), 6.5 mm, holotype, Jog Falls, Karnataka, India: **A** habitus from left side **B** coxae 1–7 **C** epimeral plates 1–3 **D, E** gnathopods 1–2.

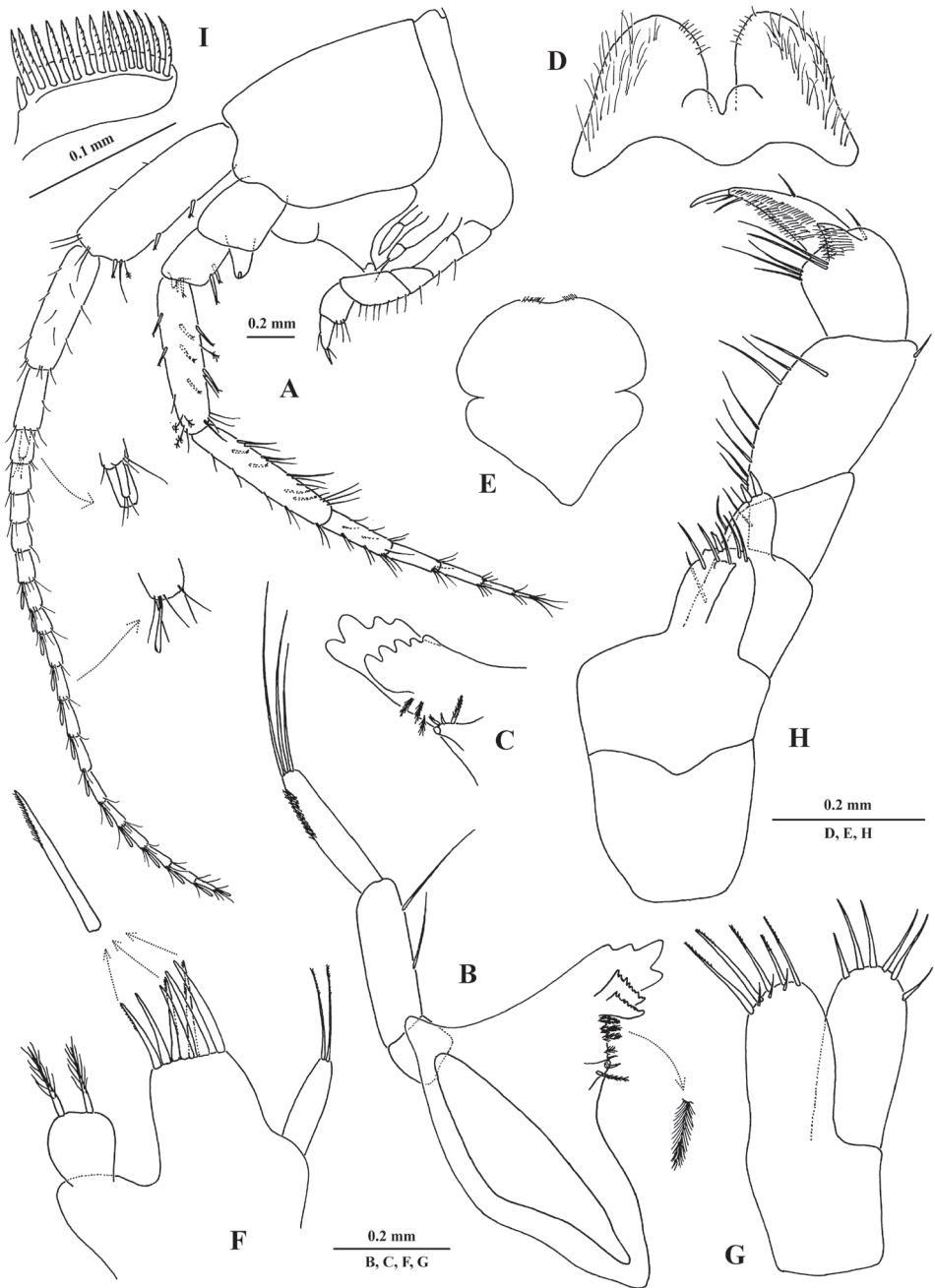
**Type locality.** Spring fed swamp in the upper reaches of a small logged brook (14.218667°N; 74.821667°E) in the Shirawati River basin, altitude above sea level 550 m, Western Ghats, Karnataka, India.

**Type material. Holotype specimen.** INDIA: probable ♂, 6.5 mm, X43794/Cr-1621-FEFU, vicinity of Jog Falls, Karnataka state, collected 5 Dec. 2008 by M.V. Chertoprud. Deposited in the Zoological Museum of the Far East Federal University, Vladivostok (FEFU).

Accompanying fauna: *Goerodes* sp. (Trichoptera: Lepidostomatidae), *Isca* sp. (Ephemeroptera: Leptophlebiidae), *Phanoperla* sp. (Plecoptera: Perlidae), *Macromyia* sp. (Odonata: Corduliidae), and many terrestrial leeches (Hirudinida) on the banks.

**Etymology.** The specific epithet honors the former Director of Zoological Survey of India, Dr. K. Venkataraman, whose assistance was pivotal in the early stages of this research.

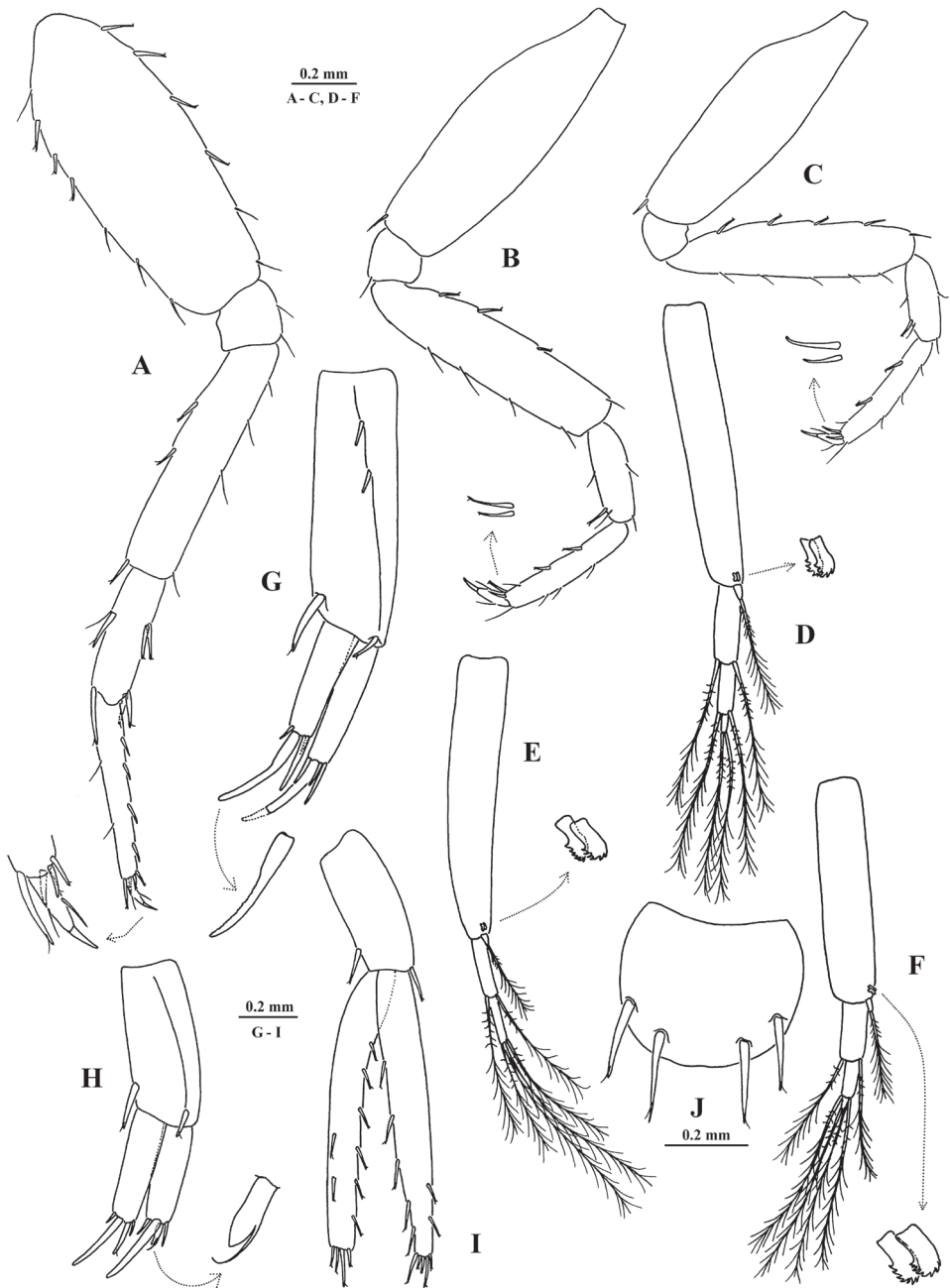
**Description of holotype X43794/Cr-1621-FEFU.** General body morphology (Figs 5A, C, 6A, 7J). Body unpigmented, smooth, sparsely setose with fine setae. *Head* longer than deep and longer than first pereon segment; rostrum pointed, interantennal lobe distinct, evenly rounded apically; eyes absent. *Epimeral plates 1–3* with acute posterodistal corners and with thin setae on posterior margin, ventral margin of plates unarmed. *Telson* subquadrate with apical margin roundly convex, width: length ratio 1 : 0.75, bearing 4 long notched spines subapically. **ANTENNAE** (Figs 5A, 6A). *Antenna 1* about 38% of body length; flagellum with 17 articles, each article with 2–4 short setae, aesthetascs present on 12 distal flagellar articles; peduncular article ratio 1 : 0.67 : 0.3; proximal article of peduncle with 3 notched spines on ventral margin; accessory flagellum small, comprised of one article. Ratio of lengths of antenna 1 : antenna 2, 1 : 0.75; flagellum of *antenna 2* with 5 articles, each article sparsely setose; peduncle article 4 as long as article 5; flagellum shorter than peduncle (articles 4+5); last two peduncular articles with notched spines and long, stiff setae; gland cone not markedly elongate. **MOUTH PARTS** (Fig. 6A–I). *Labrum* subtrapezoidal, long as broad, clypeus unfused. Inner lobes of *labium* well developed, outer lobes broad, densely setose laterally, with thin setae marginally, and lightly setose with shorter setae mediodistally, mandibular process narrow. *Left mandible*: incisor with 4 teeth, lacinia mobilis consisting of 2 finely denticulate plates of similar size; row of 3 densely plumose spines between lacinia and molar; molar vestigial, conical, bearing 2 short spines and 1 plumose seta. *Right mandible*: incisor with 4 teeth, lacinia mobilis with 5 teeth, row of 2 densely plumose spines between lacinia and molar; molar similar to that of left mandible. *Mandibular palp* article 2 slightly longer and broader than article 3; proximal palp article without a seta; the second article with 2 long setae on inner margin; distal article narrow, with 3 long setae unequal in length on apex, and numerous small, fine setae near lateral margin on distal half of article. *Maxilla 1* palp reduced, single-segmented, with 2 long setae of equal length on apex (palps symmetrical); outer plate with 7 simple spines, 3 of which are finely pectinate; inner plate broadly rounded distally, with 2 plumose setae. *Maxilla 2* plates similar in size, inner plate with 6 apical setae of varying size, outer plate with 5 long, finely pectinate setae and 3 short setae apically. *Maxilliped* with inner and outer plates short; outer plate with 2 apical spines accompanied by 2 stiff setae on lateral face; inner plate broad, with 1 bifid apical spine



**Figure 6.** *Eobogidiella venkataramani* sp. n., ♂ (?), 6.5 mm, holotype, Jog Falls, Karnataka, India: **A** head **B** left mandible **C** incisor and lacinia mobilis of right mandible **D** labium **E** labrum **F, G** maxillae 1–2 **H** maxilliped **I** lateralia.

and 3 stiff naked subapical setae, 2 setae located medially on small pedestal; palp four-segmented; palp article 2 longest, nearly straight on outer margin, shallowly convex on inner margin, with a row of 8 long, simple setae along inner margin; article 3 half as long as article 2, with sharply pointed, pubescent cuticular projection distally and bearing 2 sets of long setae apically; article 4 about as long as preceding article, curved and tapering distally, with dorsal seta, and bearing 2 longer setae at base of nail, nail  $0.33\times$  length of pedestal. *Lateralialia* with 14 strong, pectinate spines and 1 short simple spine. COXAL PLATES, GILLS AND STERNAL RESPIRATORY STRUCTURES (Fig. 5A, B). *Coxal plates* 1–7 wider than long, free, not overlapping with one another, coxa 4 largest; *coxal plates* 5–7 progressively smaller towards the posterior, semicircular, acuminate posteriorly and bearing 1 stiff seta posteriorly. *Coxal gills* oblong, stalked on coxae 3 to 6. Ventral surface of pereonites 2–7 bearing *sternal humps*. GNATHOPODS 1 AND 2 (Fig. 5D, E). *Gnathopod* 1, basis short, broadest medially, with 2 short setae on anterior margin; merus with 3 stiff setae on distoposterior margin, posterior surface densely spinose; carpus sub-triangular, with 2 setae of equal length on narrowly rounded spinose distoposterior lobe; propodus oblong, about  $1.8\times$  longer than broad, palmar margin slightly convex,  $3\times$  longer than posterior margin, palmar angle indistinct, with 1 group of oblique, long setae laterally on basal half of segment; anterior margin with 1 seta, and a group of 2 setae anterodistally; palm armed with 2 pairs of weakly notched spines accompanied by 10–12 stiff, tiny notched setae along inner and outer faces; dactylus falcate, about 70% length of propodus, demarcation of nail indistinct with 2 setules at hinge. *Gnathopod* 2, basis sublinear, with 3 short setae on distal one third of anterior margin; ischium posterior surface densely spinulose with one longer, posterodistal seta; merus with posterior surface densely spinulose, with two stiff longer, posterodistal seta; carpus triangular and slightly elongate, with numerous thin subequal setae on broadened, spinulose ventral lobe, 1 long seta distally on medial face; propodus small, slightly shorter than propodus of gnathopod 1; palmar margin oblique, subequal in length to posterior margin, palmar angle poorly developed and broadly rounded, with 1 group of oblique long setae subdistally; anterior margin with 2 setae, anterodistal group with 3 setae; palm armed with 1 pair of weakly notched spines accompanied with 5–6 stiff, tiny, notched setae along inner and outer faces; dactylus similar to that of gnathopod 1. PEREOPODS 3, 4, 6 (pereopods 5 and 7 missing) (Fig. 7A–C); lacking lenticular organs. *Pereopods* 3–4 subequal, bases rather long and narrow, each with 1 stiff seta on anterodistal margin; dactyli about  $0.33\times$  length of corresponding propodi. *Pereopod* 6 length  $0.35\times$  body length; basis narrowed distally, length:width is 1:0.4; posterior margin with 3 notched spines and 4 setae; anteriorly 4 notched spines and 2 setae; carpus short, length  $0.5\times$  preceding article, armed with strong spines on lateral and distal margins; dactylus about  $0.25\times$  length of corresponding propodus. PLEOPODS AND UROPODS (Fig. 7D–I). *Pleopods* 1–3 subequal; peduncular articles linear, in ratio 1:1:0.7, with 2 retinacula each; inner ramus reduced, 1-segmented, length less than basal width of first segment of outer ramus; outer ramus 3-segmented, fringed with long, plumose setae at distal end of each





**Figure 7.** *Eobogidiella venkataramani* sp. n., ♂ (?), 6.5 mm, holotype, Jog Falls, Karnataka, India: **A** pereopod 6 **B, C** pereopod 3-4 **D, E, F** pleopods 1-3 **G, H, I** uropods 1-3 **J** telson. Pereopods 5 and 7 are missing.

segment. *Uropod 1* peduncle without basofacial spine; with 3 dorsolateral spines and distally with 1 very strong dorsomedial spine; exopodite:endopodite length 1:0.88; endopodite length 0.5× peduncle; rami straight, each armed with 4 strong spines apically, 1 of them much larger and with marginal serrations. *Uropod 2* peduncle with 1 dorsolateral spine and 1 strong dorsomedial spine distally; exopodite:endopodite length 0.86:1; endopodite length 0.7× peduncle; rami straight, each armed with 4 spines apically, 1 of them much larger and another modified (Fig. 7H). *Uropod 3* long, with peduncle about 1 half the length of rami, armed with two notched spines on apex; endopodite curved in basal half, with 8 singly inserted notched spines along margins and 4 apical spines; exopodite straight, slightly tapering in distal half, with 6 singly inserted notched spines along margins and 5 apical spines.

**Variability.** Unknown.

**Sexual dimorphism.** Unknown, but modified spines on uropods 1 and 2 probably represent a male-specific trait.

**Distribution and ecology.** *Eobogidiella venkataramani* sp. n. dwells in a spring-fed brook habitat located on the flat bottom of a small valley in the rainforest. The biotope is a small trickling swampy stream 1–3 m wide and 0–0.05 m deep, without flow, water temperature +22 °C, and a substrate comprised of wet litter, detritus, stones, clay. Known only from type locality.

**Taxonomic comments.** *Eobogidiella venkataramani* sp. n. is distinguished from *E. purmamarcensis* by the following characteristics (characteristics of the latter in parentheses): antenna 2 reaching 75% of antenna 1 length (about 50%); accessory flagellum comprised of 1 article (2 articles); molar vestigial, non-triturative (developed, tritulative); mandibular palp article 3 with 3 setae on apex (1 seta); maxilla 1 inner plate with 2 setae (3 setae); maxilla 2 plates broad (narrow); maxilliped palp article 2 narrow (very broad); lenticular organs absent (present); telson with apical margin convex (with excavation apically).

## Discussion

The only other species in this genus, *E. purmamarcensis* was described by Grosso and Ringuelet (1979) who placed it in the genus *Bogidiella*. It occurs in sandy sediments of the Rio Grande at the entrance of Purmamarca, Jujuy Province of northwestern Argentina (Fig. 1). Karaman (1981) places this species, along with *Marigidiella brasiliensis* (Siewing, 1953) (formerly *Bogidiella brasiliensis*), in the *Bogidiella* subgenus *Eobogidiella*. At about the same time, Stock (1981) tentatively attributed *B. purmamarcensis* to the subgenus *Mexigidiella* whereas *B. brasiliensis* removed to the new genus *Marigidiella*. A year later, Karaman (1982) elevated *Eobogidiella* to generic status.

In spite of our decision assign the new species to *Eobogidiella*, weak phylogenetic support for generic concepts and relationships within the family leaves us with reservations regarding this placement. The highly disparate known geographic

distributions of *Eobogidiella venkataramani* sp. n. and *E. purmamarcensis* (India and Argentina, respectively) is suspicious, suggesting that some of their shared character states may be homoplasious. Furthermore, two important morphological characters may be misleading in their support of a close relationship between *E. venkataramani* sp. n. and *E. purmamarcensis*. First, the soft suture between the head and pereonite 1 described here for *E. venkataramani* sp. n. was not mentioned in the description of *E. purmamarcensis* (Grosso and Ringuelet 1979) nor in subsequent works treating the placement of this species (Karaman 1981, 1982; Stock 1981; Koenemann and Holsinger 1999). It is likely that the soft suture in *E. venkataramani* sp. n. is an artifact caused by the inflation of soft tissues from rehydration of the desiccated specimen. Second, we have described sternal humps as present on pereonites 2–7 of *E. venkataramani* sp. n., and these are not mentioned in the description of *E. purmamarcensis* nor in subsequent works treating the placement of this species (Karaman 1981, 1982; Stock 1981; Koenemann and Holsinger 1999). Koenemann and Holsinger (1999) included the sternal humps (as “mediosternal processes”) as a character in their phylogenetic analysis, but determined that the mediosternal gills of *Paracrangonyx* evolved independently, coding the mediosternal processes as absent in *Paracrangonyx*. However, the use of sternal humps as a character in the Bogidiellidae did not come into play until well after the treatments of *E. purmamarcensis* by Karaman (1981, 1982) and Stock (1981), so the character could have been overlooked. Additionally, we suspect that the occurrence of sternal humps (or “mediosternal processes”) in *E. venkataramani* sp. n. is likely independent and does not reflect phylogenetic proximity to the Chilean *Patagongidiella* and *Grossogidiella* (Pérez-Schultheiss 2013).

Based on our reanalysis of Koenemann and Holsinger’s (1999) dataset, relationships among and within genera of the family Bogidiellidae remain unclear. Because the available morphological characters are phylogenetically uninformative, development of additional morphological characters across the family, and, especially, implementation of modern molecular phylogenetic approaches, are desperately needed to resolve relationships within the family and to better define generic boundaries. Nevertheless, it seems that the current assignment of the genera, mostly developed by Koenemann and Holsinger (1999), should be maintained until a more robust and well supported phylogeny can be produced.

## Acknowledgements

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## Supplementary material 1

### Morphological character matrix

Authors: Dmitry A. Sidorov, Aron D. Katz, Steven J. Taylor, Mikhail V. Chertoprud

Data type: NEXUS file

Explanation note: NEXUS file including character matrix for Bogidiellidae, Artesiidae and Kergueleniolidae used in analysis..

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## Supplementary material 2

### Figure S1

Authors: Dmitry A. Sidorov, Aron D. Katz, Steven J. Taylor, Mikhail V. Chertoprud

Data type: TIF file

Explanation note: Ordered bootstrap and jackknife consensus tree. Numbers below branches are bootstrap followed by jackknife support values.

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## Supplementary material 3

### Figure S2

Authors: Dmitry A. Sidorov, Aron D. Katz, Steven J. Taylor, Mikhail V. Chertoprud

Data type: TIF file

Explanation note: Unordered bootstrap and jackknife consensus tree. Numbers below branches are bootstrap followed by jackknife support values.

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# Twelve new species and fifty-three new provincial distribution records of Aleocharinae rove beetles of Saskatchewan, Canada (Coleoptera, Staphylinidae)

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## Abstract

One hundred twenty species of aleocharine beetles (Staphylinidae) are recognized in the province of Saskatchewan. Sixty-five new provincial records, including twelve new species and one new North American record, are presented. *Oligota inflata* (Mannerheim), a Palearctic species, is newly recorded for North America. The following twelve species are described as new to science: *Acrotona pseudopygmaea* Klimaszewski & Larson, **sp. n.**, *Agaricomorpha pulchra* Klimaszewski & Larson, **sp. n.** (new genus record for Canadian fauna), *Aleochara elisabethae* Klimaszewski & Larson, **sp. n.**, *Atheta (Dimetrota) larsonae* Klimaszewski & Larson, **sp. n.**, *Atheta (Microdota) pseudopittionii* Klimaszewski & Larson, **sp. n.**, *Atheta (Microdota) spermathecorum* Klimaszewski & Larson, **sp. n.**, *Atheta (sensu lato) richardsoni* Klimaszewski & Larson, **sp. n.**, *Brachyusa saskatchewanae* Klimaszewski & Larson, **sp. n.**, *Dochmonota langori* Klimaszewski & Larson, **sp. n.**, *Dochmonota simulans* Klimaszewski & Larson, **sp. n.**, *Dochmonota websteri* Klimaszewski & Larson, **sp. n.**, and *Oxyopoda domestica* Klimaszewski & Larson, **sp. n.** Colour images of habitus and black and white images of the median lobe of the aedeagus, spermatheca, and tergite and sternite VIII are presented for all new species, *Oligota inflata* Mannerheim and *Dochmonota rudiventris* (Eppelsheim). A new synonymy is established: *Tetralina filitarsus* Casey, **syn. n.** = *Tetralina helenae* Casey, now placed in the genus *Brachyusa* Mulsant & Rey.

## Keywords

Coleoptera, rove beetles, Staphylinidae, new distribution records, new species, Canada, Saskatchewan

## Introduction

Aleocharinae beetles are the most species-rich subfamily of rove beetles (Staphylinidae) with 515 species recorded in the most recent catalog of the Coleoptera of Canada (Bousquet et al. 2013). This number is constantly increasing as new treatments of this group are published. Webster et al. (2016b) added 27 new species to the Canadian fauna from the province of New Brunswick, and Klimaszewski et al. (2015a) added two new Canadian records of species previously known from the USA, so the total number now stands at 544 species excluding the new species treated here. Aleocharinae is still one of the poorest known subfamily of rove beetles in Canada, although enormous progress has been made in investigating this group in the last two decades, especially in eastern Canada (Klimaszewski et al. 2011, Webster et al. 2016a, b). Western and northern Canada (Manitoba to British Columbia, and the three territories) (Klimaszewski et al. 2015a), however, remain poorly studied except for a few localities in coastal British Columbia (Klimaszewski and Winchester 2002, McLean et al. 2009a, b) and in the Yukon (Klimaszewski et al. 2008b, 2012). Thus the full distribution of many Canadian species is not known because of large gaps in sampling intensity (Klimaszewski et al. 2015a). Improved sampling of Staphylinidae, especially Aleocharinae, is needed to establish baseline biodiversity composition in areas of the country where ecosystems are undergoing rapid change due to resource extraction and climate change (Klimaszewski et al. 2015a). This paper contributes to improving baseline biodiversity knowledge of aleocharine beetles in the province of Saskatchewan (SK) by providing 65 new provincial species records including one new North American record and 12 species new to science.

## Materials and methods

Almost all specimens in this study were dissected to examine the genital structures. Extracted genital structures were dehydrated in absolute alcohol, mounted in Canada balsam on celluloid micro-slides, and pinned with the specimen from which they originated. Images of the entire body and the genital structures were taken using an image processing system (Nikon SMZ 1500 stereoscopic microscope; Nikon Digital Camera DXM 1200F, and Adobe Photoshop software).

Morphological terminology mainly follows that used by Seevers (1978) and Klimaszewski et al. (2011). The ventral side of the median lobe of the aedeagus is considered to be the side of the bulbus containing the foramen mediale, the entrance of the ductus ejaculatorius, and the adjacent ventral side of the tubus of the median lobe with the internal sac and its structures (this part is referred to as the parameral side in some recent publications); the opposite side is referred to as the dorsal part. In the species descriptions, microsculpture refers to the surface of the upper forebody (head, pronotum and elytra).

Tribes, genera and species within genera are arranged alphabetically in the text and in the Table 1.

**Table 1.** Species of Aleocharinae recorded from Saskatchewan and their provincial and territorial distribution within Canada. Provinces and territories in bold denote new records given in the present publication. Species marked with (†) indicate adventive species and species marked with (\*) are Holarctic.

<b>ALEOCHARINI</b>	
<i>Aleochara assiniboin</i> Klimaszewski	BC, MB, ON, SK, YT
<i>Aleochara bilineata</i> Gyllenhal†	AB, BC, MB, NB, NE, NS, ON, PE, QC, SK; USA: New England states
<i>Aleochara bimaculata</i> Gravenhorst	AB, BC, LB, MB, NB, NE, NS, ON, QC, SK, NT; USA: widespread
<b><i>Aleochara elisabethae</i> Klimaszewski &amp; Larson, sp. n.</b>	<b>SK</b>
<i>Aleochara gracilicornis</i> Bernhauer	BC, MB, NB, NS, NT, ON, QC, SK; USA: widespread
<b><i>Aleochara inexpectata</i> Klimaszewski</b>	NB, NS, ON, QC, <b>SK</b> ; USA: MI, WI
<i>Aleochara lacertina</i> Sharp	AB, BC, MB, NB, NE, NS, ON, QC, SK; USA: widespread
<i>Aleochara laramiensis</i> (Casey)	BC, SK; USA: CO, WY
<i>Aleochara lata</i> Gravenhorst†	BC, MB, ON, QC, SK, YT; USA: widespread
<b><i>Aleochara rubricalis</i> (Casey)</b>	BC, ON, <b>SK</b> ; USA: CA, AZ
<i>Aleochara sekanai</i> Klimaszewski	AB, LB, MB, NB, NT, ON, SK, YT; USA: AK
<b><i>Aleochara speculicollis</i> Bernhauer</b>	AB, ON, QC, <b>SK</b> ; USA: CA, CO, AZ, MI, NV, TX
<b><i>Aleochara suffusa</i> (Casey)</b>	AB, BC, MB, QC, <b>SK</b> ; USA: AK, AZ, CO, NM, WY
<i>Aleochara tahoensis</i> Casey	AB, BC, MB, NB, NS, NT, ON, SK, YT; USA: CA, CO, MT, NH, NM, NV, OR, WA
<i>Aleochara verna</i> Say	AB, BC, LB, MB, NB, NE, NS, ON, PE, QC, SK, YT; USA: widespread including AK
<b><i>Aleochara villosa</i> Mannerheim†</b>	AB, BC, NB, QC, <b>SK</b> ; USA: AK, CA, OR, WA
<i>Tinotus morion</i> (Gravenhorst) † [now regarded as <i>Aleochara</i> ]	AB, BC, NB, NE, NS, ON, QC, SK; USA: CT, NV
<b>ATHETINI</b>	
<b><i>Acrotona pseudopygmaea</i> Klimaszewski &amp; Larson, sp. n.</b>	<b>SK</b>
<i>Acrotona recondita</i> (Erichson)	SK; USA: AR, CA, NH, NV, NY, PA
<b><i>Acrotona subpygmaea</i> (Bernhauer)</b>	NB, NS, ON, <b>SK</b>
<b><i>Amischa analis</i> (Gravenhorst) †</b>	LB, NB, NE, NS, ON, QC, PE, <b>SK</b>
<i>Atheta celata</i> (Erichson) *	BC, NB, NE, NS, QC, SK; USA: AK
<b><i>Atheta crenuliventris</i> Bernhauer</b>	LB, NB, NE, ON, QC, <b>SK</b>
<i>Atheta dadopora</i> C.G. Thomson *	AB, BC, LB, NB, NE, NS, ON, PE, SK, YT; USA: AK, NY, PA, RI
<b><i>Atheta districta</i> Casey</b>	AB, BC, LB, NB, NE, NS, ON, QC, <b>SK</b>
<i>Atheta fanatica</i> Casey	AB, BC, LB, NB, NS, QC, SK, YT; USA: AK, NV
<b><i>Atheta frosti</i> Bernhauer</b>	BC, LB, NB, NS, ON, QC, <b>SK</b>
<i>Atheta graminicola</i> (Gravenhorst) *	AB, BC, LB, MB, NB, NE, NT, ON, QC, SK, YT; USA: AK, OR
<i>Atheta klagesi</i> Bernhauer	AB, BC, NB, NE, NS, ON, PE, QC, SK, YT; USA: IA, ME, MN, NJ, NY, PA
<b><i>Atheta larsonae</i> Klimaszewski &amp; Larson, sp. n.</b>	<b>SK</b>
<i>Atheta longicornis</i> (Gravenhorst) †	BC, NB, NE, NS, QC, SK; USA: CA, MN
<i>Atheta nigra</i> (Kraatz) †	SK

<i>Atheta platonoffi</i> Brundin*	AB, BC, LB, NB, NE, NS, ON, SK, YT; USA: AK
<i>Atheta prudhoeensis</i> (Lohse)	BC, LB, NB, NE, NS, ON, QC, SK, YT; USA: AK, VT
<b><i>Atheta pseudometlakatlana</i> Klimaszewski &amp; Godin</b>	YT, <b>SK</b>
<b><i>Atheta pseudopittionii</i> Klimaszewski &amp; Larson, sp. n.</b>	SK
<b><i>Atheta pseudoschistoglossa</i> Klimaszewski &amp; Webster</b>	BC, NB, <b>SK</b> ; USA: AK
<i>Atheta recondita</i> (Erichson)	SK; USA: AR, CA, NH, NV, PA
<i>Atheta remulsa</i> Casey	AB, BC, LB, NB, NE, NS, ON, QC, <b>SK</b> , YT
<i>Atheta riparia</i> Klimaszewski & Godin	<b>SK</b> , YT
<b><i>Atheta richardsoni</i> Klimaszewski &amp; Larson, sp. n.</b>	<b>SK</b>
<b><i>Atheta spermathecorum</i> Klimaszewski &amp; Larson, sp. n.</b>	<b>SK</b>
<i>Atheta strigosula</i> Casey	BC, LB, NB, NE, ON, QC, <b>SK</b> , YT; USA: NY
<i>Atheta subsinuata</i> (Erichson) †	YT, <b>SK</b>
<b><i>Atheta terranova</i> Klimaszewski &amp; Langor</b>	LB, NB, NE, ON, <b>SK</b> , YT
<i>Atheta ventricosa</i> Bernhauer	AB, BC, LB, NB, NE, NS, ON, QC, SK, YT; USA: AK, DC, NC, NJ, NY, PA, VT
<i>Dinaraea angustula</i> (Gyllenhal) †	AB, LB, NB, NE, NS, ON, PE, QC, <b>SK</b> , YT; USA: CA, NY
<b><i>Dinaraea pacei</i> Klimaszewski &amp; Langor</b>	AB, BC, LB, NB, QC, <b>SK</b> , YT; USA: AK
<b><i>Dochmonota langori</i> Klimaszewski &amp; Larson, sp. n.</b>	<b>SK</b>
<b><i>Dochmonota simulans</i> Klimaszewski &amp; Larson, sp. n.</b>	<b>SK</b>
<b><i>Dochmonota websteri</i> Klimaszewski &amp; Larson, sp. n.</b>	<b>SK</b>
<i>Earota dentata</i> (Bernhauer)	AB, BC, MB, NB, NE, NS, ON, QC, <b>SK</b> , YT; USA: AK
<i>Lypoglossa franclemonti</i> Hoebeke	AB, MB, NB, NE, NS, NT, ON, QC, SK, YT; USA: NY, VT
<i>Mocyta breviscula</i> (Mäklin)	AB, BC, LB, NB, NE, NS, ON, QC, <b>SK</b> , YT; USA: AK
<i>Mocyta discreta</i> (Casey)	ON, QC, SK; USA: IA, MN
<b><i>Mocyta spabgnorum</i> Klimaszewski &amp; Webster</b>	NB, NE, ON, QC, <b>SK</b>
<b><i>Nehemitropia lividipennis</i> (Mannerheim) †</b>	NB, NE, NS, ON, PE, QC, <b>SK</b> ; USA: CA, LA, MA, MN, NE, NM, NY, PA, VT, TX
<i>Phillygra botanicarum</i> (Muona) *	BC, LB, NB, NE, NS, ON, SK, YT
<b><i>Phillygra falcifera</i> Lohse</b>	MB, <b>SK</b>
<i>Phillygra jarmilae</i> Klimaszewski & Langor	NB, NE, ON, SK, YT
<i>Phillygra ripicoloides</i> Lohse	NE, NT, SK, YT
<i>Phillygra rostrifera</i> Lohse	LB, NT, SK, YT; USA: AK
<i>Phillygra sinuipennis</i> Klimaszewski & Langor	NB, LB, NE, SK, YT
<b><i>Phillygra subpolaris</i> (Fenyés)</b>	AB, <b>SK</b> ; USA: AZ
<i>Phillygra terrestris</i> Klimaszewski & Godin	NB, SK, YT
<b><i>Schistoglossa blatchleyi</i> (Bernhauer &amp; Scheerpeltz)</b>	MB, NB, NT, ON, QC, <b>SK</b> , YT; USA: AK, IN
<i>Seeversiella globicollis</i> (Bernhauer)	AB, BC, NB, NE, NS, ON, QC, SK; USA: AZ, CO, ID, MN, MT, NH, SD, WI



<i>Strigota ambigua</i> (Erichson)	LB, NB, NS, NE, ON, PE, <b>SK</b> , YT; USA: CA, CO, CT, IA, KS, MO, NC, NJ, NM, NY, TX
<i>Strigota obscurata</i> Klimaszewski & Brunke	NB, ON, <b>SK</b>
<b>AUTALIINI</b>	
<i>Autalia rivularis</i> (Gravenhorst) †	AB, BC, LB, NB, NE, NS, ON, QC, <b>SK</b> ; USA: CA, MI, MN, NH, NY, OR
<b>FALAGRINI</b>	
<i>Falagria caesa</i> Erichson†	AB, NB, ON, QC, <b>SK</b> ; USA: MA to VA, UT
<i>Falagria dissecta</i> Erichson	AB, BC, MB, NB, NS, ON, QC, SK; USA: widespread
<i>Myrmecocephalus arizonicus</i> (Casey)	AB, BC, <b>SK</b>
<b>GYMNUSINI</b>	
<i>Gymnusa campbelli</i> Klimaszewski	MB, NB, NE, NT, ON, QC, SK, YT; USA: AK
<b>HOMALOTINI</b>	
<i>Agaricochara pulchra</i> Klimaszewski & Larson, sp. n.	<b>SK</b>
<i>Gyrophana affinis</i> Mannerheim	BC, MB, NB, NE, NS, ON, QC, SK; USA: widespread
<i>Gyrophana criddlei</i> Casey	LB, MB, NB, ON, SK, YT
<i>Gyrophana insolens</i> Casey	BC, LB, MB, NB, NE, ON, SK; USA: MI
<i>Gyrophana keeni</i> Casey	AB, BC, LB, NB, NE, ON, QC, SK, YT; USA: FL, MA, MT, NH, NY, TN, WA
<i>Gyrophana lobata</i> Casey	NB, <b>SK</b> ; USA: DC, IL, IN, KS, MI, WI
<i>Gyrophana uteana</i> Casey	AB, BC, NB, ON, QC, SK; USA: CA, CO, UT
<i>Gyrophana subnitens</i> Casey (NCR)	MB, <b>SK</b> ; USA: IL, KS, ME, MN, MO, WI
<i>Leptusa gatineauensis</i> Klimaszewski & Pelletier	AB, BC, NB, NE, NS, ON, QC, <b>SK</b>
<b>HYPOCYPHTINI</b>	
<i>Cypha crotchii</i> (Horn)	AB, BC, <b>SK</b>
<i>Cypha inexpectata</i> Klimaszewski & Godin	ON, YT, <b>SK</b>
<i>Oligota inflata</i> (Mannerheim)† (NPR, NCR, NAR)	<b>SK</b>
<b>LOMECHUSINI</b>	
<i>Xenodusa reflexa</i> (Walker)	AB, BC, MB, NB, NS, QC, ON, SK
<i>Zyras obliquus</i> (Casey)	AB, BC, MB, NB, NE, NS, ON, QC, <b>SK</b> ; USA: MI, MO, NH, NY, OR
<b>MYLLAENINI</b>	
<i>Myllaena arcana</i> Casey	AB, LB, NB, NE, NS, ON, QC, SK; USA: AL, FL, IA, IL, MA, NH, NJ
<i>Myllaena insomnis</i> Casey	AB, BC, LB, MB, NB, NE, NS, NT, ON, QC, SK, YT; USA: AK, ID, MA, MN, WI
<b>OXYPODINI</b>	
<i>Cratarea suturalis</i> (Mannerheim) †	BC, LB, NB, NS, ON, SK; USA: IL, MA, MO, PA, SC, VA, VT
<i>Devia prospera</i> (Erichson) *	AB, BC, LB, MB, NB, NT, ON, SK, YT; USA: AK, CO, MI, MN, NM, OR, SD, UT, WA, WY
<i>Gnathusa eva</i> Fenyes	AB, BC, <b>SK</b> , YT; USA: CA
<i>Hylota ochracea</i> Casey	NB, NS, NT, ON, QC, <b>SK</b> ; USA: NY
<i>Ocyusa canadensis</i> Lohse	NB, NE, ON, SK, YT; USA: AK
<i>Oxypoda canadensis</i> Klimaszewski	AB, MB, LB, NE, NT, ON, QC, SK, YT; USA: AK
<i>Oxypoda demissa</i> Casey	LB, NB, NE, NS, ON, QC, <b>SK</b> , YT

<b><i>Oxypoda domestica</i> Klimaszewski &amp; Larson, sp. n.</b>	<b>SK</b>
<i>Oxypoda grandipennis</i> (Casey)	AB, BC, LB, NB, NE, NS, ON, QC, SK, YT; USA: AK, NH
<b><i>Oxypoda irrada</i> Mäklin</b>	AB, <b>SK</b> , YT; USA: AK, OR
<i>Oxypoda lacustris</i> Casey	AB, BC, LB, MB, NB, NE, NS, NT, ON, QC, SK, YT; USA: AK
<b><i>Oxypoda manitobae</i> Casey</b>	BC, MB, <b>SK</b> ; USA: CO
<i>Oxypoda orbicollis</i> Casey	AB, LB, NB, NS, ON, QC, SK, YT; USA: WI
<i>Oxypoda pseudolacustris</i> Klimaszewski	AB, NB, NE, NS, ON, QC, SK
<b><i>Parocysa fuliginosa</i> (Casey)</b>	LB, ON, <b>SK</b> ; USA: MA, NC, PA
<i>Tachyusa obsoleta</i> Casey	BC, NB, SK
<b>PLACUSINI</b>	
<b><i>Placusa incompleta</i> Sjöberg †</b>	AB, BC, NB, NE, NS, ON, QC, <b>SK</b> ; USA: WA
<b><i>Placusa pseudosuecica</i> Klimaszewski</b>	AB, BC, ON, QC, <b>SK</b>
<b><i>Placusa tachyporoides</i> (Waltl) †</b>	AB, BC, NB, NS, ON, QC, <b>SK</b> ; USA: CA, MA
<b><i>Placusa tacomae</i> Casey</b>	AB, BC, NB, NE, NS, NT, ON, QC, <b>SK</b> , YT; USA: AZ, MA, WA, WI
<b><i>Placusa vaga</i> Casey</b>	BC, NB, NS, NT, ON, QC, <b>SK</b> , YT; USA: CA
<b>SILUSINI</b>	
<b><i>Silusa californica</i> Bernhauer</b>	AB, BC, NB, NE, NS, NT, QC, ON, <b>SK</b> , YT; USA: AK, CA, MN
<b>TACHYUSINI</b>	
<b><i>Brachyusa helenae</i> (Casey)</b>	LB, NB, NE, NT, ON, <b>SK</b> , YT; USA: AK, MT
<b><i>Brachyusa saskatchewanae</i> Klimaszewski &amp; Larson, sp. n.</b>	<b>SK</b>
<i>Gnypeta caerulea</i> (C.R. Sahlberg) *	AB, BC, LB, MB, NB, NE, NS, NT, ON, PE, QC, SK, YT; USA: AK
<i>Gnypeta carbonaria</i> (Mannerheim)	AB, MB, NB, NE, NT, ON, QC, SK; USA: AK
<i>Gnypeta dentata</i> Klimaszewski	AB, NT, SK
<b><i>Gnypeta minuta</i> Klimaszewski &amp; Webster</b>	NB, <b>SK</b>
<b><i>Gnypeta saccharina</i> Klimaszewski &amp; Webster</b>	NB, <b>SK</b>
<i>Gnypeta sellmani</i> Brundin	LB, MB, NE, NT, QC, SK, YT; USA: AK

## Major habitat characterization

Almost all collections reported here were made in southwestern Saskatchewan and adjacent Alberta. This area is in the Mixed Grassland and Cypress Upland Ecoregions of the Prairies Ecozone (Ecological Stratification Working Group 1995). The Mixed Grasslands are a semiarid northern portion of the shortgrass prairie of the North American Great Plains. Summer moisture deficits promote the dominance of grasses (especially spear, blue gramma and wheat grasses) and a variety of low herbs and shrubs including sagebrush and cactus. This grassland encircles an upland area known as the Cypress Uplands. These uplands rise rather abruptly from the plains in the west to their highest elevations of almost 1500 m in SE Alberta and adjacent SK, then gradually become lower towards the east. Much of the uplands are treed with lodgepole pine, white spruce and aspen with open areas dominated by rough fescue grass and shrubby

cinquefoil. The 1000 m contour was arbitrarily chosen as the boundary between these two zones for the actual boundary is complex with interdigitation of habitats such as trees and mesic plants following stream courses and valleys out into the grasslands and conversely dry grassland species occur on ridges and south-facing slopes well above the 1000 m contour. The most frequently referenced collection site is the Larson Ranch. This is located on the boundary of these two ecozones with the 1000 m contour running through the farmyard. Collections here are from a variety of habitats including: aspen or maple woodlands; fescue-cinquefoil or mixed grasslands; stream and pond margins; and on various soil types including arid tills and bedrock clays. Many ranch collections are from habitats of domestic or agricultural origin such as compost and manure piles, livestock housing or associated with exotic plants.

Other habitats within the area from which aleocharines have been collected include sand hills and saline ponds of closed drainage basins, both of which occur mainly to the north of the Cypress Hills, stream margins, and springs and fens that are common in the Cypress Hills. Considerable collecting has been done around large reservoirs. Accumulated plant material along the reservoir water lines (wrack) is often rich in beetles but windward shores (the lee shore of mariners) are often rich collecting sites as flying insects that fall into water are blown onto these shores and can sometimes be found in large numbers pulling themselves up onto the beach. Such insects are referred to as occurring in drift. Species found in wrack may in fact be in their normal habitat, but those recorded from drift are probably vagrants, but they do indicate presence and time of year of dispersal.

The low annual precipitation in the region means that a state of drought or near drought occurs frequently. Aleocharines occur mainly in moist environments, thus the majority of Mixed Grassland collections are from sites with moisture such as margins of water bodies or from moist habitats such as carrion and manure (which is very abundant due to the high populations of cattle). Carrion and manure are rich staphylinid habitat but they promote the widespread synanthropic species and a few of our new records come from these habitats. Mushrooms and other fungi, especially as they age and decay, are rich habitats but again irregularity in precipitation means that occurrence and duration of such habitats is very unpredictable over the season and from year to year. Higher levels of precipitation and lower evapotranspiration in the Cypress Uplands produce a wider and more consistent array of moist habitats and this is where we found the richest aleocharine fauna.

### **Depository/institutional abbreviations**

<b>BGC</b>	Benoit Godin collection, Whitehorse, Yukon Territory, Canada.
<b>CNC</b>	Canadian National Collection of Insects, Arachnids and Nematodes, Agriculture and Agri-Food Canada, Ottawa, Ontario, Canada.
<b>LFC</b>	Natural Resources Canada, Canadian Forest Service, Laurentian Forestry Centre, R. Martineau Insectarium, Quebec City, Quebec, Canada.
<b>DLC</b>	David Larson collection, Maple Creek, Saskatchewan, Canada.
<b>USNM</b>	United State National Museum, Washington, D.C., USA.

## Abbreviations of Canadian Provinces and Territories

AB – Alberta	NB – New Brunswick	ON – Ontario
NF – Newfoundland	PE – Prince Edward Island	BC – British Columbia
NS – Nova Scotia	QC – Quebec	LB – Labrador
NT – Northwest Territories	SK – Saskatchewan	MB – Manitoba
NU – Nunavut	YT – Yukon Territory	

USA state abbreviations follow those of the US Postal Service.

## Discussion

Our knowledge of the diversity and distribution of Aleocharinae in Canada has increased rapidly over the last two decades (Klimaszewski et al. 2011, 2015a, Webster et al. 2016a, b). This increase may be attributed to a surge in sampling of this subfamily and intensive taxonomic studies, as well as the increased interest in aleocharines as a target group in forestry impact studies (Klimaszewski et al. 2008a, Pohl et al. 2007, 2008, Langor, unpublished data). Recently published contributions to the knowledge of aleocharine beetles in central Canada provided 33 new provincial records for the province of SK (Klimaszewski et al. 2015a). The present study, based on material from intensive collecting by D. Larson in southwestern SK provides 65 additional new records for the province and increased the number of known species there to 120. Of these 65 new provincial records, 12 represent species new to science, one record of an adventive species new to the province and North America (*Oligota inflata*), and 53 new provincial records of species known from other parts of Canada and or USA. It is interesting to note a high percentage of adventive species (16 sp., 13.3%), and a low number of Holarctic species (7 sp., 5.8%) in the SK fauna. The high percentage of adventive species is probably due to the highly modified prairie landscape that is responsible for supporting diverse habitats, and the inadequate knowledge of the total, very likely higher number of species. Agriculture has produced an environment unsuitable for many native species yet similar to European agricultural environments. Also, the sampling responsible for the species list presented here had a high bias towards habitats created in an active farm, habitats favoring synanthropic species that are likely to be transported by man. The low number of Holarctic species is most likely due to poor collection in the north of the province. The Cypress Hills Upland is largely treed and contains a boreal element in its flora. However, much of its biota is derived from the western Cordillera thus contributing to the lower proportion of Holarctic species. From the 12 new species discovered, 8 represent Athetini (*Acrotona* - 1 sp., *Atheta* - 4 spp., *Dochmonota* - 3 spp.), one Aleocharini (*Aleochara* - 1 sp.), one Homalotini (*Agaricochara* - 1 sp.), one Oxypodini (*Oxypoda* - 1 sp.), and one Tachyusini (*Brachyusa* - 1 sp.). While new species in poorly known groups like *Acrotona*, *Agaricochara* and some subgenera of *Atheta*, are expected to increase with study efforts, it was surprising to see undescribed spe-

cies in well studied genera like *Aleochara*, *Brachyusa* and *Oxypoda*. These species are from specialized habitats that were missed in collection or were not adequately sampled previously. The most interesting discoveries are 3 new species of native *Dochmonota* (Athetini), a genus previously known only from western Palearctic with one species, *D. rudiventris* (Eppelsheim), recorded from eastern Canada as adventive, ID and MA (Klimaszewski et al. 2011, 2013b). Due to new distribution records (Bousquet et al. 2013), this is now considered a Holarctic species. The sampling effort by D. Larson in SK more than doubled the previously known species from the province, now standing at 122 species (Table 1).

In Canada, the Maritime provinces (NB, NS, NF, PE), and the YT are so far the best-studied regions of the country in terms of the aleocharine fauna (Klimaszewski et al. 2005, 2007b, 2008b, 2009a, b, 2010, 2011, 2012, Majka and Klimaszewski 2010, Webster et al. 2009, 2012, 2016a, b, Klimaszewski et al. 2015a). Some small areas of Quebec, Ontario, and coastal British Columbia have also received intensive sampling coupled with expert identification of material in recent years (Klimaszewski and Winchester 2002, Klimaszewski et al. 2007b, Brunke et al. 2012).

However, the large majority of central, western and northern Canada remains poorly studied. Large numbers of aleocharines (and other staphylinids) have been collected over the last 25 years as a result of numerous trapping studies in forests, native grasslands, agricultural lands, and wetlands, especially in Alberta (Klimaszewski et al. 2015a). The estimated underscribed/undiscovered aleocharine species in Canada was recently discussed in Klimaszewski et al. (2015a). Bousquet et al. (2013) recorded 27 species of aleocharines from SK, while Klimaszewski et al. (2015a) estimated that some additional 227 species are awaiting discovery in SK. In this paper we recognize 120 species in SK, so at least another 100 species may be awaiting discovery.

## New records and new species

### ALEOCHARINI Fleming

#### *Aleochara (Echiochara) elisabethae* Klimaszewski & Larson, sp. n.

<http://zoobank.org/6F4ECBB4-AA61-4E1F-A1D9-8CF0EBED4650>

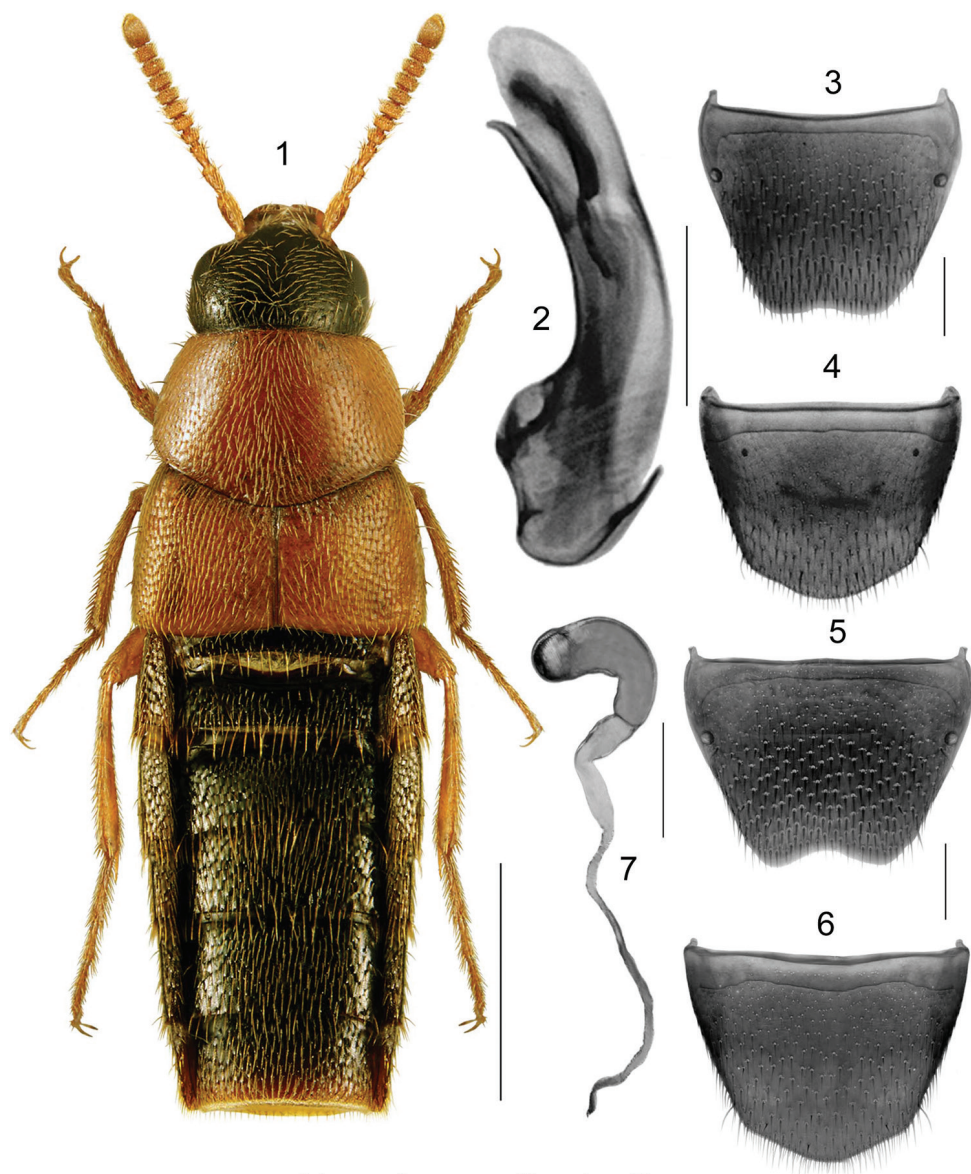
Figs 1–7

**Holotype** (female). Canada, Saskatchewan, Bowie Ranch, 20 km NW Piapot, sand dunes, 29-V-2008, D. Larson (LFC). **Paratype**. Canada, Alberta, Empress, Alberta – Saskatchewan border, 5-VIII-1981, Lot 1, B.F. & J.L. Carr (CNC) 1 male.

**Etymology.** This species is named for Dr. Élisabeth Gauthier, research director at LFC, for her continuous support of beetle biodiversity research in Canada.

**Diagnosis.** Body compact, narrowly oval (Fig. 1); head and abdomen dark brown, almost black, with pronotum, elytra and appendages orange (Fig. 1); length 3.8–4.3 mm; forebody with strong and dense meshed microsculpture; pubescence moderately dense; punctation coarser on elytra than elsewhere (Fig. 1); elytra at suture shorter than





### *Aleochara elisabethae*

**Figures 1–7.** *Aleochara (Echiochara) elisabethae* Klimaszewski & Larson, sp. n.: **1** habitus in dorsal view **2** median lobe of aedeagus in lateral view **3** male tergite VIII **4** male sternite VIII **5** female tergite VIII **6** female sternite VIII **7** spermatheca. Scale bar for habitus = 1 mm, and the remaining scale bars = 0.2 mm.

pronotum at middle length (Fig. 1); antennomeres V–X strongly transverse (Fig. 1); mesosternum not carinate. MALE. Tergite VIII shallowly emarginate apically (Fig. 3); sternite VIII rounded apically and slightly produced medially (Fig. 4); median lobe of aedeagus with tubus arcuate ventrally and with sharp apex, internal sac with elongate structures (Fig. 2). FEMALE. Tergite VIII emarginate apically (Fig. 5); sternite VIII



rounded apically and slightly produced (Fig. 6); spermatheca with C-shaped tubular capsule, and short stem (Fig. 7).

This species is readily distinguished from remaining Nearctic species of subgenus *Echochara* by its strongly transverse and orange pronotum (dark brown or black in remaining species), arcuate tubus of median lobe of aedeagus with sharp apex (Fig. 2), and C-shaped swollen capsule of spermatheca (Fig. 7), which is narrower and club- or L-shaped in other species, and by the emarginated male and female tergite VIII (Figs 3, 5).

**Distribution.** This species is known from the type localities in AB and SK.

**Natural history.** The female holotype was captured on a dead ground squirrel in sand dunes. The male was collected in August from unspecified habitat. Species of subgenus *Echochara* are known from caves and animal burrows (Klimaszewski 1984).

*Aleochara (Xenochara) inexpectata* Klimaszewski

(for diagnosis and illustrations, see Klimaszewski et al. 1984)

**Distribution.**

Origin	Nearctic
Distribution	Canada: NB, NS, ON, QC, <b>SK</b> . USA: MI, WI
New provincial records	CANADA, <b>Saskatchewan</b> : Larson Ranch, Hwy 21, 16 km S Maple Creek, 20-X-2014, in dry polypore fungus, D. Larson (DLC) 1 female
References	Klimaszewski 1984, Webster et al. 2009, Brunke et al. 2012, Bousquet et al. 2013

**Natural history.** In Saskatchewan, one female was captured in dry polypore fungus in October, and this constitutes the westernmost distribution record for this species. In NB, *Aleochara inexpectata* was collected from fresh moose dung in an eastern white cedar swamp and in decaying sea wrack resting on vegetation on the upper margin of a salt marsh. Adults were collected during May and June (Webster et al. 2009). Collection method: sifting.

*Aleochara (Calochara) rubricalis* (Casey)

(for diagnosis and illustrations, see Klimaszewski et al. 1984)

**Distribution.**

Origin	Nearctic
Distribution	Canada: BC, ON?, <b>SK</b> . USA: AZ, CA
New provincial records	CANADA, <b>Saskatchewan</b> : Larson Ranch, Hwy 21, 16 km S Maple Creek: 20-V-2008, D. Larson (LFC) 1 male; 25-VI-2008, carrion trap, D. Larson (DLC) 3 males, 1 female; 8-IV-2005, D. Larson (LFC) 1 female
References	Casey 1906, Klimaszewski 1984, Brunke et al. 2012 [one doubtfull record from ON], Bousquet et al. 2013

**Natural history.** In Saskatchewan, specimens were collected from March through June, several adults were captured from carrion trap. Elsewhere, one specimen was taken from a mouse nest and other specimens were collected from February to October (Klimaszewski 1984).

*Aleochara (Calochara) speculicollis* Bernhauer

(for diagnosis and illustrations, see Klimaszewski et al. 1984)

**Distribution.**

Origin	Nearctic
Distribution	Canada: AB, ON, QC, <b>SK</b> . USA: CA, CO, AZ, MI, NV, TX
New provincial records	CANADA, <b>Saskatchewan</b> : Cypress Hills Park, Center Block, Sucker Creek, 1-4-VI-2012, D. Larson (LFC) 1 female.
References	Bernhauer 1901, Klimaszewski 1984, Bousquet et al. 2013

**Natural history.** In Saskatchewan, one female was captured in June from unspecified habitat.

**Comments.** We tentatively associate the SK specimen with this species because it is missing the spermatheca.

*Aleochara (Coprochara) suffusa* (Casey)

(for diagnosis and illustrations, see Klimaszewski et al. 1984)

**Distribution.**

Origin	Nearctic
Distribution	Canada: AB, BC, MB, QC, <b>SK</b> . USA: AK, AZ, CO, NM, WY
New provincial records	CANADA, <b>Saskatchewan</b> : Larson Ranch, Hwy 21, 16 km S Maple Creek: 27-V-2008, D. Larson (DLC) 1 female; 1-VI-2010, D. Larson (DLC, LFC) 2 females; 24-IX-2008, D. Larson (DLC) 1 female; 25-VI-2008, carrion trap, D. Larson (DLC) 1 female; 14-IX-2008, D. Larson (DLC) 1 sex undetermined; Cypress Lake, E dam, wind-drift, 9-V-2012, D. Larson (DLC) 1 female; Harris Res., 10 km S Maple Creek, 12-VI-2013, wind-drift, D. Larson (DLC) 1 male.
References	Casey 1906, Klimaszewski 1984, Bousquet et al. 2013

**Natural history.** In Saskatchewan, one female was captured in a carrion trap and one from wind-drift. Elsewhere, specimens were found under rocks in a high altitude meadow and some from AB were reared in laboratory (Klimaszewski 1984).

**Comments.** The SK specimens are darker and have only the central part of elytra reddish and the rest of the body piceous whereas the typical form of this species has

the entire elytra orange or reddish-brown. Pubescence and punctation pattern and the genitalia of SK specimens are identical to the typical form with orange or reddish elytra.

### *Aleochara (Calochara) villosa* Mannerheim

(for diagnosis and illustrations, see Klimaszewski et al. 1984)

#### Distribution.

Origin	Palearctic, adventive in Canada
Distribution	Canada: AB, BC, NB, QC, <b>SK</b> . USA: AK, CA, OR, WA
New provincial records	CANADA, <b>Saskatchewan</b> : Larson Ranch, Hwy 21, 16 km S Maple Creek: 21-III-2007, sheep barn window, D. Larson (DLC) 2 males; 1-IV-2013, D. Larson (LFC) 1 female; 14-IV-2012, D. Larson (LFC) 1 male; 27-VII-2012, D. Larson (DLC) 1 female; 17-IX-2012, compost, D. Larson (DLC) 1 male.
References	Mannerheim 1830, Klimaszewski 1984, Webster et al. 2009, Bousquet et al. 2013

**Natural history.** In SK, 2 males were captured from a sheep barn window, and one male was found in compost. SK specimens were collected in March, April, July and September. In New Brunswick, *A. villosa* was collected from the nest contents of a great horned owl, *Bubo virginianus* (Gmelin) (Webster et al. 2009). Elsewhere, specimens have been collected from carrion and sifting an old hay pile (Klimaszewski 1984). Adults were collected in May. Collection method: sifting.

#### ATHETINI Casey

### *Acrotona pseudopygmaea* Klimaszewski & Larson, sp. n.

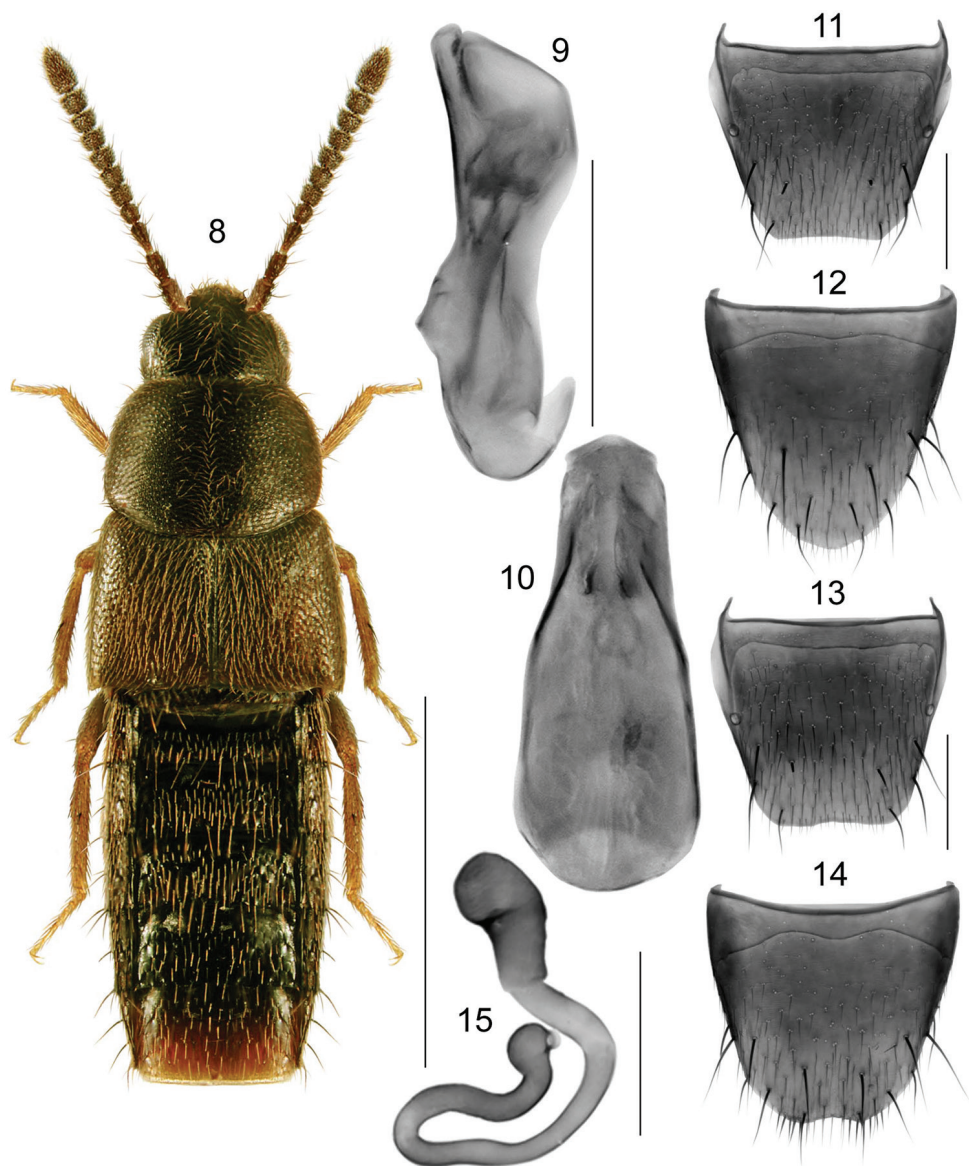
<http://zoobank.org/E28F742F-730E-4D21-A43E-65FEEF229288>

Figs 8–15

**Holotype (male).** Canada, Saskatchewan, Larson Ranch, Hwy 21, 16 km S Maple Creek, 24-VII-2010, sifted from old mouldy alfalfa hay, D. Larson (LFC). **Paratypes.** 1 male and 1 female, with same label and collection data as the holotype (CNC).

**Etymology.** The name of this species derives from the Latin participle *pygmaea*-, meaning small, and the prefix *pseudo*-, false. The genital structures of this species are similar to those of Palearctic *Acrotona pygmaea* (Gravenhorst).

**Diagnosis.** Body narrowly elongate, moderately convex, uniformly dark brown to almost black except for paler legs (Fig. 8); punctation on forebody fine, dense and asperate on elytra; head narrower than pronotum, ratio of maximum width of head to maximum width of pronotum 0.6; pronotum moderately transverse, ratio of maximum width to length 1.4, about as wide as elytra (Fig. 8); elytra at suture about as long as



### *Acrotona pseudopygmaea*

**Figures 8–15.** *Acrotona pseudopygmaea* Klimaszewski & Larson, sp. n.: **8** habitus in dorsal view **9** median lobe of aedeagus in lateral view, and **10** in dorsal view **11** male tergite VIII **12** male sternite VIII **13** female tergite VIII **14** female sternite VIII **15** spermatheca. Scale bar for habitus = 1 mm, and the remaining scale bars = 0.2 mm.

pronotum (Fig. 8); abdomen slightly narrowed posteriad; body length 2.4 mm; antennal articles V-X subquadrate. MALE. Tergite VIII moderately elongate and truncate apically (Fig. 11); sternite VIII rounded apically (Fig. 12); median lobe of aedeagus broad and rounded apically in dorsal view (Fig. 10), and tubus straight with apex facing upward in lateral view (Fig. 9). FEMALE. Tergite VIII truncate and slightly concave apically (Fig. 13); sternite VIII slightly emarginate apically (Fig. 14); spermatheca with tubular capsule and long, thin and sinuate posteriorly stem (Fig. 15).

Distinguished from all other *Acrotona* by the shape of median lobe of aedeagus with apex turned dorsally in lateral view (Fig. 9), by the shape of spermatheca with thin, long, sinuate, and posteriorly looped stem (Fig. 15), and by the shape of tergite and sternite VIII, which have basal margin straight and not sinuate (Figs 11-14).

**Distribution.** This species is known only from the type locality in SK.

**Natural history.** The type specimens were sifted from old mouldy alfalfa hay.

**Comments.** This species is similar to Palaearctic *A. pygmaea* (Gravenhorst) from which it differs by subquadrate antennal articles VI-X, by apex of tubus of median lobe of aedeagus more angular, female sternite VIII emarginated apically and spermatheca with much longer and broadly looped stem. It is also genitally similar to Nearctic *Acrotona actuella* (Casey) and *A. egregiella* (Casey), from which it differs by straight and not sinuate ventral margin of tubus of median lobe of aedeagus, by straight and not sinuate basal margin of male tergite VIII, and by differently shaped spermatheca with posterior loop of stem sinuate.

*Acrotona subpygmaea* (Bernhauer)

(for diagnosis and illustrations, see Webster et al. 2016b )

**Distribution.**

Origin	Nearctic
Distribution	Canada: NB, NS, ON, <b>SK</b>
New provincial records	CANADA, <b>Saskatchewan</b> : Larson Ranch, Hwy 21, 16 km S Maple Creek, 5-6-VI-2013, maple litter, D. Larson (DLC) 1 female; 20-XI-2014, sifting willow leaf litter, D. Larson (DLC) 1 female.
References	Majka and Klimaszewski 2010, Brunke et al. 2012, Bousquet et al. 2013, Webster et al. 2016b

**Natural history.** In SK, one female was captured from maple (*Acer negundo*) litter and one from willow (*Salix* spp.) leaf litter in June and October, respectively. In NB, *Acrotona subpygmaea* was found in litter of a variety of forest types and in wetlands including swamps, sphagnum bog, marshes and river margins. Specimens have also been taken from gilled mushroom and under bark (Webster et al. 2016b). Most adults were collected in May, with a few in April, June, August, and September.

*Amischa analis* (Gravenhorst)

(for diagnosis and illustrations, see Klimaszewski et al. 2011)

**Distribution.**

Origin	Palearctic, adventive in Canada
Distribution	Canada: LB, NB, NF, NS, ON, QC, PE, <b>SK</b>
New provincial records	CANADA, <b>Saskatchewan</b> : Belanger Creek, Frenchman Valley, 18-X-2014, D. Larson (DLC) 1 female.
References	Moore and Legner 1975, Klimaszewski et al. 2005, Klimaszewski et al. 2007a, b, Majka and Klimaszewski 2010, Klimaszewski et al. 2011, Bousquet et al. 2013

**Natural history.** In SK, one female was captured in October by sifting leaf litter along a creek. In NL, adults were collected in pitfall traps in agricultural fields, an urban field and on coastal sand dunes amidst vegetation, and the activity period was June to September (Klimaszewski et al. 2011). Elsewhere, adults in general occur in organic litter.

*Atheta (Dimetrota) crenuliventris* Bernhauer

(for diagnosis and illustrations, see Klimaszewski et al. 2011)

**Distribution.**

Origin	Nearctic
Distribution	Canada: LB, NB, NF, ON, QC, <b>SK</b>
New provincial records	CANADA, <b>Saskatchewan</b> , Larson Ranch, Hwy 21, 16 km S Maple Creek: 1-IX-2012, compost, D. Larson (DLC) 1 male; 8-IX-2012, compost, D. Larson (DLC) 1 male; Cypress Lake, E end, 31-VII-2012, sifting wrack, D. Larson (DLC) 1 female; Swift Current Cr., 28-VIII-2011, D. Larson (DLC) 1 female; Prince Albert, 53.9804, 106.2800, 532 m, 4-VI-2013, sand beach, sifting debris, B. Godin & D. Horwood (BGC, LFC) 2 males, 1 female.
References	Gusarov 2003, Lohse et al. 1990, Klimaszewski et al. 2005, Majka and Klimaszewski 2010, Bousquet et al. 2013

**Natural history.** In SK, two males were found in compost in September, one female in wrack on lakeshore in July, and one female from unknown habitat in August. In NF, adults were collected from May to August in carrion-baited pitfall traps and flight intercept traps in conifer-dominated and mixedwood forests, and on the coastal barrens of southeastern LB (Klimaszewski et al. 2011). In NB, adults were collected in September from red spruce forest (Klimaszewski et al. 2005).



***Atheta (Dimetrota) districta* Casey**

(for diagnosis and illustrations, see Klimaszewski et al. 2011)

**Distribution.**

Origin	Nearctic
Distribution	Canada: AB, BC, LB, NB, NF, NS, ON, QC, <b>SK</b>
New provincial records	CANADA, <b>Saskatchewan</b> , Cypress Hills Park, Center Block: Lodgepole Trail, 21-VIII-2013, dry and decaying mushrooms, D. Larson (DLC) 1 male; Highland Trail, 13-IX-2012, sifting spruce litter, D. Larson (DLC) 1 male.
References	Casey 1911, Klimaszewski et al. 2005, Majka and Klimaszewski 2008, 2010, Bousquet et al. 2013

**Natural history.** In SK, one male was captured from dry and decaying mushroom, and another from spruce litter in September. In NF, adults were collected from June to August in carrion-baited pitfall traps and flight intercept traps in conifer-dominated and mixedwood forests, and on coastal barrens (Klimaszewski et al. 2011). In NB, adults were collected in June through September in red spruce forest (Klimaszewski et al. 2005).

***Atheta (Dimetrota) pseudometlakatlana* Klimaszewski & Godin**

(for diagnosis and illustrations, see Klimaszewski et al. 2008b)

**Distribution.**

Origin	Nearctic
Distribution	Canada: <b>SK</b> , YT
New provincial records	CANADA, <b>Saskatchewan</b> , Cypress Hills Park, Center Block: Loch Lomond, 19-IX-2014, decaying mushrooms, D. Larson (DLC) 1 male, 1 female; 7-IX-2014, spruce-aspen, D. Larson (DLC) 1 female; fire guard, 10-IX-2013, decaying mushrooms, D. Larson (LFC) 1 male; Sucker Creek, 23-VI-204, aspen woodland, bracket gilled fungi, D. Larson (DLC) 1 male.
References	Klimaszewski et al. 2008b, Bousquet et al. 2013

**Natural history.** In SK, specimens were collected from decaying mushrooms, bracket/gilled fungi, in spruce-aspen and aspen woodland forests. In YT adults were captured in June, July, and August at an elevation of 772 m in a white spruce and mixed white spruce-lodgepole pine forests (Klimaszewski et al. 2008b).

***Atheta (Dimetrota) larsonae* Klimaszewski & Larson, sp. n.**

<http://zoobank.org/4911C55F-055C-44C1-BE33-9ADE90B75144>

Figs 16–20

**Holotype (male).** Canada, Saskatchewan, Royal Edward Road, 25 km NW Maple Creek, 5-VI-2011, D. Larson (LFC).

**Etymology.** The name of this species is dedicated to R.I. Larson. Ruby I. Larson was a geneticist at the Agriculture Canada Research Station, Lethbridge, who worked on wheat genetics. She was very active in promoting science and from 1958 to 1973 ran a Science Club for Junior High and High School age children. Members of this club went on to a variety of professional careers, including three (DJL included) who became professional entomologists. Her love of learning and science was infectious and her support and encouragement were major factors in our career choices. She taught us the joy and personal rewards of following one's curiosity.

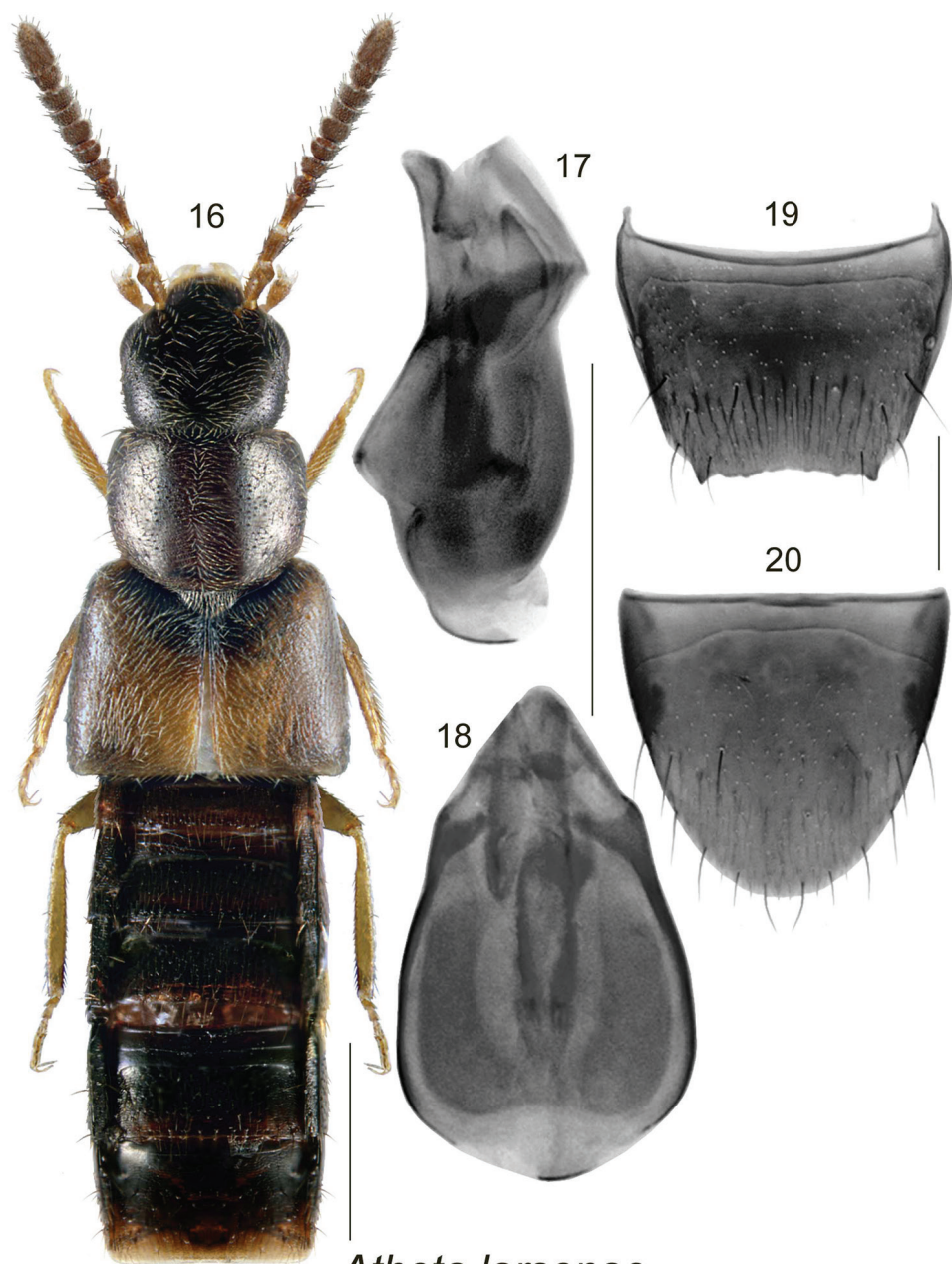
**Diagnosis.** Body narrowly elongate, slightly flattened (particularly on elytra), uniformly dark brown, almost black except for paler, light brown sutural section of elytra and legs (Fig. 16); punctuation on forebody fine, dense and sparse; integument strongly glossy; head slightly narrower than pronotum; pronotum moderately transverse, and much narrower than elytra (Fig. 16); elytra strongly transverse, and at suture about as long as pronotum (Fig. 16); abdomen subparallel and distinctly narrower than elytra (Fig. 16); body length 2.5 mm; antennal articles V–X moderately transverse. MALE. Tergite VIII serrate apically with two larger lateral teeth (Fig. 19); sternite VIII rounded apically (Fig. 20); median lobe of aedeagus with broad and rounded bulbus and short and broadly triangular tubus in dorsal view (Fig. 18), and tubus straight with apex produced ventrally in lateral view (Fig. 17). FEMALE. Unknown.

Distinguished from all other *Atheta (Dimetrota)* by narrow head and pronotum, broad and short elytra, strongly glossy integument, and the shape of median lobe of aedeagus with apex produced ventrally in lateral view (Fig. 17).

**Distribution.** This species is known only from the type locality in SK.

**Natural history.** The holotype was captured in June from unspecified habitat.

**Comments.** This species is superficially similar to Nearctic *Atheta (D.) peticapensis* Klimaszewski & Webster, with which it shares similar body proportions and enlarged bulbus of median lobe of aedeagus. However, these differences may not necessarily indicate a close relationship between these species.



*Atheta larsonae*

**Figures 16–20.** *Atheta (Dimetrota) larsonae* Klimaszewski & Larson, sp. n.: **16** habitus in dorsal view **17** median lobe of aedeagus in lateral view, and **18** in dorsal view **19** male tergite VIII **20** male sternite VIII. Scale bar for habitus = 1 mm, and the remaining scale bars = 0.2 mm.

*Atheta (Dimetrota) strigosula* Casey

(for diagnosis and illustrations, see Klimaszewski et al. 2011)

**Distribution.**

Origin	Nearctic
Distribution	Canada: BC, LB, NB, NF, ON, QC, <b>SK</b> , YT; USA: AK, NY
New provincial records	CANADA, <b>Saskatchewan</b> : Cypress Hills Park, Center Block, fire guard, 8-VIII-2013, gilled mushrooms, D. Larson (DLC) 1 male, 2 females; Lodgepole Trail, 21-VIII-2013, dry and decaying mushrooms, D. Larson (DLC) 1 female.
References	Casey 2010, Klimaszewski et al. 2005, 2008a, b, 2011, Bousquet et al. 2013

**Natural history.** In SK, several females were found in dry and decaying mushrooms in August. In NF, adults were collected from June to October in carrion-baited and unbaited pitfall traps and in flight intercept traps in many forest types (coniferous, mixedwood and deciduous), and some adults were found in rotting mushrooms in forests (Klimaszewski et al. 2011). Elsewhere, adults were collected in June and August, from organic litter in red spruce forest in NB and forest litter in YT (Klimaszewski et al. 2005, 2008b).

*Atheta (Dimetrota) terranova* Klimaszewski & Langor

(for diagnosis and illustrations, see Klimaszewski et al. 2011, Brunke et al. 2012)

**Distribution.**

Origin	Nearctic
Distribution	Canada: LB, NB, NF, ON, QC, <b>SK</b> , YT
New provincial records	CANADA, <b>Saskatchewan</b> : Cypress Hills Park, Center Block: fire guard, 18-VIII-2014, old polypore fungus on dead lodgepole pine stump, D. Larson (DLC) 2 males; 7-IX-2014, spruce-aspen, D. Larson (DLC) 1 male, 1 female.
References	Klimaszewski et al. 2011, Brunke et al. 2012, Klimaszewski et al. 2012, Webster et al. 2012, Bousquet et al. 2013

**Natural history.** This species is frequently associated with forest mushrooms. In SK, specimens were captured from an old polypore fungus on dead lodgepole pine stump, and in spruce-aspen forest, in August and September. In NF, adults were collected from June to August in carrion-baited and unbaited pitfall traps and in flight intercept traps in many forest types (coniferous, mixedwood and deciduous), and some adults were found in rotting mushrooms in forests (Klimaszewski et al. 2011). In YT, specimens were found in mushrooms, in birch and mixed pine and willow forests, and white spruce and feathermoss forest in July and August (Klimaszewski et al. 2012). Most specimens from NB were collected from fresh and decaying gilled mushrooms. One individual was collected from a rotting lobster mushroom and another from a coral mushroom on a spruce log (Webster et al. 2012). This species was found in

mixed forests, mature red spruce forests with red maple or birch, a black spruce forest, an eastern white cedar swamp, and a red oak forest (Webster et al. 2012). Adults from New Brunswick were collected during August, September (most specimens), and October (Webster et al. 2012).

***Atheta (Microdota) pseudopittionii* Klimaszewski & Larson, sp. n.**

<http://zoobank.org/9D833E80-70C3-4EBF-9ADC-5AFACB0D09BE>

Figs 21–28

**Holotype (male).** Canada, Saskatchewan, Larson Ranch, Hwy 21, 16 km S Maple Creek, 7-IX-2010, ex *Lepiota rhacodes*, D. Larson (LFC). **Paratypes.** Canada, Saskatchewan, Larson Ranch, Hwy 21, 16 km S Maple Creek: 25-VI-2008, carrion trap, D. Larson (CNC) 1 male, 1 female; 8-VII-2013, mushrooms, D. Larson (CNC, LFC) 1 male, 3 females; 15-VII-2014, decaying polypore mushroom, D. Larson (DLC, LFC) 2 females; 6-VIII-2013, ex *Lepiota rhacodes*, D. Larson (DLC, LFC) 3 males; 7-IX-2010, ex *Lepiota rhacodes*, D. Larson (DLC) 1 male, 2 females.

**Etymology.** The species name *pseudopittionii* derived from the prefix *pseudo-* (false) and the specific name of European species *Atheta pittionii* Scheerpeltz, to which it is similar externally and has similar genitalia.

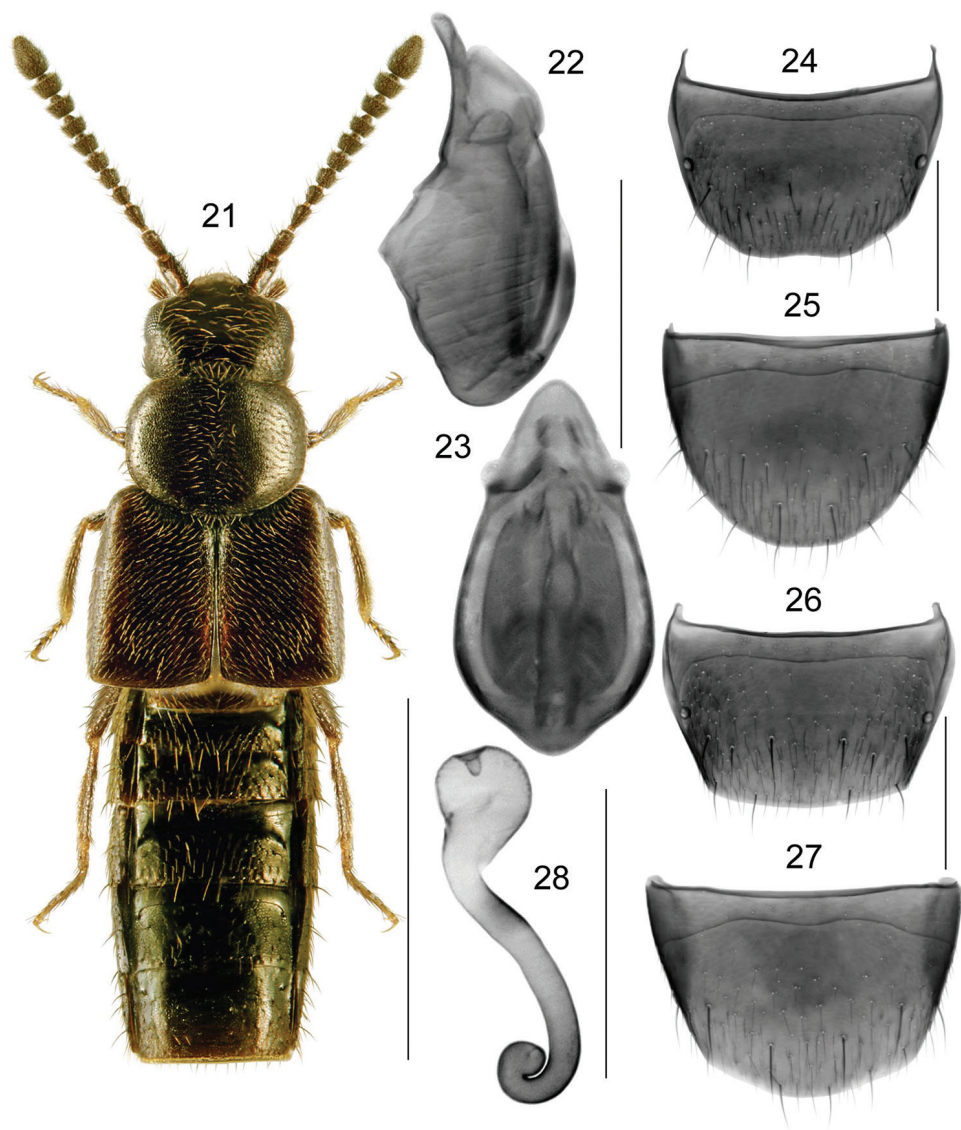
**Diagnosis.** Body narrowly subparallel (Fig. 21), length 1.9–2.0 mm, uniformly black with tarsi yellowish; head, pronotum and elytra finely and sparsely punctate and pubescent, punctures small; integument strongly glossy, more so on abdomen, with meshed microsculpture; pronotum transverse, distinctly narrower than elytra, with pubescence directed obliquely anteriad anteriorly and obliquely posteriad posteriorly from median line of disc (Fig. 21); elytra at suture distinctly longer than pronotum (Fig. 21); abdomen subparallel. MALE. Tergite VIII truncate apically and slightly emarginate (Fig. 24); sternite VIII rounded apically (Fig. 25). Median lobe of aedeagus with large oval bulbus, and short and broadly triangular tubus in dorsal view (Fig. 23), in lateral view tubus arcuate with base near bulbus sinuate (Fig. 22); internal sac structures as illustrated (Figs 22, 23). FEMALE. Tergite VIII truncate apically (Fig. 26); sternite VIII broadly arcuate apically (Fig. 27); spermatheca with spherical capsule bearing narrow apical invagination, stem narrow, and with a small coiled apex (Fig. 28).

This species is very similar to European *A. pittionii* Scheerpeltz, from which it differs by broader and more elongate elytra, larger bulbus of median lobe of aedeagus in dorsal view (Fig. 23), more sinuate base of tubus of median lobe of aedeagus in lateral view (Fig. 22), and differently shaped complex structures of the internal sac (Figs 22, 23). For genitalia of *A. pittionii*, see Brundin (1948) [under the name of *A. parvicornis*].

**Distribution.** Adults are known only from SK.

**Natural history.** Most adults of this species were collected from Shaggy parasol mushrooms, *Chlorophyllum rhacodes* (= *Lepiota rhacodes*), from unspecified mushrooms, and from carrion.





### *Atheta pseudopittionii*

**Figures 21–28.** *Atheta (Microdota) pseudopittionii* Klimaszewski & Larson, sp. n.: **21** habitus in dorsal view **22** median lobe of aedeagus in lateral view, and **23** in dorsal view **24** male tergite VIII **25** male sternite VIII **26** female tergite VIII **27** female sternite VIII **28** spermatheca in lateral view;. Scale bar for habitus = 1 mm, and the remaining scale bars = 0.2 mm.



***Atheta (Microdota) riparia* Klimaszewski & Godin**

(for details and body image, see Klimaszewski et al. 2012)

**Distribution.**

Origin	Nearctic
Distribution	Canada: <b>SK</b> , <b>YT</b>
New provincial records	CANADA, <b>Saskatchewan</b> : Cypress Hills Park, Center Block: fire guard, Sucker Creek, 23-VI-2014, aspen woodland bracket/gilled fungi, D. Larson (DLC) 1 male; 7-IX-2014, spruce-aspen, D. Larson (DLC) 1 male.
References	Klimaszewski et al. 2012, Bousquet et al. 2013

**Natural history.** One SK male was captured in bracket/gilled fungi in aspen woodland in June, and the other from spruce-aspen woodland in September. In YT, two males were captured by sifting litter in mixed aspen and white spruce forest in September, and one female was found on a mushroom in August (Klimaszewski et al. 2012).

***Atheta (Microdota) spermathecorum* Klimaszewski & Larson, sp. n.**

<http://zoobank.org/8561AFDD-2420-4FC5-8B6D-F1AED26157B7>

Figs 29–32

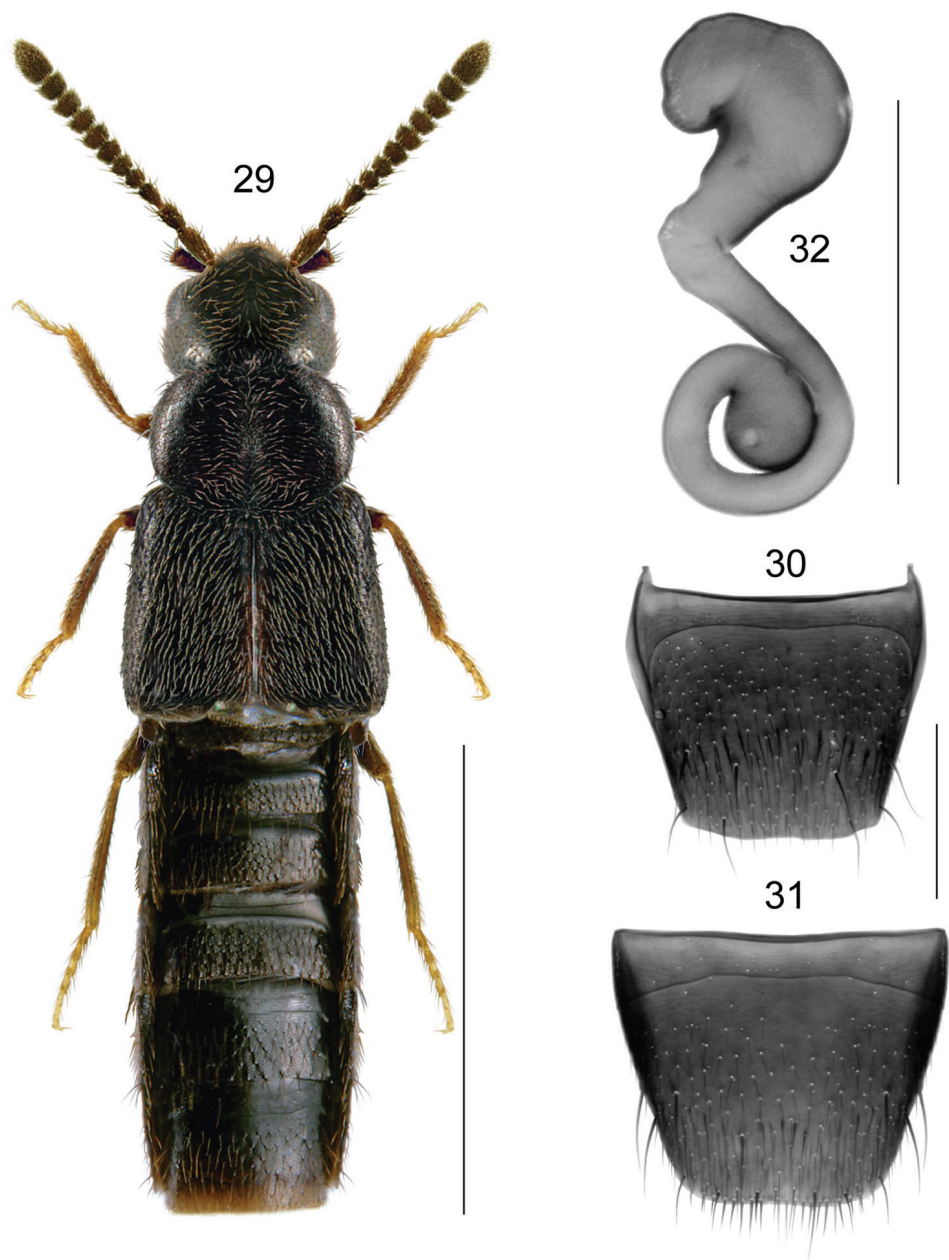
**Holotype** (female). Canada, Saskatchewan, Larson Ranch, Hwy 21, 16 km S Maple Creek, 8-VI-2014, D. Larson (LFC). **Paratypes.** Canada, Saskatchewan, Larson Ranch, Hwy 21, 16 km S Maple Creek: 29-V-2012 (LFC) 1 female; 30-V-2014, D. Larson (CNC) 1 female; 17-VII-2014, decaying polypore mushroom, D. Larson (CNC) 1 female; Belanger Creek, Frenchman Valley, 11-V-2013, D. Larson (DLC) 1 female; Harris Res., 10 km S Maple Creek, 20-V-2004, drift, D. Larson (DLC) 1 female; Alberta, Lethbridge, 24-III-1964, D. Larson (DLC) 1 female.

**Etymology.** The species name *spermathecorum* is derived from the name of spermatheca in reference to unusually shaped capsule of the spermatheca of this species.

**Diagnosis.** Body narrowly subparallel (Fig. 29), length 1.9–2.2 mm, uniformly black, legs with at least tarsi reddish-brown; head, pronotum and elytra finely and moderately densely punctate and pubescent, punctures small (Fig. 29); integument moderately glossy, more so on abdomen; pronotum transverse, narrower than elytra, with pubescence directed obliquely anteriad and posteriad posteriorly from median line of disc (Fig. 29); elytra at suture slightly longer than pronotum; abdomen subparallel (Fig. 29). MALE. Unknown. FEMALE. Tergite VIII truncate and slightly concave apically (Fig. 30); sternite VIII truncate and slightly emarginate apically (Fig. 31); spermatheca with irregularly-shaped capsule without apparent apical invagination, stem narrow, and with a single posterior coil bearing swollen apical part (Fig. 32).

It is distinguished from all other Nearctic species of *Atheta*, subgenus *Microdota*, by the unique shape of spermatheca bearing bulbous apical projection on top of capsule (Fig. 32).

**Distribution.** Adults are known from SK and AB.



## *Atheta spermathecorum*

**Figures 29–32.** *Atheta (Microdota) spermathecorum* Klimaszewski & Larson, sp. n. (female): **29** habitus in dorsal view **30** tergite VIII **31** sternite VIII **32** spermatheca. Scale bar for habitus = 1 mm, and the remaining scale bars = 0.2 mm.

**Natural history.** Females were captured in March (Alberta), May and July (Saskatchewan): one was found in a decaying polypore mushroom and one was found in lake drift in May.

***Atheta (Rhagocneme) subsinuata* Erichson**

(for details and body image, see Klimaszewski et al. 2008b)

**Distribution.**

Origin	Palearctic, adventive in Canada
Distribution	Canada: <b>SK</b> , YT
New provincial records	CANADA, <b>Saskatchewan</b> , Larson Ranch, Hwy 21, 16 km S Maple Creek, 1-VI-2011, D. Larson (DLC) 1 female; 27-VI-2010, old wet alfalfa hay with <i>Coprinus</i> , D. Larson (DLC, LFC) 3 females; 24-VII-2010, sifted from old mouldy alfalfa hay, D. Larson (DLC) 1 female; 1-IX-2012, compost, D. Larson (LFC) 1 female.
References	Klimaszewski et al. 2008b, Bousquet et al. 2013

**Natural history.** Like many introduced species, *A. subsinuata* appears to be synanthropic, as all collections have been made from artificial habitats. The Saskatchewan specimens were sifted from old mouldy alfalfa hay in June and July, and one female was taken in September from compost. In YT, four specimens were captured in a compost pile in September 2005 (Klimaszewski et al. 2008b).

***Atheta (Tetropla) frosti* Bernhauer**

(for details and illustrations, see Gusarov 2003, Klimaszewski et al. 2011)

**Distribution.**

Origin	Nearctic
Distribution	Canada: BC, LB, NB, NS, ON, QC, <b>SK</b> ; USA: MA, NC, NH, NY, PA, RI, VT
New provincial records	CANADA, <b>Saskatchewan</b> , Cypress Hills, Center Block, Lake, Lodgepole Trail, 24-IX-2014, decaying mushrooms, D. Larson (DLC) 1 female.
References	Gusarov 2003, Klimaszewski et al. 2005, Majka and Klimaszewski 2008, 2010, Klimaszewski et al. 2011, Bousquet et al. 2013

**Natural history.** The SK female was captured in decaying mushrooms in September. In LB, adults were abundant in pitfall traps during July and August in an open spruce forest with sandy soil and *Cladina* lichen cover, and a few adults were captured using pitfall traps in a birch-dominated forest (Klimaszewski et al. 2011). Elsewhere, adults occurred from July to October in organic debris in red spruce forest, in polypore fungus in coniferous forest, and on the forest floor in red oak and deciduous forests (Klimaszewski et al. 2005, Majka and Klimaszewski 2008, 2010).

**Incertae sedis**

The following species have uncertain subgeneric affiliation in the large and diverse genus *Atheta*. Some of the species belong to a group of species described in Europe by Benick and Lohse (1974) as the “Mischgruppe” (mixed group) of *Atheta*.

***Atheta pseudoschistoglossa* Klimaszewski & Webster**

(for details, genitalia and body image, see Webster et al. 2016b)

**Distribution.**

Origin	Nearctic
Distribution	Canada: NB, <b>SK</b>
New provincial records	CANADA, <b>Saskatchewan</b> : Cypress Hills Park, Sucker Creek, 21-VIII-2012, aspen-pine litter, D. Larson (DLC) 1 male; Cypress Hills Park, Center Block, Lodgepole Trail, 18-IX-2012, pine-spruce litter near stream, D. Larson (DLC) 1 female; Belanger Creek, Frenchman Valley, 18-X-2014, D. Larson (DLC) 1 male.
References	Webster et al. 2016b

**Natural history.** The SK specimens were captured from aspen/pine litter and pine/spruce litter in August through October. In NB, most adults of *A. pseudoschistoglossa* were found in or near wetland habitats including among cobblestones, drift material, and flood debris along river margins, moist leaves along vernal pond margin in a silver maple swamp, in leaf litter and moss along brook margins in alder swamps, and in litter at base of red maple, in *Carex* hummock in *Carex* marshes, in leaf litter in a red oak forest near seasonally flooded marsh, in a salt marsh, in marsh litter in a *Carex*-sedge marsh, and in litter and sphagnum at the base of a tree in a marsh (Webster et al. 2016b). A few adults were captured in Lindgren funnel traps in hardwood woodland near a seasonally flooded marsh and in an old mixed forest (Webster et al. 2016b). Adults were collected from mid-April to August (Webster et al. 2016b).

***Atheta remulsa* Casey**

(for details and illustrations, see Klimaszewski et al. 2011)

**Distribution.**

Origin	Nearctic
Distribution	Canada: AB, BC, LB, NB, NE, NS, ON, QC, <b>SK</b> , YT
New provincial records	CANADA, <b>Saskatchewan</b> : Cypress Hills Park, Center Block, Lodgepole Trail, 21-VIII-2013, dry and decaying mushrooms, D. Larson (DLC) 1 female.
References	Casey 1910, Klimaszewski et al. 2005, 2007b, Majka and Klimaszewski 2008, 2010, Bousquet et al. 2013

**Natural history.** In SK one female was captured from dry and decaying mushrooms. In NL, adults were collected from June to September using unbaited and carrion-baited pitfall traps and flight intercept traps in many forest types (deciduous, mixedwood, coniferous, riparian), and also in rotting mushrooms in forests (Klimaszewski et al. 2011). Elsewhere, adults were collected in NB from red spruce mixed forest from June through September (Klimaszewski et al. 2005), and in QC from yellow birch/balsam fir dominated forest in June and July (Klimaszewski et al. 2007b).

***Atheta richardsoni* Klimaszewski & Larson, sp. n.**

<http://zoobank.org/D56426E0-874E-4E33-B620-5DB5EFA42097>

Figs 33–40

**Holotype (male).** Canada, Saskatchewan, Hwy 21, 20 km N Maple Creek, 25-VI-2010, Gramma-stipa pasture, Richardson ground squirrel burrow, D. Larson (LFC). Paratype. Canada, Saskatchewan, Grassland National Park, W Block Larson's Prairie Dog colony, 11-VI-2009, D. Larson (LFC) 1 female.

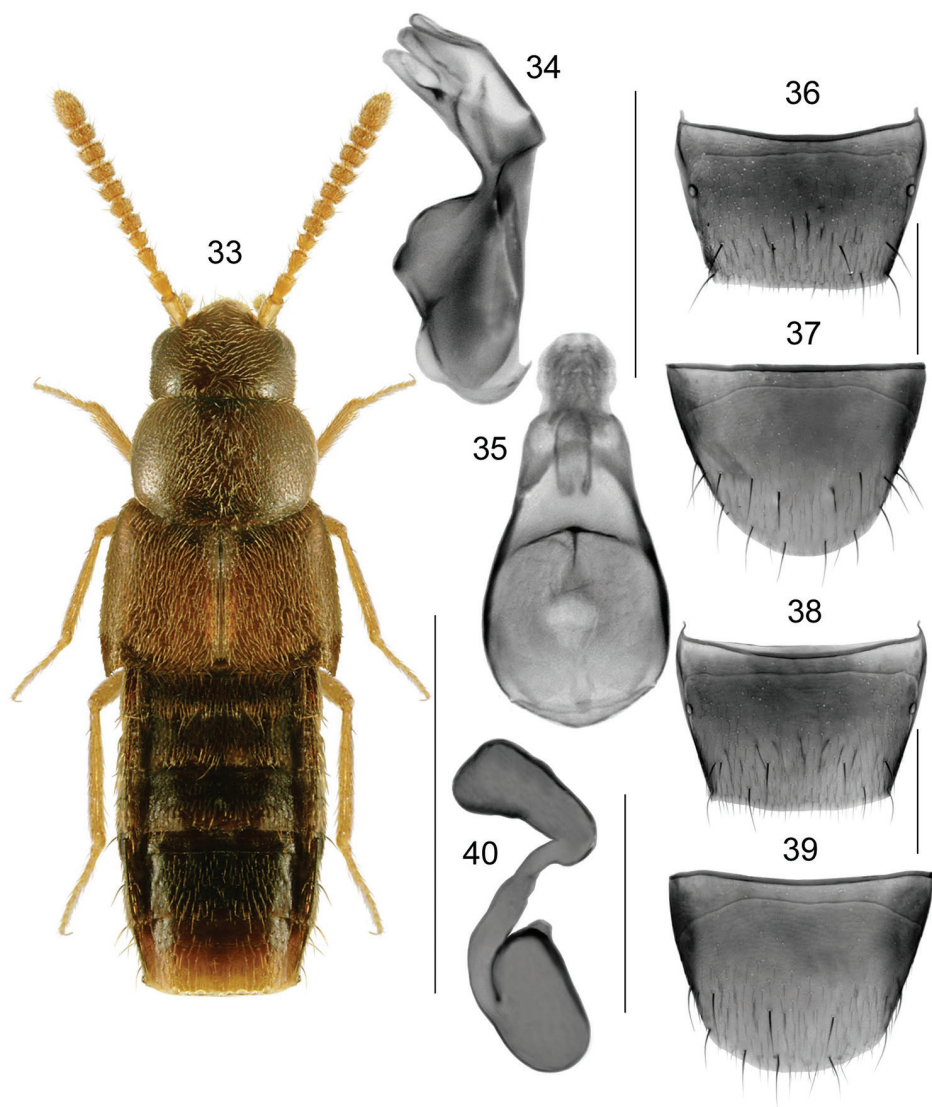
**Etymology.** This species name is derived from the surname of Sir John Richardson, the surgeon-naturalist who participated in 19th century British naval expeditions to the arctic coast of "British North America", now Canada. In 1820 he discovered a new species of ground squirrel along the Saskatchewan River, which was later named after him as *Urocitellus richardsonii*. The holotype of *Atheta richardsoni* was found in a Richardson's ground squirrel burrow.

**Diagnosis.** Body narrowly subparallel (Fig. 33), length 1.9 mm, dark brown, with appendages yellowish-brown; head, pronotum and elytra finely and densely punctate and pubescent, punctures small, all pubescence directed straight or obliquely posteriad; integument moderately glossy, more so on abdomen (Fig. 33); pronotum transverse, narrower than elytra, with pubescence directed straight posteriad on median line of disc (Fig. 33); elytra at suture about as long as pronotum (Fig. 33); abdomen subparallel. MALE. Tergite VIII truncate apically (Fig. 36); sternite VIII broadly rounded apically (Fig. 37). Median lobe of aedeagus with large oval bulbus and broad tubus rapidly tapering near apex in dorsal view (Fig. 35), in lateral view tubus straight and narrowly rounded at apex, strongly produced ventrally (Fig. 34); internal sac structures as illustrated (Figs 34, 35). FEMALE. Tergite VIII transverse and truncate apically (Fig. 38); sternite VIII broadly arcuate apically, antecostal suture strongly sinuate (Fig. 39); spermatheca with narrowly pitcher-shaped capsule and thin stem ending with enlarged, sac-like posterior part (Fig. 40).

Distinguished from all other species of Nearctic *Atheta* by its small size, densely and finally punctate and pubescent forebody, nearly all pronotal pubescence directed straight posteriad (Fig. 33), the shape of median lobe of aedeagus with very broad tubus of median lobe in dorsal view (Fig. 35), and the shape of spermatheca with enlarged, sac-shaped posterior part of stem (Fig. 40).

**Distribution.** Adults are known from SK.





### *Atheta richardsoni*

**Figures 33–40.** *Atheta (sensu lato) richardsoni* Klimaszewski & Larson, sp. n.: **33** habitus in dorsal view **34** median lobe of aedeagus in lateral view, and **35** in dorsal view **36** tergite VIII **37** sternite VIII **38** female tergite VIII **39** female sternite VIII **40** spermatheca. Scale bar for habitus = 1 mm, and the remaining scale bars = 0.2 mm.

**Natural history.** The single male from SK was captured in a ground squirrel burrow, and the single female was found in a Prairie Dog colony in June.

**Comments.** This species in body size and general appearance is similar to species of the subgenus *Microdota* of *Atheta*. However, it has a different pubescence pattern of pronotum with microsetae along midline of disc directed straight posteriad and elsewhere



straight or obliquely posteriad (Fig. 33), and pubescence on elytra with microsetae directed approximately straight posteriad (Fig. 33). The tubus of the median lobe of the aedeagus is very broad and abruptly narrowed apically in dorsal view (Fig. 34), and spermatheca has enlarged and sac-shaped posterior part of stem (Fig. 40). These are unique features of this species, which slightly resemble those of European *Atheta liturata* Stephens, which has a similarly shaped median lobe of aedeagus and spermatheca, but the European species has a differently shaped male tergite VIII with strong lateral projections (for illustrations, see Palm 1970). The European species is known from mushrooms. Benick and Lohse (1974) assigned *A. liturata* to *Atheta* (Mischgruppe III, IV).

*Dinaraea angustula* (Gyllenhal)

(for details and illustrations, see Klimaszewski et al. 2011, 2013a, b)

**Distribution.**

Origin	Palearctic, adventive in Canada
Distribution	Canada: AB, LB, NB, NF, NS, ON, PE, QC, <b>SK</b> , YT. USA: CA, NY
New provincial records	CANADA, <b>Saskatchewan</b> : Saskatoon, 16-VI-1976, D. Larson (DLC) 1 female; Larson Ranch, Hwy 21, 16 km S Maple Creek, 5-V-2008, D. Larson (DLC, LFC) 2 males; 22-VI-2014, D. Larson (LFC) 1 male.
References	Moore and Legner 1975, Muona 1984, Klimaszewski et al. 2007a, Webster et al. 2009, Majka and Klimaszewski 2010, Klimaszewski et al. 2011, 2013a, b, Bousquet et al. 2013

**Natural history.** The SK specimens were captured in May and June from unspecified habitat. Elsewhere, this species is associated with soil and organic debris in agricultural fields and disturbed urban meadows. It is also found in marsh litter, in leaf litter in mixed forests, in compost, under bark of decaying spruce logs, amongst vegetation on a coastal sand dune, in litter in a cattail marsh, in leaf litter along a vernal pond, and in drift material along a lakeshore (Webster et al. 2009, Klimaszewski et al. 2010, 2011, 2013a, b). The adult activity period is April to September.

*Dinaraea pacei* Klimaszewski & Langor

(for details and illustrations, see Klimaszewski et al. 2011, 2013a)

**Distribution.**

Origin	Nearctic
Distribution	Canada: AB, BC, LB, NB, ON, PE, QC, <b>SK</b> , YT. USA: AK
New provincial records	CANADA, <b>Saskatchewan</b> : Cypress Hills Park, Center Block: fire, Sucker Creek, 23-VI-2014, aspen woodland bracket/gilled fungi, D. Larson (DLC) 1 female; 1-VI-2004, under aspen bark, Hooper & Larson (DLC) 1 male.
References	Webster et al. 2009, Majka and Klimaszewski 2010, Klimaszewski et al. 2011, 2013a, Bousquet et al. 2013

**Natural history.** The SK specimens were captured from aspen woodland bracket/gilled fungi, and from under aspen bark. Adults in NF and LB were collected from June to August using pitfall traps and flight intercept traps in various coniferous forest types, and one specimen was collected under the bark of a dead red pine (Klimaszewski et al. 2011). In BC, adults were caught in July and September in emergence traps attached to the trunks of lodgepole pine (*Pinus contorta* Dougl. ex Loud. *latifolia* Engelm.) infested by mountain pine beetle (*Dendroctonus ponderosae* Hopkins) (Klimaszewski et al. 2013a). In NB, adults were found: under the bark of large fallen spruce in an old-growth eastern white cedar swamp; under tight bark of American elm; in a silver maple forest; in fleshy polypore fungi at the base of a dead standing *Populus* sp. in a wet alder swamp; and in a group of *Pholiota* sp. at the base of a dead *Populus* sp. in a mixed forest. In Quebec, adults were found in dead black spruce in a black spruce forest (Webster et al. 2009). Adults were also captured in Lindgren funnel traps deployed in an old-growth white spruce (*Picea glauca* (Moench) Voss) and balsam fir forest, an old mixed forest with red and white spruce, red and white pine (*Pinus strobus* L.), and a rich Appalachian hardwood forest with some conifers (Webster et al. 2009). Adults were collected from March to September (Webster et al. 2009).

### *Dochmonota* Thomson

(for synonymies and discussion, see Gusarov 2003)

**Remark.** Untill now, only one native species, *Dochmonota rudiventris* (Eppelsheim) (Figs 41-48), was reported from North America including Canada (Gusarov 2003, Klimaszewski et al. 2011).

### Key to Nearctic species of *Dochmonota*

- 1 Head about as broad as pronotum (Fig. 49); body narrow with elytra at base only slightly broader than pronotum (Fig. 49); male sternite VIII notched dorsally (Fig. 53); ventral margin of tubus of median lobe of aedeagus straight with base slightly sinuate in lateral view (Fig. 50); spermatheca with capsule broad, pitcher-shaped, and stem coiled (Fig. 56)..... *D. langori* Klimaszewski & Larson, sp. n.
- Head distinctly narrower than pronotum (Figs 41, 57, 65); body broad with elytra at base distinctly broader than pronotum (Figs 41, 57, 65); male sternite VIII with apex entire (Figs 45, 61, 69); ventral margin of tubus of median lobe of aedeagus differently shaped (Figs 42, 58, 66); spermatheca with capsule moderately broad, subspherical and stem coiled (Figs 48, 64, 72) ... 2
- 2 Elytra at suture longer than pronotum (Fig. 57); male tergite VIII with two small lateral teeth at the apical margin (Fig. 60); median lobe of aedeagus with sinuate apical margin of tubus (Fig. 58); spermatheca with capsule sub-

- spherical and with twisted stem (Fig. 64) .....  
 ..... ***D. simulans* Klimaszewski & Larson, sp. n.**
- Elytra at suture about as long as pronotum (Figs 41, 65); male tergite VIII without teeth on apical margin (Figs 44, 68); median lobe of aedeagus with straight apical margin of tubus in lateral view (Figs 42, 66)..... 3
3. Elytral posterior corners with strong lateral emarginations (Fig. 41); median lobe of aedeagus with large crista apicalis of bulbos (Fig. 42); spermatheca with capsule compressed dorso-ventrally (Fig. 48) .....  
 ..... ***D. rudiventris* (Eppelsheim)**
- Elytral posterior corners with slight emarginations laterally (Fig. 65); median lobe of aedeagus with small crista apicalis of bulbos (Fig. 66); spermatheca with capsule spherical (Fig. 72)..... ***D. websteri* Klimaszewski & Larson, sp. n.**

***Dochmonota langori* Klimaszewski & Larson, sp. n.**

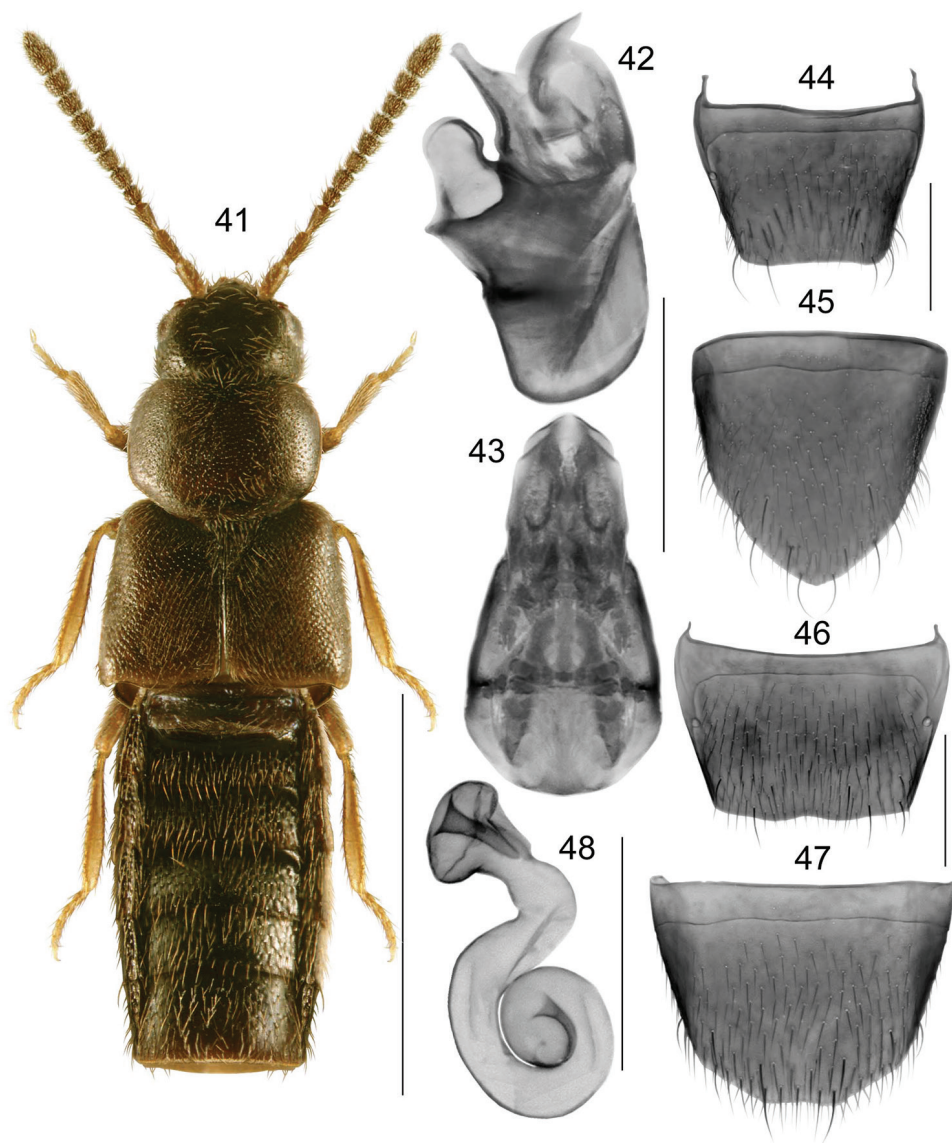
<http://zoobank.org/60D5577B-AD81-414F-A167-5E8375999138>

Figs 49–56

**Holotype (male).** Canada, Saskatchewan, Cypress Lake, E dam, 9-V-2012, wind-drift, D. Larson (LFC) 1 male. **Paratypes.** Canada, Saskatchewan, Cypress Lake, E dam, 9-V-2012, wind-drift, D. Larson (CNC, LFC) 3 females; Cypress Lake, E dam, 31-VII-2012, sifting wrack, D. Larson (DLC) 2 females; Crane Lake, NE Piapot, 28-VIII-2011, beach wrack, D. Larson (CNC) 1 female.

**Etymology.** The species is named for our friend and professional colleague Dr. David W. Langor, Canadian Forest Service, collaborator and supporter of many joint entomological projects. He contributed to the discovery and descriptions of many new species of aleocharine beetles in Canada, particularly in Newfoundland and Alberta.

**Diagnosis.** Body narrowly subparallel (Fig. 49), length 2.2–2.5 mm, uniformly black; head, pronotum and elytra finely and densely punctate, punctures small; pubescence dense; integument moderately glossy, more so on abdomen, with meshed microsculpture (Fig. 49); antenna with articles V–X subquadrate to slightly transverse (Fig. 49); head about as wide as pronotum (Fig. 49); pronotum transverse, slightly narrower than elytra at base, with pubescence directed obliquely laterad from median line of disc and in basal part of median line directed anteriad and laterad, base of disc with small oval impression (Fig. 49); elytra at suture about as long as pronotum and slightly wider at base than pronotum (Fig. 49); abdomen subparallel. **MALE.** Tergite VIII truncate apically (Fig. 52); sternite VIII elongate and notched apically (Fig. 53). Median lobe of aedeagus with large broad bulbos and narrow triangular tubus in dorsal view, bulbos strongly sinuate laterally (Fig. 51), in lateral view tubus straight and slightly sinuate basally; crista apicalis of bulbos small (Fig. 50); internal sac structures as illustrated (Figs 50, 51). **FEMALE.** Tergite VIII truncate apically (Fig. 54); sternite VIII arcuate apically (Fig. 55); spermatheca with pitcher-shaped capsule bearing broad and deep apical invagination, stem broad, and coiled (Fig. 56).



### *Dochmonota rudiventris*

**Figures 41–48.** *Dochmonota rudiventris* (Eppelsheim): **41** habitus in dorsal view **42** median lobe of aedeagus in lateral view, and **43** in dorsal view **44** male tergite VIII **45** male sternite VIII **46** female tergite VIII **47** female sternite VIII **48** spermatheca. Scale bar for habitus = 1 mm, and the remaining scale bars = 0.2 mm.

**Distribution.** This species is known only from SK.

**Natural history.** Adults of this species were collected by sifting wrack on lakeshore beach, and were found in wind-drift on a lake.

***Dochmonota simulans* Klimaszewski & Larson, sp. n.**

<http://zoobank.org/01385C86-C902-4A1D-91BF-5973E19D18F9>

Figs 57–64

**Holotype (male).** Canada, Saskatchewan, Royal Edward Rd., 25 km NW Maple Creek, 5-VI-2011, D. Larson (LFC) 1 male. **PARATYPE** (female): Canada, Saskatchewan, Hwy 21, 17 km N Maple Creek, 26-VI-2010, saline slough, D. Larson (LFC).

**Etymology.** The species name is derived from Latin adjective *simulans*-, meaning imitating, in reference to its similarity to the closely related *Dochmonota websteri*.

**Diagnosis.** Body narrowly subparallel (Fig. 57), length 3.0 mm, uniformly black; head, pronotum and elytra finely and densely punctate, punctures small; pubescence dense; integument moderately glossy, more so on abdomen, with meshed microsculpture; antenna with articles V–VII subquadrate to slightly transverse (Fig. 57); head distinctly narrower than pronotum (Fig. 57); pronotum transverse, distinctly narrower than elytra at base, with pubescence directed obliquely laterad from median line of disc and pubescence in basal part of median line directed anteriad and laterad, base of disc without impression (Fig. 57); elytra at suture distinctly longer than pronotum and wider than pronotum (Fig. 57); abdomen subparallel. **MALE.** Tergite VIII truncate apically with two small lateral teeth (Fig. 60); sternite VIII elongate and rounded apically (Fig. 61). Median lobe of aedeagus with large suboval bulbus and small triangular tubus in dorsal view, lateral sides of bulbus slightly sinuate (Fig. 59), tubus sinuate in lateral view, crista apicalis of bulbus small (Fig. 58); internal sac structures as illustrated (Figs 58, 59). **FEMALE.** Tergite VIII truncate apically (Fig. 62); sternite VIII emarginated apically (Fig. 63); spermatheca with subspherical capsule bearing broad invagination, stem irregularly twisted and with swollen apical part (Fig. 64).

**Distribution.** Adults are known only from SK.

**Natural history.** The male of this species was captured in June in unspecified habitat, and one female was taken from saline slough, also in June.

***Dochmonota websteri* Klimaszewski & Larson, sp. n.**

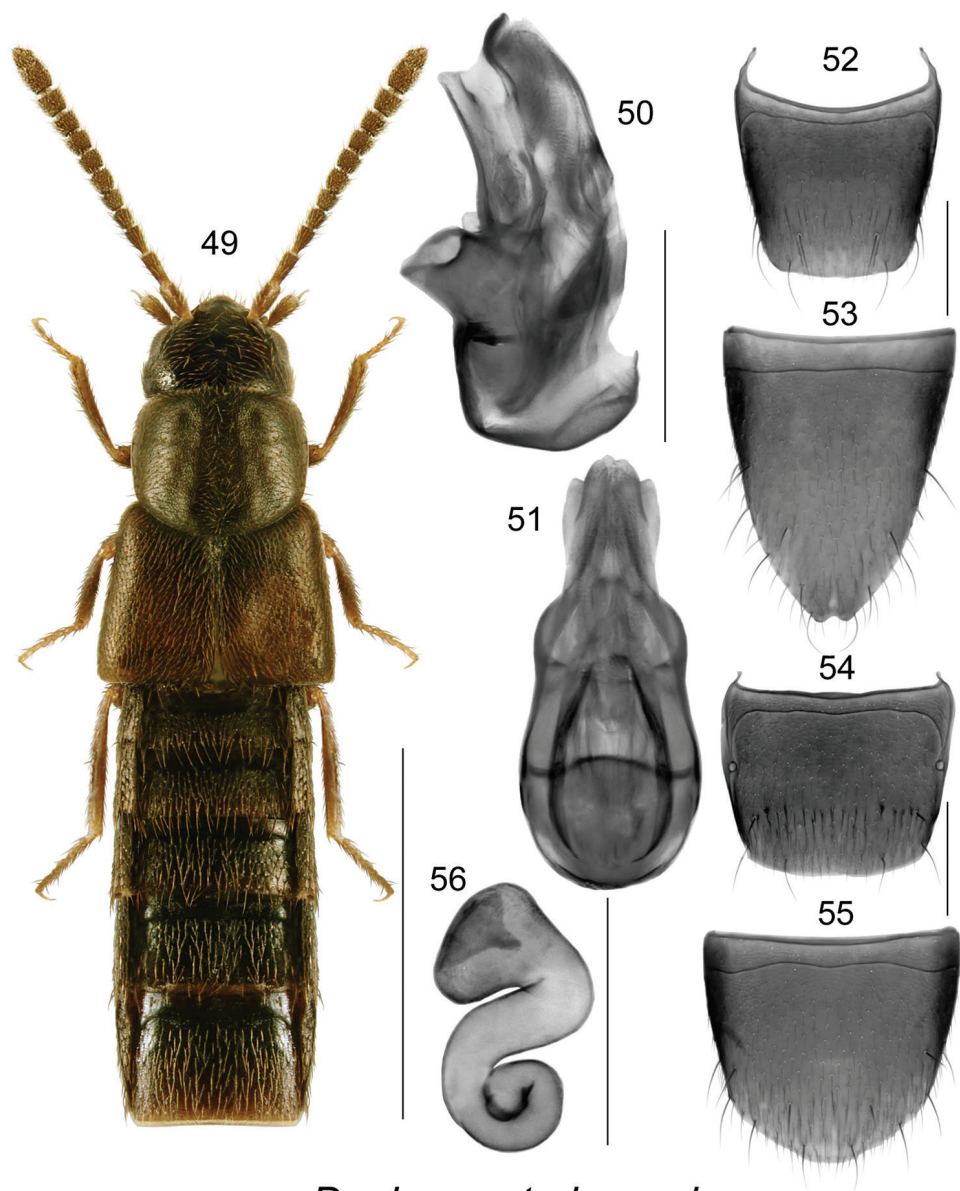
<http://zoobank.org/5FE92AA7-3FBB-4C0B-8C63-55C1FB560506>

Figs 65–72

**Holotype (male).** Canada, Saskatchewan, Bigstick Lake, 16 km E Golden Prairie, 1-IX-2011, D. Larson (LFC). **Paratypes.** Canada, Saskatchewan, Bigstick Lake, 16 km E Golden Prairie, 1-IX-2011, D. Larson (LFC) 1 female; Bear Creek at Crane Lake, NE Piapot, 18-VIII-2011, D. Larson (DLC) 1 female. **NON-TYPE:** Canada, Saskatchewan, Bigstick Lake, N Maple Creek, 4-IX-2012, organic mud/sedges, rushes, etc. near water, D. Larson (DLC) 1 male.

**Etymology.** The species is named for Dr. Reginald R. Webster, close friend of JK, and extraordinary entomologist who “understands aleocharine beetles” and who

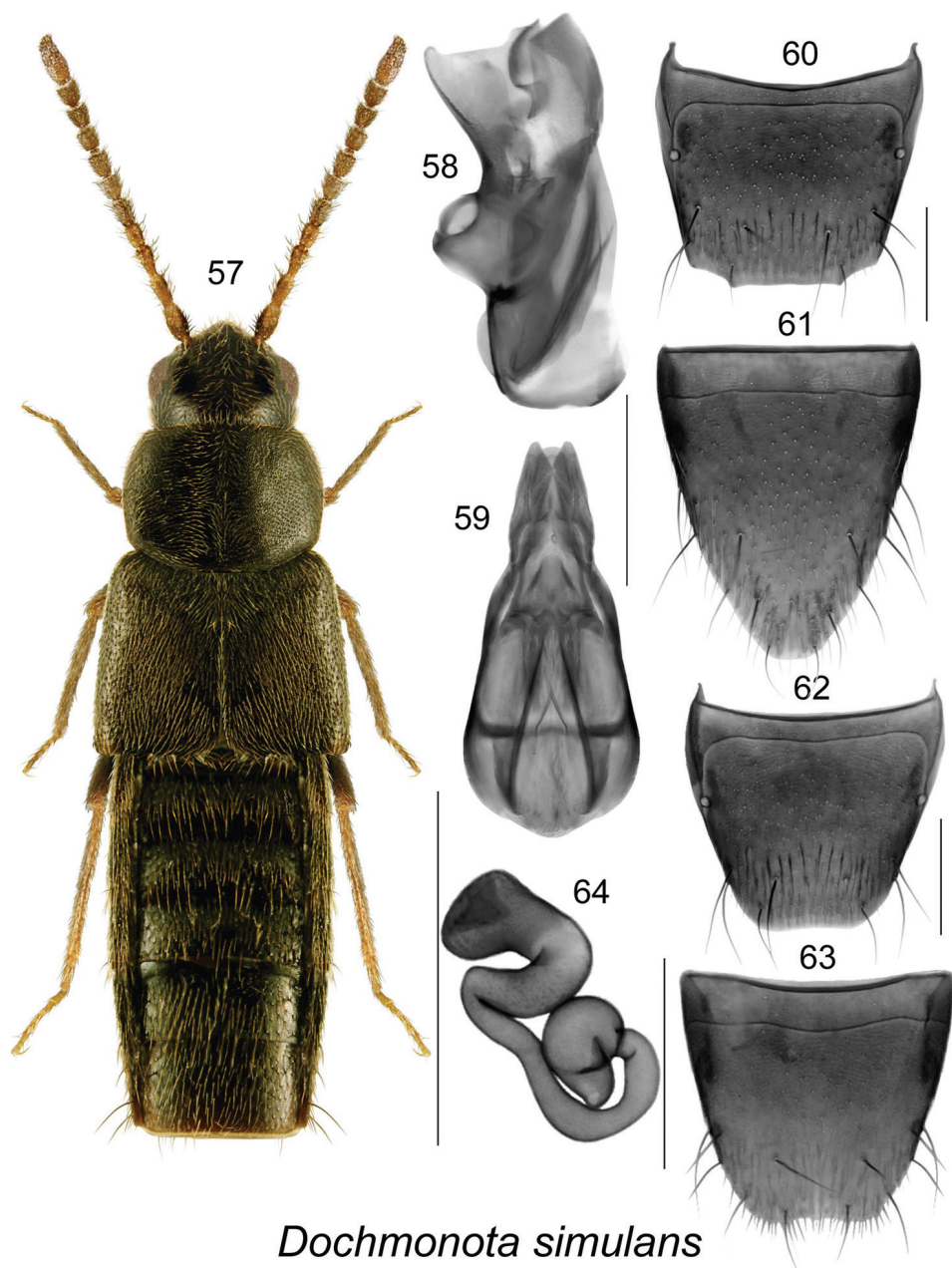




*Dochmonota langori*

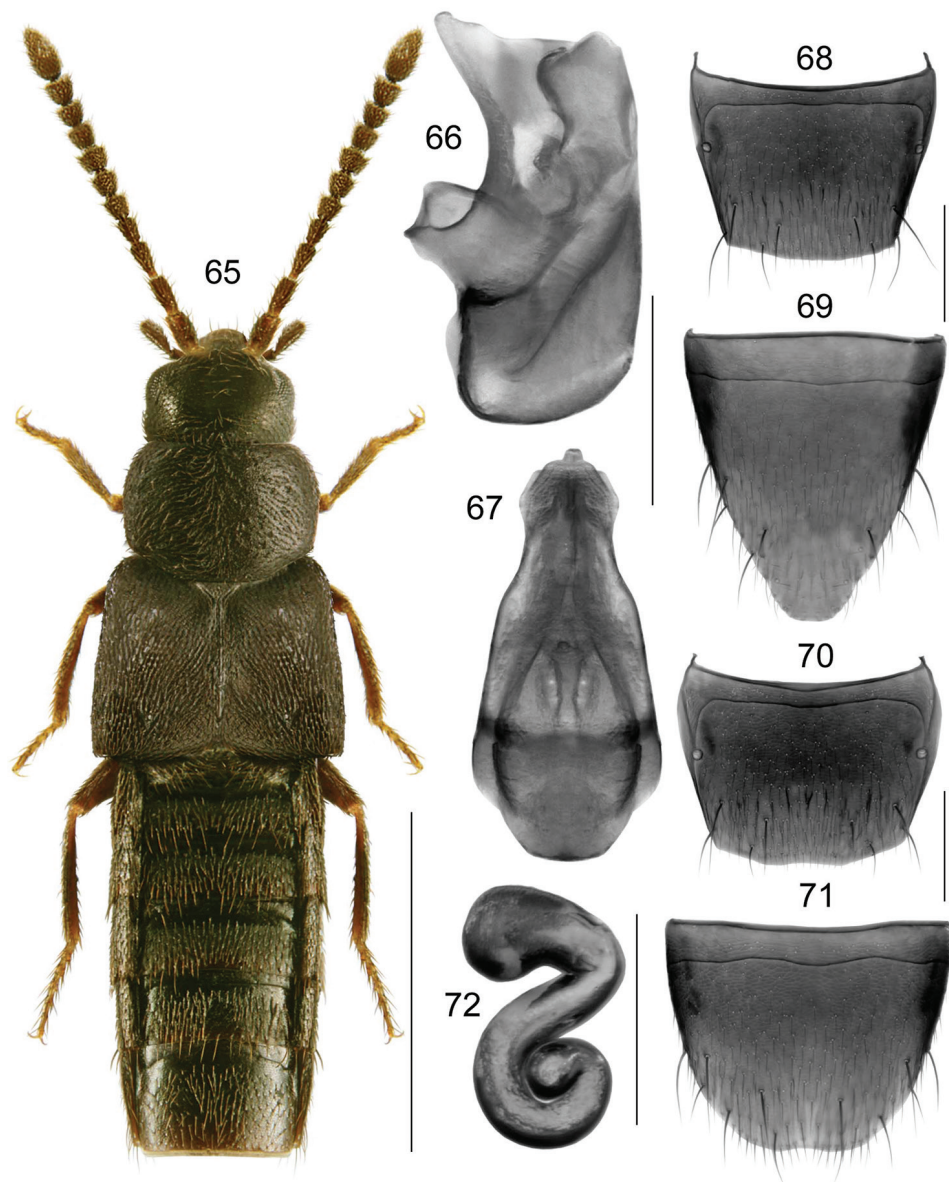
**Figures 49–56.** *Dochmonota langori* Klimaszewski & Larson, sp. n.: **49** habitus in dorsal view **50** median lobe of aedeagus in lateral view, and **51** in dorsal view **52** male tergite VIII **53** male sternite VIII **54** female tergite VIII **55** female sternite VIII **56** spermatheca. Scale bar for habitus = 1 mm, and the remaining scale bars = 0.2 mm.





### *Dochmonota simulans*

**Figures 57–64.** *Dochmonota simulans* Klimaszewski & Larson, sp. n.: **57** habitus in dorsal view **58** median lobe of aedeagus in lateral view, and **59** in dorsal view **60** male tergite VIII **61** male sternite VIII **62** female tergite VIII **63** female sternite VIII **64** spermatheca. Scale bar for habitus = 1 mm, and the remaining scale bars = 0.2 mm.



### *Dochmonota websteri*

**Figures 65–72.** *Dochmonota websteri* Klimaszewski & Larson, sp. n.: **65** habitus in dorsal view **66** median lobe of aedeagus in lateral view, and **67** in dorsal view **68** male tergite VIII **69** male sternite VIII **70** female tergite VIII **71** female sternite VIII **72** spermatheca. Scale bar for habitus = 1 mm, and the remaining scale bars = 0.2 mm.

changed the beetle map of New Brunswick by endless discovery of new species. In memory of our “grappa discussions” and fruitful collaboration.

**Diagnosis.** Body moderately narrow, subparallel (Fig. 65), length 3.0-3.4 mm, uniformly black with tarsi reddish-brown; antenna with articles I-IV elongate, and V-X slightly transverse (Fig. 65); head, pronotum and elytra finely and densely punctate, punctures small; pubescence dense; integument moderately glossy, more so on abdomen, with meshed microsculpture; head distinctly narrower than pronotum (Fig. 65); pronotum strongly transverse, distinctly narrower than elytra at base, with pubescence directed obliquely laterad from median line of disc and pubescence in basal part of median line directed posteriad and laterad, base of disc without impression (Fig. 65); elytra at suture as long as or slightly longer than pronotum (Fig. 65); abdomen subparallel. MALE. Tergite VIII truncate apically and without apical teeth (Fig. 68); sternite VIII elongate, tapering posteriorly and rounded at apex (Fig. 69). Median lobe of aedeagus with large suboval bulbus and small broad triangular tubus in dorsal view, lateral sides of bulbus gradually narrowed apically (Fig. 67), in lateral view tubus arcuate basally and straight apically and crista apicalis of bulbus small (Fig. 66); internal sac structures as illustrated (Figs 66, 67). FEMALE. Tergite VIII truncate apically (Fig. 70); sternite VIII gradually narrowed apically and truncate, apical margin slightly emarginate (Fig. 71); spermatheca with spherical capsule bearing scarcely seen apical invagination, stem broad, and coiled (Fig. 72).

**Distribution.** Adults are known only from SK.

**Natural history.** Most adults of this species were collected from shorelines of eutrophic lakes in June, August and September, and one male was captured in organic mud/sedges, and rushes near water.

**Comments.** A male from Bigstick Lake had slightly distorted median lobe of aedeagus and was excluded from the type series.

*Earota dentata* (Bernhauer)

(for details and illustrations, see Klimaszewski et al. 2011)

**Distribution.**

Origin	Nearctic
Distribution	Canada: AB, BC, MB, NB, NL, NS, ON, QC, <b>SK</b> . USA: AK, AL, AZ, CO, IA, IL, NC, NJ, NM, OR, VA, WA
New provincial records	CANADA, <b>Saskatchewan</b> : Larson Ranch, Hwy 21, 16 km S Maple Creek, 16-VI-2011, D. Larson (DLC) 2 females.
References	Gusarov 2002, Klimaszewski and Winchester 2002, Klimaszewski et al. 2005, 2007b, 2008a, Webster et al. 2009, Majka and Klimaszewski 2008, 2010, Klimaszewski et al. 2011, Bousquet et al. 2013

**Natural history.** The SK females were captured in June from unspecified habitat. In NL, adults were captured from June to September in the litter of a riparian forest

and along the shore of a pond (Klimaszewski et al. 2011). Elsewhere, adults were captured in leaf litter near the margin of a brook in a red maple swamp, in mixed forests of different ages, in river debris, gopher burrows, and under decaying seaweed on a sea-shore (Klimaszewski and Winchester 2002, Klimaszewski et al. 2005, Majka and Klimaszewski 2008, Webster et al. 2009). Adult activity occurs from April to September.

*Mocyta breviscula* (Mäklin)

(for details and illustrations, see Klimaszewski et al. 2015a, b)

Distribution.

Origin	Nearctic
Distribution	Canada: AB, BC, MB, NB, NF, NL, NS, NT, <b>SK</b> , YT. USA: AK, OR
New provincial records	CANADA, <b>Saskatchewan</b> : Larson Ranch, 16 km S Maple Creek: 8-IV-2010, sifting aspen choke-cherry leaf litter, D. Larson (DLC) 2 females; 18-VI-2010, D. Larson (DLC, LFC) 3 males, 2 females; 27-IV-2013, sifting willow, aspen, hawthorn litter near creek, D. Larson (DLC, LFC) 2 males, 6 females; 3-V-2013, aspen litter, D. Larson (DLC, LFC) 2 males, 2 females; 6-V-2013, sifting willow litter, D. Larson (DLC) 2 females; 10-V-2014, under fresh-cut aspen log rings, D. Larson (DLC) 2 males; 13-V-2014, under fresh-cut aspen log rings, D. Larson (DLC) 1 female; 14-V-2014, under fresh-cut aspen log rings, D. Larson (DLC) 3 females; 20-V-2008, D. Larson (DLC) 1 female; 5-6-VI-2013, maple litter, D. Larson (DLC) 3 females; 8-VI-2014, under fresh-cut aspen log rings, D. Larson (DLC) 1 male; 21-VI-2012, decaying bracket fungus on aspen, D. Larson (DLC) 3 females; 10-VIII-2012, aspen/maple litter, D. Larson (DLC) 2 males, 1 female; 8-IX-2012, compost, D. Larson (DLC) 3 females; 28-IX-2010, D. Larson (DLC) 1 male, 3 females; 20-X-2014, sifting willow leaf litter, D. Larson (DLC) 2 males, 7 females; Belanger Creek, Frenchman Valley, 18-X-2014, D. Larson (DLC) 5 males, 4 females; Cypress Hills Park, Center Block: Sucker Creek, 15-V-2013, sifting aspen litter, D. Larson (DLC) 1 male; 16-VI-2011, sifting wrack, D. Larson (DLC) 1 male; 18-VI-2012, sifting aspen litter, D. Larson (DLC) 3 females; Sucker Creek, 23-VI-2014, aspen woodland bracket/gilled fungi, D. Larson (DLC) 1 female; Saskatoon, 27-VII-1972, D. Larson (DLC) 1 female; 7-IX-2014, spruce-aspen, D. Larson (DLC) 1 female; Saskatoon, 7-X-1976, D. Larson (DLC) 1 female.
References	Lohse et al. 1990, Klimaszewski et al. 2005, 2007b, 2008a, b, 2015a, b, Bousquet et al. 2013

**Natural history.** The SK specimens were captured by sifting aspen litter, maple litter, aspen choke-cherry leaf litter, willow and aspen litter, hawthorn litter near creek, willow leaf litter, under fresh-cut aspen log rings, from decaying woodland bracket/gilled fungi, and from compost, in May through October. In Newfoundland, adults were frequently caught in pitfall traps in various forest types (birch, spruce-lichen, spruce-poplar, fir), in vegetation on coastal sand dunes, on shrubby limestone barrens and in disturbed fields amongst grass and weeds (Klimaszewski et al. 2011). The activity period is June to September. Adults were captured with pitfall traps from June to August in moss and leaf litter in red spruce forest in New Brunswick and yellow birch/balsam fir forests in southern Quebec (Klimaszewski et al. 2005b, 2007b, 2015b).



***Mocyta sphagnorum* Klimaszewski & Webster**

(for details and illustrations, see Klimaszewski et al. 2015b)

**Distribution.**

Origin	Nearctic
Distribution	Canada: NB, NF, ON, QC, <b>SK</b> .
New provincial records	CANADA, <b>Saskatchewan</b> : Larson Ranch, Hwy 21, 16 km S Maple Creek: 27-IV-2013, sifting willow-aspen, hawthorn litter near creek, D. Larson (DLC) 1 male, 1 female; 20-V-2008, D. Larson (DLC) 1 female; 25-V-2013, D. Larson (DLC) 1 female; 12-VII-2012, wet grass and weed clippings, D. Larson (DLC) 2 females; 16-VIII-2012, new brome/alfalfa hay, D. Larson (DLC) 1 female; 8-IX-2012, compost, D. Larson (DLC) 1 female; Gull Lake, N town of Gull Lake, 17-V-2014, D. Larson (DLC) 1 female; Cypress Hills Park, Center Block: Highland Trail, 20-V-2013, moist spruce litter near stream, D. Larson (DLC) 2 females; 7-IX-2014, spruce-aspen, D. Larson (DLC) 1 male; 13-IX-2012, sifting spruce litter, D. Larson (DLC) 1 female; Loch Lomond, 21-IX-2011, spruce-aspen litter, D. Larson (DLC) 1 female; Lodgepole Trail, 24-IX-2014, decaying mushrooms, D. Larson (DLC) 1 female.
References	Klimaszewski et al. 2015b

**Natural history.** In SK, specimens were captured from May through September from willow-aspen litter, hawthorn litter near creek, wet grass and weed clippings, moist spruce litter near stream, spruce litter, spruce-aspen litter, and in decaying mushrooms. In NB, adults were found in sphagnum moss and litter in calcareous eastern white cedar fens and in a black spruce forest (Klimaszewski et al. 2015b). One individual was collected from mouldy conifer duff at the base of a large pine in a mixed forest (Klimaszewski et al. 2015b). Adults were found in April and May in New Brunswick, and June to August elsewhere. This species often seems to be associated with moist sphagnum moss (Klimaszewski et al. 2015b).

**Comments.** Males of this species can be mixed up with those of *M. breviscula* and positive identification may only be possible with female association as *Mocyta* are definitively identified by the shape of the spermatheca.

***Nehemitropia lividipennis* (Mannerheim)**

(for details and illustrations, see Klimaszewski et al. 2007a, 2011)

**Distribution.**

Origin	Palearctic, adventive in Canada
Distribution	Canada: NB, NL, NS, ON, PE, QC, <b>SK</b> . USA: CA, LA, MA, MN, NE, NM, NY, PA, VT, TX
New provincial records	CANADA, <b>Saskatchewan</b> : Saskatoon, 26-IX-1976, D. Larson (DLC) 1 male, 1 female.
References	Moore and Legner 1975, Klimaszewski et al. 2007a, Majka and Klimaszewski 2010, Klimaszewski et al. 2011, Bousquet et al. 2013

**Natural history.** The SK specimens were captured from an unspecified habitat in September. In NL, one specimen was collected in October from an unspecified habitat (Klimaszewski et al. 2011). Elsewhere in North America, adults were captured in open fields and pastures, in organic debris including dead grass, in caribou, horse and cow dung, in open marsh, maple/beech forest, the edge of an oak forest, and in the nest of *Microtus pennsylvanicus* (Ord) (Klimaszewski et al. 2007a, 2011).

*Philbygra falcifera* Lohse

(for details and illustrations, see Lohse et al. 1990)

**Distribution.**

Origin	Nearctic
Distribution	Canada: MB, <b>SK</b>
New provincial records	CANADA, <b>Saskatchewan</b> : Cypress Hills Park, Highland Trail, 10-VI-2013, treading quaking moss, <i>Typha</i> , <i>Equisetum</i> , D. Larson (DLC) 1 male.
References	Lohse et al. 1990, Bousquet et al. 2013

**Natural history.** The SK male was captured in June by treading quaking moss, *Typha*, and *Equisetum*. The MB specimens were captured in June and August, from unspecified habitat (Lohse et al. 1990).

*Philbygra subpolaris* (Fenyès)

(for diagnosis and illustrations, see Fenyès 1909, Klimaszewski et al. 2016)

**Distribution.**

Origin	Nearctic
Distribution	Canada: AB, <b>SK</b> . USA: AZ
New provincial records	CANADA, <b>Saskatchewan</b> : Larson Ranch, Hwy 21, 16 km S Maple Creek, 9-V-2013, sifting willow/grass litter, D. Larson (DLC) 1 male; Cypress Lake Park, 16-VI-2011, sifting wrack, D. Larson (DLC) 1 female.
Reference	Fenyès 1909, Klimaszewski et al. 2016

**Natural history.** In SK, one male was captured in May by sifting willow/grass litter, and one female was sifted from wrack on a lakeshore in June. In AB, adults were caught in window traps attached to aspen snags in a boreal aspen stand harvested 2 years previously, and in pitfall traps deployed in canola fields. Adults were collected in July (Klimaszewski et al. 2016a).



***Schistoglossa blatchleyi* (Bernhauer & Scheerpeltz)**

(for diagnosis and illustrations, see Klimaszewski et al. 2009a)

**Distribution.**

Origin	Nearctic
Distribution	Canada: MB, NB, NT, ON, QC, <b>SK</b> , YT; USA: AK, IN
New provincial records	CANADA, <b>Saskatchewan</b> : Cypress Hills Park, Center Block, Highland Trail, 10-VI-2013, treading quaking moss, <i>Typha</i> and <i>Equisetum</i> in June, D. Larson (DLC) 1 male.
Reference	Blatchley 1910, Bernhauer and Scheerpeltz 1926, Klimaszewski et al. 2009a, Bousquet et al. 2013

**Natural history.** In SK, one male was captured in June by treading quaking moss, *Typha* and *Equisetum*.

***Strigota ambigua* (Erichson)**

(for diagnosis and illustrations, see Klimaszewski et al. 2011)

**Distribution.**

Origin	Nearctic
Distribution	Canada: LB, NF, NS, ON, PE, QC, <b>SK</b> , YT. USA: CA, CO, CT, IA, KS, MO, NC, NJ, NM, NY, TX
New provincial records	CANADA, <b>Saskatchewan</b> : Great Sand Hills, 50.9°N, 109.11°W, Bowie Ranch, 8-VII-2013, Larson (DLC) 1 female; Larson Ranch, 16 km S Maple Creek, 9-VII-2014, D. Larson (DLC) 1 female; 12 km NE Gull Lake, <i>Scirpus</i> wrack, saline pond, 25-V-2011, D. Larson (DLC) 1 male; Tompkins, Sidewood Rad, 15-IX-2014, D. Larson (DLC) 1 male.
References	Gusarov 2003, Majka et al. 2008, Majka and Klimaszewski 2010, Brunke et al. 2012, Bousquet et al. 2013, Webster et al. 2016b

**Natural history.** In SK, one specimen was found in *Scirpus* wrack on the shore of saline pond, and three others were found in unspecified habitats in May, July and September. In NB, one specimen was found under a cobblestone on moist sand on a lake margin (Webster et al. 2016b). This widespread species occurs in open habitats, including dunes, beaches, limestone barrens, soybean fields, old fields, open gaps in spruce forest, riverbanks and groundhog burrows (Brunke et al. 2012).

***Strigota obscurata* Klimaszewski & Brunke**

(for diagnosis and illustrations, see Brunke et al. 2012)

**Distribution.**

Origin	Nearctic
Distribution	Canada: NB, ON, <b>SK</b>
New provincial records	CANADA, <b>Saskatchewan</b> : Cypress Lake, E dam, wind-drift, 9-V-2012, D. Larson (DLC) 1 female.
References	Brunke et al. 2012, Bousquet et al. 2013, Webster et al. 2016b

**Natural history.** In SK, one female was captured in May from wind-drift on the lake. In NB, *S. obscurata* was found in flood debris on a river margin, on soil at the base of grass in a residential lawn, and captured in a Lindgren funnel trap in an old jack pine forest (Webster et al. 2016b). Brunke et al. (2012) reported this as the most common species in southern Ontario soybean fields, often occurring in open habitats with *S. ambigua*.

**Tribe AUTALIINI Thomson**

***Autalia rivularis* (Gravenhorst)**

(for diagnosis and illustrations, see Klimaszewski et al. 2011)

**Distribution.**

Origin	Palearctic, adventive in Canada
Distribution	Canada: AB, BC, LB, NB, NF, NS, ON, QC, <b>SK</b> . USA: CA, MI, MN, NH, NY, OR
New provincial records	CANADA, <b>Saskatchewan</b> : Cypress Hills Park, C Block, Sucker Creek, 23-VIII-2012, moose dung, D. Larson (DLC) 2 females; Larson Ranch, Hwy 21, 16 km S Maple Creek: 21-VI-2012, under bark of dead aspen, D. Larson (DLC) 1 female; 1-IX-2012, compost, D. Larson (DLC) 1 male.
References	Hoebeke 1988, Klimaszewski et al. 2005, Majka and Klimaszewski 2010, Klimaszewski et al. 2011, Bousquet et al. 2013

**Natural history.** The SK specimens were found in moose dung, under bark of dead aspen, and in compost in June, August and September. In NL, adults were collected in July using flight intercept traps in mixedwood forest and carrion traps on coastal shrubby barrens (Klimaszewski et al. 2011). Elsewhere, adults were collected in July and August from red spruce dominated regenerating forest in NB (Klimaszewski et al. 2005). In Europe, this species is very common in cow dung and rotting organic debris.

**Tribe FALAGRINI Mulsant & Rey*****Falagria caesa* Erichson**

(for diagnosis and illustrations, see Klimaszewski et al. 2013b, Hoebeke 1985 [as *F. sulcata* (Paykull)])

**Distribution.**

Origin	Palearctic, adventive in Canada
Distribution	Canada: AB, BC, NB, ON, QC, <b>SK</b> . USA: IL, MA, MD, NJ, NY, UT, VA
New provincial records	CANADA, <b>Saskatchewan</b> : Larson Ranch, Hwy 21, 16 km S Maple Creek: 1-IX-2012, compost, D. Larson (DLC, LFC) 1 female, 1 sex undetermined; 22-27-VI-2005, D. Larson (DLC) 1 sex undetermined; 17-IX-2012, compost, D. Larson (LFC) 1 male; Cypress Hills Lake: E dam, wind-drift, 9-V-2012, D. Larson (DLC) 1 sex undetermined; E end, sifting wrack, 31-VII-2012, D. Larson (DLC, LFC) 1 female, 5 sex undetermined; Crane Lake, NE Piapot., beach wrack, 28-VIII-2011, D. Larson (DLC, LFC) 1 male, 3 sex undetermined; Bigstick Lake, 16 km E Golden Prairie, 21-IX-2011, D. Larson (DLC) 1 sex undetermined; Saskatoon, 26-IX-1976, compost, D. Larson (DLC) 1 sex undetermined.
References	Hoebeke 1985, Klimaszewski et al. 2010, Webster et al. 2012, Klimaszewski et al. 2013b, Bousquet et al. 2013

**Natural history.** The SK specimens were found in compost, wind drift, and beach wrack, from June through September. In North America, this species is associated with decaying plant material such as compost, mouldy corncobs, cornhusks, weeds, haystacks and rotting fungi (Hoebeke 1985, Webster et al. 2012, Klimaszewski et al. 2013b).

**Comments.** This species is well established in northeastern and western North America (Hoebeke 1985). It was listed in North America as *F. sulcata* (Hoebeke 1985, Campbell and Davies 1991, Klimaszewski et al. 2010, Webster et al. 2012). The oldest record of this adventive species in SK is that of 1976.

***Myrmecocephalus arizonicus* (Casey)**

(for diagnosis and illustrations, see Hoebeke 1985)

**Distribution.**

Origin	Nearctic
Distribution	Canada: AB, BC, <b>SK</b> . USA: AZ, CO, ID, NM, UT
New provincial records	CANADA, <b>Saskatchewan</b> : Larson Ranch, Hwy 21, 16 km S Maple Creek: 22-V-2008, D. Larson (DLC) 1 sex undetermined; 5-6-VI-2013, D. Larson (DLC) 1 sex undetermined; 15-30-VI-2006, D. Larson (DLC) 1 male; 18-VI-2001, D. Larson (LFC) 1 male; Cypress Hills, Center Block: Hidden Valley, 1-VI-1999, D. Larson (DLC) 1 male, 1 sex undetermined; 4-VI-2006, pine clearcut, D. Larson (DLC, LFC) 1 male, 1 female; Ski Lodge, 25-VI-2004, recently dead white spruce, D. Larson (DLC, LFC) 1 female, 2 sex undetermined; fire guard, 29-IX-2013, sifting moss and pine litter, D. Larson (DLC) 1 sex undetermined.
References	Hoebeke 1985, Bousquet et al. 2013

**Natural history.** The SK specimens were found in pine clearcut, on recently dead white spruce, and in moss and pine litter in May, June and September. Elsewhere, specimens were collected from under bark of logs, from leaf litter, flood debris and wet moss, from soil along a stream, from fungus (*Fomitopsis pinicola*, *Fomes robineae*), and from a squirrel midden (Hoebeke 1985).

## HOMALOTINI Heer

### *Agaricochara pulchra* Klimaszewski & Larson, sp. n.

<http://zoobank.org/9BD29B8C-4286-4D39-A0AB-0B4DC688AE8E>

Figs 73–79

**Holotype (male).** Canada, Saskatchewan, Larson Ranch, Hwy 21, 16 km S Maple Creek, 12-IX-2013, mouldy aspen log, D. Larson (LFC). **Paratypes.** Canada, Saskatchewan, Larson Ranch, Hwy 21, 16 km S Maple Creek, 12-IX-2013, mouldy aspen log, D. Larson (DLC, LFC) 1 male, 2 females, 11 sex undetermined; Cypress Hills Pk., Center Block, Hidden Valley, 1-VI-1999, D. Larson (DLC) 1 female; Cypress Hills Pk., Center Block, Sucker Cr., 18-VII-2012, sifting aspen litter, D. Larson (DLC) 1 female.

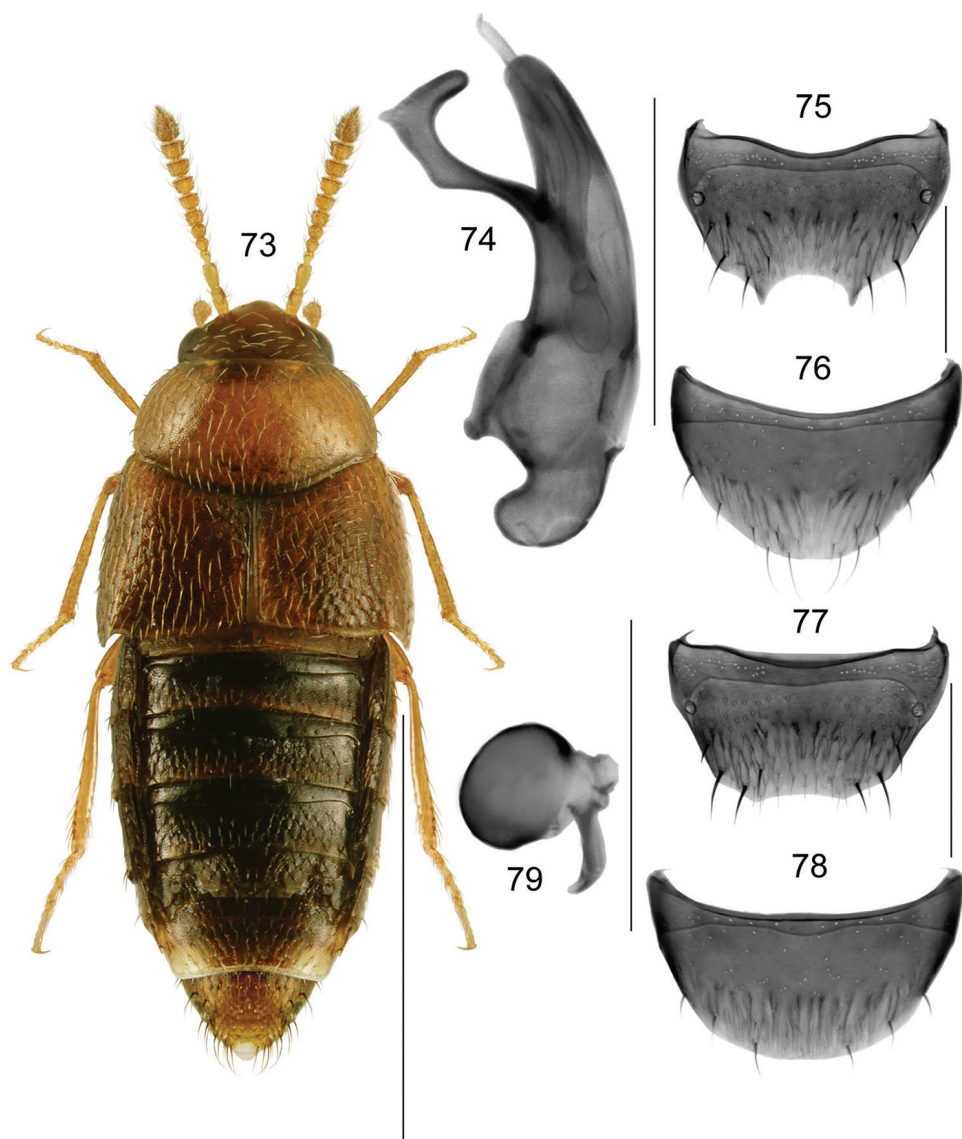
**Etymology.** A Latin feminine adjective *pulchra*, meaning beautiful, in reference to the body shape and beautiful colour of this species.

**Diagnosis.** Body minute, narrowly oval, moderately convex, length 1.4–1.6 mm (Fig. 73); head and abdomen (except for apex) piceous, pronotum and elytra reddish-yellow, elytra with darker scuteller and posterior angle sections, legs and antennae except for the last article yellow (Fig. 73); punctation on forebody fine and sparse, those on elytra asperate; pubescence on pronotum directed posteriad (Fig. 73); abdomen tapering apically with scale-like sculpture (Fig. 73); antennae gradually broadening apically, articles V–X transverse (Fig. 73). MALE. Tergite VIII emarginate medially and with two lateral teeth (Fig. 75); sternite VIII rounded apically (Fig. 76); median lobe of aedeagus with subapical process angular subapically (Fig. 74). FEMALE. Tergite and sternite VIII shallowly concave apically (Fig. 77); sternite VIII transverse and broadly arcuate apically (Fig. 78); spermatheca small, capsule spherical (Fig. 79).

**Distribution.** Known only from SK. This constitutes new genus record for Canadian fauna.

**Natural history.** Adults were collected from mouldy aspen logs in September and by sifting aspen litter in July.

**Comments.** Seevers (1951) considered *Agaricochara* Kraatz as a subgenus of *Gyrophana* Mannerheim, but Ashe (1984) elevated it to the generic rank. We have followed Ashe (1984) in treating this taxon as a genus. There are two species of *Agaricochara* in Europe and six in North America (Seevers 1951). No member of either group



### *Agaricochara pulchra*

**Figures 73–79.** *Agaricochara pulchra* Klimaszewski & Larson, sp. n.: **73** habitus in dorsal view **74** median lobe of aedeagus in lateral view **75** male tergite VIII **76** male sternite VIII **77** female tergite VIII **78** female sternite VIII **79** spermatheca. Scale bar for habitus = 1 mm, and the remaining scale bars = 0.2 mm.

of species matches our new species from SK, which has very distinctively shaped tubus of the median lobe of the aedeagus with ventral process-like projection angularly bent subapically and directed dorsally (Fig. 74).

*Gyrophaena lobata* Casey

(for diagnosis and illustrations, see Seevers 1951, Klimaszewski et al. 2009b)

Distribution.

Origin	Nearctic
Distribution	Canada: NB, <b>SK</b> . USA: DC, IL, IN, KA, MI, NY, WA, WI
New provincial records	CANADA, <b>Saskatchewan</b> : Larson Ranch, Hwy 21, 16 km S Maple Creek, 29-VIII-2014, D. Larson (DLC) 1 male.
References	Casey 1906, Seevers 1951, Klimaszewski et al. 2009b, Bousquet et al. 2013

**Natural history.** The SK specimen was collected in August from unspecified habitat. In NB, adults were captured in gilled mushrooms in mixed and hardwood forests from July through September by sifting mushrooms and aspirating specimens (Klimaszewski et al. 2009b).

*Gyrophaena subnitens* Casey

(for diagnosis and illustrations, see Seevers 1951, Klimaszewski et al. 2009b)

Distribution.

Origin	Nearctic
Distribution	Canada: MB, ON, <b>SK</b> . USA: IL, KS, ME, MN, MO, NY, WI
New provincial records	CANADA, <b>Saskatchewan</b> : Cypress Hills Park, Block Fire, Sucker Creek, 23-VI-2014, aspen woodland bracket/gilled fungi, D. Larson (LFC) 1 male; Maple Creek, Hwy 21, 16 km S, 18-VII-2003, D. Larson (DLC) 1 male, 1 female.
References	Casey 1906, Seevers 1951, Klimaszewski et al. 2009b, Bousquet et al. 2013

**Natural history.** Two SK specimens were found in aspen woodland on bracket/gilled fungi, in June and July. In NB, specimens were collected by sifting in June from sun-exposed gilled mushrooms on stump in 8.5-year-old regenerating mixed forest and red oak (Klimaszewski et al. 2009b).



***Leptusa gatineauensis* Klimaszewski & Pelletier**

(for diagnosis and illustrations, see Klimaszewski et al. 2004)

**Distribution.**

Origin	Nearctic
Distribution	Canada: AB, BC, NB, NE, NS, ON, QC, <b>SK</b>
New provincial records	CANADA, <b>Saskatchewan</b> : Cypress Hills Park, Center Block, 1-VI-2004, Hooper & Larson (DLC) 1 male, 1 sex undetermined; Larson Ranch, Hwy 21, 16 km S Maple Creek: 27-IV-2013, sifting willow, aspen, hawthorn near creek, D. Larson (DLC, LFC) 1 male, 6 sex undetermined; 14-V-2014, under bark/in polypore fungus on aspen, D. Larson (DLC) 3 sex undetermined; 5-6-VI-2013, maple litter, D. Larson (DLC) 2 sex undetermined; 6-VI-2013, D. Larson (DLC) 1 sex undetermined; 8-VI-2007, under bark/in polypore fungus on aspen, D. Larson (DLC) 1 female, 1 sex undetermined; 21-VI-2012, under bark of dead aspen, D. Larson (DLC) 1 sex undetermined.
References	Klimaszewski et al. 2004, McLean et al. 2009a, b, Bousquet et al. 2013

**Natural history.** The SK specimens were collected from willow, aspen, and hawthorn litter near creek, under bark of dead aspen, in polypore fungus on aspen, in May and June. Elsewhere, two specimens were captured in May on *Polyporus betulinus*, one by general sweeping in deciduous forest, and one in June in red spruce/hemlock mature forest (Klimaszewski et al. 2004). A few specimens were collected by funnel trap in Stanley Park, Vancouver (McLean et al. 2009a, b).

**Tribe HYPOCYPHTINI Laporte**

***Cypha crotchii* (Horn)**

(for illustrations, see Klimaszewski et al. 2008b)

**Distribution.**

Origin	Nearctic
Distribution	Canada: AB, BC, <b>SK</b>
New provincial records	CANADA, <b>Saskatchewan</b> : Cypress Hills Park, Center Block, Lodgepole Trail, 24-IX-2014, decaying mushrooms, D. Larson (DLC) 1 male.
References	Klimaszewski et al. 2008b, Bousquet et al. 2013

**Natural history.** The SK male was found in September in decaying mushrooms.

*Cypha inexpectata* Klimaszewski & Godin

(for illustrations, see Klimaszewski et al. 2008b)

Distribution.

Origin	Nearctic
Distribution	Canada: ON, <b>SK</b> , YT
New provincial records	CANADA, <b>Saskatchewan</b> : Cypress Hills Park, Center Block: Lodgepole Trail, 24-IX-D. Larson (DLC) 1 female; Belanger Creek, 14-X-2014, mossy hummocks bordering marsh and spruce forest, D. Larson (DLC, LFC) 4 females; Belanger Creek, Frenchman Valley, 18-X-2014, mossy hummocks near creek, D. Larson (LFC) 1 male.
References	Klimaszewski et al. 2008b, Bousquet et al. 2013

**Natural history.** In SK, specimens were collected from mossy hummocks at the border between a marsh and spruce forest, and mossy hummocks near creek, in September and October.

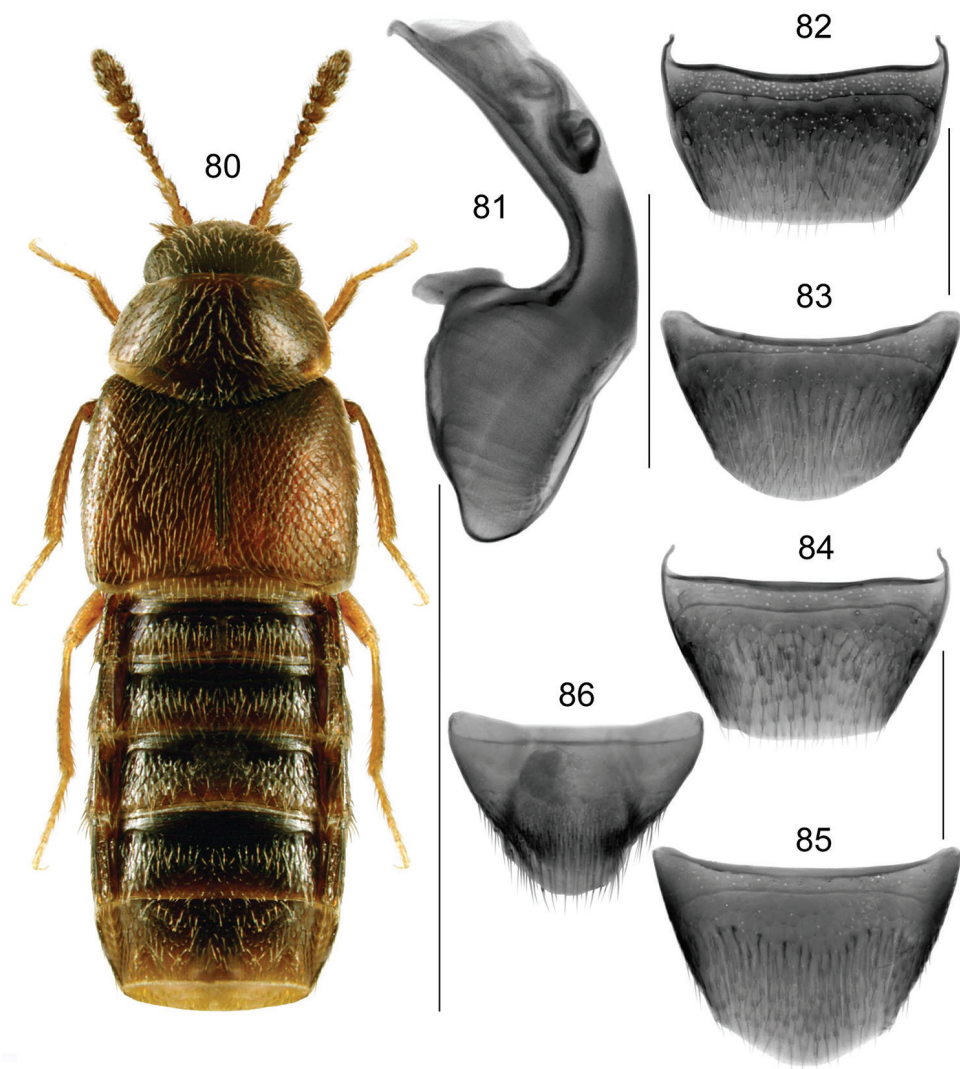
*Oligota inflata* (Mannerheim)

Figs 80–86

**Diagnosis.** Body length 1.4–1.5 mm, compact, subparallel, piceous to nearly black, with legs/tarsi, three basal antennal articles, maxillary palps, posterior edge of elytra, and tip of abdomen yellowish brown (Fig. 80); moderately glossy; integument with microsculpture mesh-like on head and pronotum, and coarse, scale-like on elytra and abdomen (Fig. 80); pubescence sparse and long; head transverse with pubescence directed anteriorly; eyes large, and protruding (Fig. 80); antennae with four apical articles forming loose club, articles VI–VII narrow and VIII–X moderately to strongly transverse (Fig. 80); pronotum strongly transverse, lateral margins strongly converging apically, pubescence directed obliquely laterad (Fig. 80); elytral margins broadly arcuate laterally with pubescence directed obliquely laterad (Fig. 80); abdomen gradually narrowed apically. MALE. Tergite VIII truncate apically (Fig. 82); sternite VIII with apical margin arcuate (Fig. 83); median lobe of aedeagus with tubus long, arcuate, and apex hooked ventrally in lateral view, bulbus moderately long with small and irregularly oval crista apicalis (Fig. 81). FEMALE. Tergite VIII truncate apically (Fig. 84); sternite VIII broadly rounded and slightly produced apically (Fig. 85); pygidium as illustrated (Fig. 86); spermatheca not found.

Distribution.

Origin	Palearctic, adventive in Canada
Distribution	Canada: <b>SK</b>
New North American, Canadian and provincial records	CANADA: <b>Saskatchewan</b> , Larson Ranch, Hwy 21, 16 km S Maple Creek: 14-V-2013 (DLC) 1 female; 22-27-VI-2005 (DLC) 1 female; 16-VIII-2012, new brome/alfalfa hay, D. Larson (DLC, LFC) 2 males, 5 females; 1-IX-2012, compost, D. Larson (DLC, LFC) 5 males, 9 females.
References	Mannerheim 1830, Williams 1978



### *Oligota inflata*

**Figures 80–86.** *Oligota inflata* (Mannerheim): **80** habitus in dorsal view **81** median lobe of aedeagus in lateral view **82** male tergite VIII **83** male sternite VIII **84** female tergite VIII **85** female sternite VIII **86** female pygidium. Scale bar for habitus = 1 mm, and the remaining scale bars = 0.2 mm.

**Natural history.** The SK specimens were found in compost and new brome/alfalfa hay. Collecting period: June, August and September

**Comments.** *Oligota inflata* is a Palaearctic species known from Europe, N. Africa, Congo, Egypt, and Brazil. It is reported here for the first time from North America.

Tribe LOMECHUSINI Fleming

*Zyras obliquus* (Casey)

(for illustrations, see Klimaszewski et al. 2011)

Distribution.

Origin	Nearctic
Distribution	Canada: AB, BC, MB, NB, NF, NS, ON, QC, <b>SK</b> . USA: MI, MO, NH, NY, OR
New provincial records	CANADA, <b>Saskatchewan</b> : Larson Ranch, 16 km S Maple Creek, 1-15-VI-2005, D. Larson (DLC) 1 sex undetermined; Cypress Hills Park, Center Block, 13-VI-2003, D. Larson (DLC, LFC) 2 sex undetermined
References	Casey 1893, Klimaszewski et al. 2005, Webster et al. 2009, Majka and Klimaszewski 2010, Klimaszewski et al. 2011, Bousquet et al. 2013

**Natural history.** The SK specimens were collected in June from unspecified habitat.

Tribe OXYPODINI C.G. Thomson

*Ganthusa eva* Fenyés

(for illustrations, see Klimaszewski et al. 2014)

Distribution.

Origin	Nearctic
Distribution	Canada: AB, BC, <b>SK</b> , YT. USA: CA
New provincial records	CANADA, <b>Saskatchewan</b> : Cypress Hills Park, Center Block, Sucker Creek, 20-V-2013, lodgepole pine litter, D. Larson (DLC) 1 male
References	Fenyés 1909, Klimaszewski and Winchester 2002, Majka and Klimaszewski 2008, Bousquet et al. 2013, Klimaszewski et al. 2014

**Natural history.** In SK, one specimen was collected in May from lodgepole pine litter. Elsewhere, adults were captured in clear-cut Sitka spruce forest on Vancouver Island and in moss and gravel at the edge of small pools at other localities in the interior of British Columbia (Klimaszewski and Winchester 2002). Additional specimens were found in British Columbia in a 1-year-old harvested Douglas-fir stand. In west-central Alberta, adults were collected in pitfall traps deployed in Upper Cordilleran coniferous forests, including subxeric lodgepole pine forests, mesic white spruce and lodgepole pine stands and spruce-dominated subhygric and hygric forests, but not in deciduous-dominated forest or in grassy or shrubby meadows (Klimaszewski et al. 2014). In Alberta, adults also emerged from lodgepole pine trees infested by bark beetles (Klimaszewski et al. 2014). In the Yukon Territory, adults were found in a squirrel midden in spring, probably overwintering, and in a coniferous woodchip pile (Klimaszewski et al. 2014).

***Hylota ochracea* Casey**

(for illustrations, see Klimaszewski et al. 2006)

**Distribution.**

Origin	Nearctic
Distribution	Canada: NB, NS, NT, ON, QC, <b>SK</b> . USA: NY
New provincial records	CANADA, <b>Saskatchewan</b> , Larson Ranch, Hwy 21, 16 km S Maple Creek: 25-VI-2008, carrion trap, D. Larson (DLC) 1 female; 4-VIII-1998, D. Larson (DLC) 1 female; 27-VIII-2012, pigeon coop, D. Larson (DLC) 1 male
References	Casey 1906, Klimaszewski et al. 2006, Majka et al. 2006, Webster et al. 2009, Bousquet et al. 2013, Webster et al. 2016b

**Natural history.** In SK, one specimen was collected from pigeon coop, one from carrion trap, and one from unspecified habitat. In NB, *Hylota ochracea* was a common inhabitant of barred owl nests (Webster et al. 2009). Barred owl nests were in tree holes (usually in large trees) and in artificial nest boxes (Webster et al. 2009). Adults of *H. ochracea* occurred in the nest contents, which usually consisted of rich decaying organic material with bones, fur, owl pellets, portions of dead prey items (mice, squirrels, small birds), and often the contents had a strong urine smell. This species was also found in the nest contents of the great horned owl. Majka et al. (2006) reported this species from the nests of the boreal owl, *Aegolius funereus richardsoni* (Bonaparte) and northern saw-whet owl, *Aegolius acadicus* (Gmelin) in Nova Scotia. Interestingly, *H. ochracea* was also common among decaying vegetables inside a plastic compost bin, which in some respects mimics the conditions found within a tree hole occupied by an owl (Webster et al. 2009). Only one adult of *H. ochracea* has been captured in New Brunswick in a habitat other than a tree hole or other enclosed situation; in drift material along a river margin (Webster et al. 2009). Adults were collected in May, June, August and September.

***Oxypoda demissa* Casey**

(for illustrations, see Klimaszewski et al. 2006, 2011)

**Distribution.**

Origin	Nearctic
Distribution	Canada: LB, NB, NF, NS, ON, QC, <b>SK</b> , YT
New provincial records	CANADA, <b>Saskatchewan</b> , Larson Ranch, Hwy 21, 16 km S Maple Creek: Apr., 27-IV-2013, sifting willow, aspen, hawthorn litter near creek, D. Larson (DLC) 1 male, 1 female; 21-VI-2012, under bark of dead aspen, D. Larson (DLC) 1 female; 20-X-2014, sifting willow leaf litter, D. Larson (DLC) 1 female.
References	Casey 1911, Klimaszewski et al. 2006, Webster et al. 2009, Klimaszewski et al. 2011, Bousquet et al. 2013

**Natural history.** In SK, specimens were captured in willow, aspen, and hawthorn litter near creek, and under bark. In New Brunswick, adults were captured in moist leaf litter on the margin of a vernal pond in a mixed forest, among leaves and sedges on pond margin, in moist grass litter and sphagnum in *Carex* marsh, among sedges along margin of small spring-fed brook in a mature hardwood forest and among leaf litter and grass on hummocks in a wet alder (*Alnus* sp.) swamp (Webster et al. 2009). In Nova Scotia, this species was reported from litter of *Alnus* clumps (Klimaszewski et al. 2006). A number of adults were collected with a net during late afternoon (15:00 to 18:00 h) flights (Webster et al. 2009). Adults were captured from April to July, and in October. Collection method: sifting leaf litter, some collected in flight with net during evening.

***Oxypoda domestica* Klimaszewski & Larson, sp. n.**

<http://zoobank.org/028AB4CE-90D8-4A0F-A833-E5E75466FEFD>

Figs 87–91

**Holotype (male).** Canada, Saskatchewan, Larson Ranch, Hwy 21, 16 km S Maple Creek, 22-IV-2012, D. Larson (LFC). **Paratype.** Canada, Saskatchewan, Larson Ranch, Hwy 21, 16 km S Maple Creek, 1-IV-2012, D. Larson (CNC) 1 male.

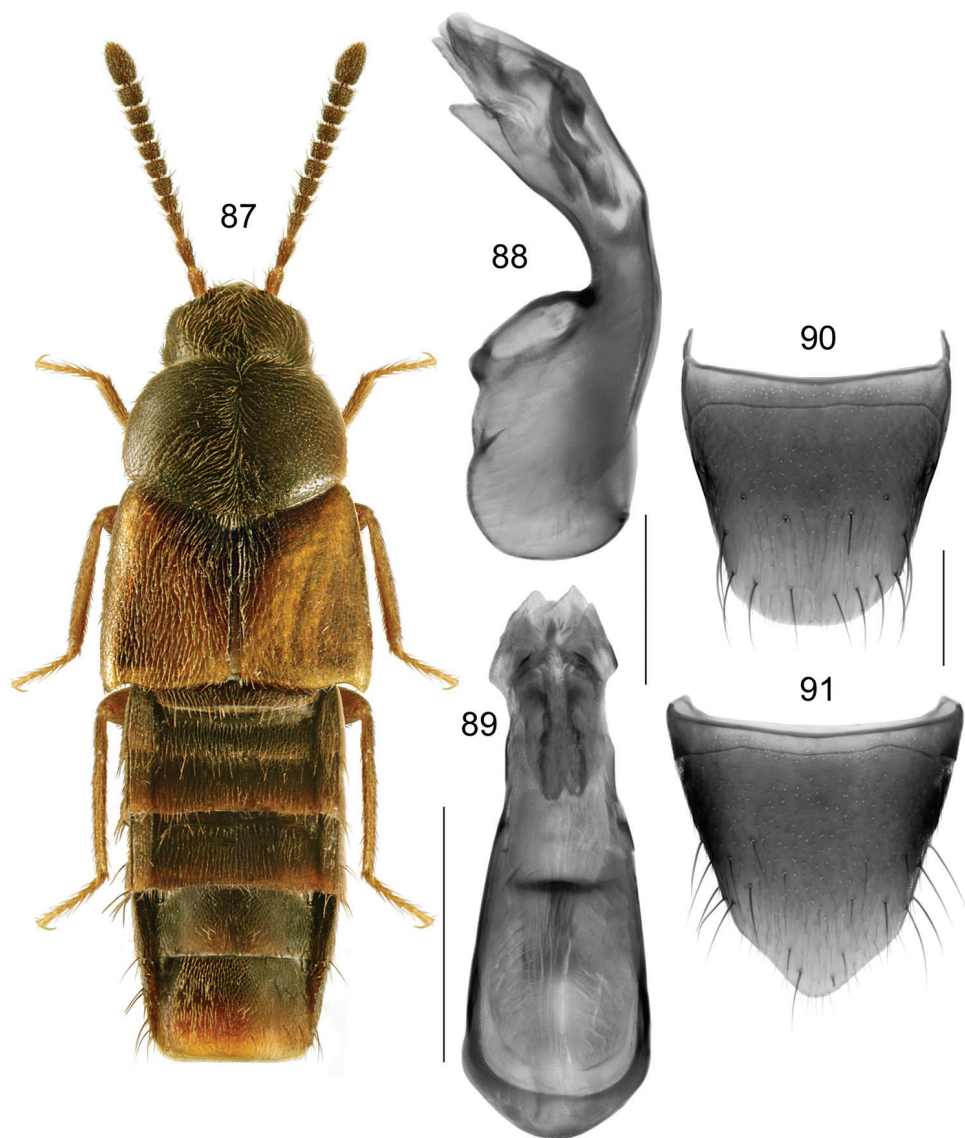
**Etymology.** The name of this species is derived from Latin feminine adjective *domestica*-, meaning domestic, in reference to the capture of the type specimens in the vicinity of the farmstead.

**Diagnosis.** Body length 3.4–3.6 mm, narrowly subparallel, broadest at posterior elytra, abdomen subparallel (Fig. 87); piceous with legs, basal antennal article, and two narrow oblique sections of elytra yellowish-brown (the extent of this section is variable) (Fig. 87); pubescence and punctuation of forebody dense; integument with isodiametric microsculpture. Head distinctly broader than half of pronotal width (Fig. 87); eyes large, longer than postocular area in dorsal view; antennae slender, antennomeres I–III strongly elongate, IV slightly elongate, V subquadrate, VI–X moderately transverse (Fig. 87); pronotum moderately convex, strongly transverse and about one fifth broader than long, broadest in basal third, pubescence directed antieriad apically along midline and obliquely posteriad from midline of disc elsewhere (Fig. 87); elytra slightly broader than pronotum and at suture about as long as pronotum, pubescence directed approximately straight posteriad (Fig. 87); abdomen subparallel and slightly tapering apically (Fig. 87). MALE. Tergite VIII transverse and broadly arcuate apically, antecostal suture approximately straight (Fig. 90); sternite VIII triangularly produced apically, antecostal suture slightly sinuate (Fig. 91); median lobe of aedeagus with narrowly oval bulbus and broad and subparallel tubus in dorsal view (Fig. 89); ventral margin of tubus slightly sinuate and with apex triangular in lateral view (Fig. 88); internal sac with elongate subapical structures (Figs 88, 89); bulbus with ovally elongate crista apicalis (Fig. 88). FEMALE. Unknown.

**Natural history.** The two males were captured in April in an unspecified habitat near a farmstead.

**Comments.** This species is very similar externally to *O. irrasa* Mäklin, from which it may be distinguished by the shape of tubus of median lobe of aedeagus with slightly





### *Oxypoda domestica*

**Figures 87–91.** *Oxypoda domestica* Klimaszewski & Larson, sp. n.: **87** habitus in dorsal view **88** median lobe of aedeagus in lateral view, and **89** in dorsal view **90** male tergite VIII **91** male sternite VIII. Scale bar for habitus = 1 mm, and the remaining scale bars = 0.2 mm.

sinuate ventral margin and triangular apical part in lateral view (Fig. 85). In *O. irrasa*, tubus of median lobe of aedeagus is angularly bent ventrally and apical part is evenly narrowly elongate. For illustrations of *O. irrasa*, see Klimaszewski et al. (2006).

*Oxypoda irrasa* Mäklin

(for illustrations, see Klimaszewski et al. 2006)

Distribution.

Origin	Nearctic
Distribution	Canada: AB, <b>SK</b> , YT. USA: AK, OR
New provincial records	CANADA, <b>Saskatchewan</b> , Larson Ranch, Hwy 21, 16 km S Maple Creek: Apr., 22-IV-2010, dam, D. Larson (DLC) 1 female; 28-IV-2011, on snowbank (DLC) 1 female; 15-VII-2014, decaying polypore mushrooms (DLC) 1 male; 7-X-2010, (LFC) 1 male; Cypress Hills Park, Center Block fire guard, 8-VIII-2013: gilled mushroom, D. Larson (DLC, LFC) 1 male, 5 females; 18-VIII-2014, old polypore fungus on dead lodgepole pine stump (DLC) 2 males, 1 female; Highland Trail, 2-X-2014, gilled mushroom (LFC) 1; 7-X-2014, spruce-aspen (DLC) 1 female; 10-X-2013, decaying mushrooms (DLC) 2 females.
References	Mäklin 1953, Lohse and Smetana 1985, Klimaszewski et al. 2006, 2008a, Bousquet et al. 2013

**Natural history.** In SK, specimens were captured on decaying and old polypore mushrooms in lodgepole pine and spruce-aspen habitats in March, July, August and September. One specimen was captured on snowbank in March. Elsewhere, adults were captured from May through August with most of the specimens taken in August (Klimaszewski et al. 2006). At the EMEND site (Alberta), adults of *Oxypoda irrasa* (n = 519), like those of *O. grandipennis*, were found in all cover types and all retention treatments but were most abundant in unharvested stands (Klimaszewski et al. 2006). *Oxypoda irrasa* was collected from May through August at EMEND (Alberta), however a few individuals were collected in May through July (Klimaszewski et al. 2006). This species was most abundant in August. Collecting methods: unbaited pitfall traps, sifting forest litter and processing it through Berlese funnels.

*Oxypoda manitobae* Casey

(for illustrations, see Klimaszewski et al. 2006)

Distribution.

Origin	Nearctic
Distribution	Canada: BC, MB, <b>SK</b> . USA: CO
New provincial records	CANADA, <b>Saskatchewan</b> , Larson Ranch, Hwy 21, 16 km S Maple Creek: 17-VI-2005, flood debris, D. Larson (DLC) 1 male; 15-30-VIII-2005, D. Larson (DLC) 1 female.
References	Casey 1911, Klimaszewski et al. 2006, Bousquet et al. 2013

**Natural history.** In SK, specimens were captured in June and August, one male was found in flood debris along the margin of a seasonal creek. Elsewhere, adults were captured in July and August in Arctic habitats or in the Rocky Mountains (853-2896 m) (Klimaszewski et al. 2006).

*Parocyusa fuliginosa* (Casey)

(for illustrations, see Klimaszewski et al. 2011, Brunke et al. 2012)

**Distribution.**

Origin	Nearctic
Distribution	Canada: LB, ON, <b>SK</b> . USA: MA, NC, PA
New provincial records	CANADA, <b>Saskatchewan</b> , Larson Ranch, Hwy 21, 16 km S Maple Creek: 30-VIII-2014, D. Larson (DLC) 1 female.
References	As <i>Tetralecopora</i> : Casey 1906, Moore and Legner 1975, Seevers 1978; as <i>Parocyusa</i> : Klimaszewski et al. 2011, Brunke et al. 2012, Bousquet et al. 2013

**Natural history.** In SK, one female was captured in August from unspecified habitat. In NF, adults were collected from rocks/gravel at a stream margin in early August (Klimaszewski et al. 2011).

**PLACUSINI Mulsant & Rey**

*Placusa incompleta* Sjöberg

(for diagnosis and illustrations, see Klimaszewski et al. 2001, 2011)

**Distribution.**

Origin	Palearctic, adventive in North America; possibly introduced separately in eastern Canada and western WA
Distribution	Canada: AB, BC, NB, NF, NS, ON, QC, <b>SK</b> . USA: WA; Palearctic: Europe
New provincial records	CANADA, <b>Saskatchewan</b> , Cypress Hills Park, Center Block: Lodgepole Trail, 18-IX-2012, pine/spruce litter near stream, D. Larson (DLC) 1 male; fire guard, 29-X-2013, under fresh-cut pine slabs, D. Larson (DLC) 1 male; Sucker Creek, 1-VI-2012, under bark of recently killed aspen, D. Larson (DLC) 1 female.
References	Klimaszewski et al. 2001, 2011, Bousquet et al. 2013, Klimaszewski et al. 2015a

**Natural history.** In SK, specimens were captured in pine/spruce litter near stream, under fresh-cut pine slabs, and under bark of recently killed aspen. In AB, adults were collected from dead or dying white spruce in aggregated retention patches surrounded by different levels of dispersed retention, using emergence traps and window traps (Klimaszewski et al. 2015a). Elsewhere, adults were found in various deciduous and coniferous forests, using a pit-light trap and ethanol-baited Lindgren funnel traps (Klimaszewski et al. 2001, 2011). The adults in northwestern Alberta were collected from June to September (Klimaszewski et al. 2015a).

*Placusa pseudosuecica* Klimaszewski

(for diagnosis and illustrations, see Klimaszewski et al. 2001)

**Distribution.**

Origin	Nearctic
Distribution	Canada: AB, BC, QC, ON, <b>SK</b>
New provincial records	CANADA, <b>Saskatchewan</b> , Cypress Hills Park, Center Block: fire guard, 29-X-2013, under fresh-cut pine slabs, D. Larson (DLC) 1 male, 1 female.
References	Klimaszewski et al. 2001, Bousquet et al. 2013, Klimaszewski et al. 2015a

**Natural history.** In SK, adults were captured under fresh-cut pine slabs. In AB, adults were collected from dead or dying white spruce in aggregated retention patches surrounded by different levels of dispersed retention, using window traps (Klimaszewski et al. 2015a). Elsewhere, adults were found in mature coniferous forests, using pit-light traps and ethanol-baited Lindgren funnel traps (Klimaszewski et al. 2001). The adults were collected from July to August.

*Placusa tachyporoides* (Waltl)

(for diagnosis and illustrations, see Klimaszewski et al. 2001)

**Distribution.**

Origin	Palearctic, adventive in North America
Distribution	Canada: AB, BC, NB, NS, QC, ON, <b>SK</b> . USA: CA, MA. Palearctic: Europe, the Mediterranean, Caucasus, Siberia, Japan
New provincial records	CANADA, <b>Saskatchewan</b> , Larson Ranch, Hwy 21, 16 km S Maple Creek, 30-V-2014, D. Larson (DLC) 1 male; Cypress Hills Park, Center Block, Sucker Creek, 1-4-VI-2012, under bark of recently killed aspen, D. Larson (DLC) 1 male.
References	Moore and Legner 1975, Klimaszewski et al. 2001, Bousquet et al. 2013, Klimaszewski et al. 2015a

**Natural history.** In SK, one male was captured under bark of recently killed aspen. In AB, adults were reared from white spruce logs in early and intermediate decay stages in white spruce dominated stands (Klimaszewski et al. 2015a). Elsewhere, adults were found in various deciduous and coniferous forests, using a flight intercept trap, ethanol-baited Lindgren funnel traps, pit-light traps, and pitfall traps (Klimaszewski et al. 2001).

***Placusa tacomae* Casey**

(for diagnosis and illustrations, see Klimaszewski et al. 2001)

**Distribution.**

Origin	Nearctic
Distribution	Canada: AB, BC, NB, NF, NS, NT, QC, ON, <b>SK</b> , YT. USA: AZ, MA, WA, WI
New provincial records	CANADA, <b>Saskatchewan</b> , Larson Ranch, Hwy 21, 16 km S Maple Creek, 12-IX-2013, mouldy aspen log, D. Larson (DLC) 1 female; Cypress Hills Park, Center Block, fire guard: 10-IX-2013, newly cut lodgepole pine log, D. Larson (DLC, LFC) 3 males, 3 females; 8-VIII-2013, <i>Ips</i> tunnels in lodgepole pine (DLC) 3 males, 1 female; 26-VIII-2014, under bark of lodgepole pine (DLC) 1 male.
References	Casey 1893, Hatch 1957, Moore and Legner 1975, Klimaszewski et al. 2001, Webster et al. 2009, Klimaszewski et al. 2011, Bousquet et al. 2013

**Natural history.** In SK, adults were captured from mouldy aspen log, newly cut lodgepole pine log, and in *Ips* tunnels in lodgepole pine. In eastern Canada, *P. tacomae* was collected in Lindgren funnel traps from *Pinus strobus*, *Pinus resinosa*, *Pinus banksiana*, *Picea glauca*, and *A. saccharum* stands (Klimaszewski et al. 2001). In western Canada, a single individual of this species was recovered from an alpha-pinene-baited Lindgren trap at 850 m elevation in the coastal montane forest near Campbell River on Vancouver Island (Klimaszewski et al. 2001). One specimen from Colorado was taken at an elevation of 9600 ft (1 ft = 0.3048 m) from *Picea engelmannii* forest (Klimaszewski et al. 2001). Western host tree forest: *Pinus monticola*, mature *T. heterophylla* – *A. amabilis*, *Pinus contorta* (Klimaszewski et al. 2001). Collection period: May-August and October in British Columbia. Scolytid host: *Dendroctonus ponderosae* (Alberta); *Ips pini* (British Columbia) (Klimaszewski et al. 2001).

***Placusa vaga* Casey**

(for diagnosis and illustrations, see Klimaszewski et al. 2001)

**Distribution.**

Origin	Nearctic
Distribution	Canada: BC, NB, NS, NT, QC, ON, <b>SK</b> , YT. USA: CA
New provincial records	CANADA, <b>Saskatchewan</b> , Cypress Hills Park, Lodgepole Trail, 18-IX-2012, under bark of lodgepole pine, D. Larson (DLC) 1 male.
References	Casey 1911, Moore and Legner 1975, Klimaszewski et al. 2001, Bousquet et al. 2013

**Natural history.** In SK, one specimen was captured under bark of lodgepole pine. In QC, specimens were captured in *Abies balsamea* stands: old-growth stands, undetermined age stands, in *Picea glauca* stand, and *Populus tremuloides* with *Picea glauca* stand (Klimaszewski et al. 2001). All Quebec specimens except one (Multi-Pher 7 pitfall trap) were captured in Lindgren funnel traps baited with alpha-pinene and 95% ethanol, and with 70% ethanol as preservative (Klimaszewski et al. 2001). Collecting period: June to August.

Tribe SILUSINI Fenyés

*Silusa californica* Bernhauer

(for diagnosis and illustrations, see Klimaszewski et al. 2003, 2011)

Distribution.

Origin	Nearctic
Distribution	Canada: AB, BC, NB, NF, NS, NT, QC, ON, <b>SK</b> , YT. USA: AK, CA, MN
New provincial records	CANADA, <b>Saskatchewan</b> , Cypress Hills Park, Center Block, fire guard: 8-VIII-2013, gilled mushrooms, D. Larson (DLC) 2 males, 1 female, 1 sex undetermined; 10-IX-2013, decaying mushrooms, D. Larson (DLC) 1 female; 10-VIII-2004, lodgepole pine, D. Larson (DLC) 1 sex undetermined; 18-VIII-2014, old polypore fungus on dead lodgepole pine stump, D. Larson (DLC) 2 males, 2 females, 3 sex undetermined; Cypress Hills Park, Lodgepole Trail, 21-VIII-2013, dry and decaying mushrooms, D. Larson (DLC) 2 males.
References	Bernhauer 1905, Klimaszewski and Winchester 2002, Klimaszewski et al. 2003, 2005, Majka and Klimaszewski 2010, Bousquet et al. 2013

**Natural history.** In SK, adults were captured from gilled mushrooms, dry and decaying mushrooms, old polypore fungus on dead lodgepole pine stump and on lodgepole pine. Elsewhere, adults of *S. californica* were collected from July through September by means of passive pitfall traps, Luminoc pit-light traps, Malaise traps and by sifting forest litter, wet moss on forest floor, marten dung on moss, and mushrooms (Klimaszewski et al. 2003). Most specimens were captured in the passive pitfall traps. Adults occurred in coniferous (red spruce, Sitka spruce), mixed-wood (yellow birch/ balsam fir), and unspecified deciduous forests (Klimaszewski et al. 2003). The Alberta specimens were collected in boreal mixed-wood forest, predominantly trembling aspen with a small amount of eastern balsam poplar, white birch, white spruce, and willow species (Klimaszewski et al. 2003). Five of the specimens were taken from old stands at least 100 years of age, nine were from mature stands 65 to 75 years of age, and three were from a recently harvested stand, 3 years of age (Klimaszewski et al. 2003). The specimens from the Carmanah Valley, Vancouver Island, British Columbia, were mainly captured in the forest interior, followed by fewer in the transition zone, and only two specimens were found in the clear-cut zone (Klimaszewski and Winchester 2002).

Tribe TACHYUSINI Thomson

*Brachyusa* Mulsant & Rey

Key to Canadian species of *Brachyusa*

- 1 Median lobe of aedeagus with narrowly triangular apical part forming dorsally distinct angular projection in apical half of tubus in lateral view (see Fig. 5N, in Seevers 1978) ..... *Brachyusa americana* (Fenyés)



- Median lobe of aedeagus with narrowly triangular apical part without angular dorsal projection in apical half of tubus in lateral view (Figs 93, 100) .....**2**
- 2 Body broad (Fig. 99); pronotal base strongly sinuate laterally (Fig. 99); median lobe of aedeagus with tubus extremely elongate (Fig. 100); male tergite VIII emarginate apically (Fig. 101); spermatheca L-shaped (Fig. 105) .....  
.....***Brachyusa saskatchewanae* Klimaszewski & Larson, sp. n.**
- Body moderately narrow (Fig. 92); pronotal base evenly arcuate (Fig. 92); median lobe of aedeagus with tubus moderately elongate (Fig. 93); male tergite VIII truncate apically (Fig. 94); spermatheca S-shaped (Fig. 98) .....  
..... ***Brachyusa helenae* Casey**

***Brachyusa helenae* (Casey)**

Figs 92–98

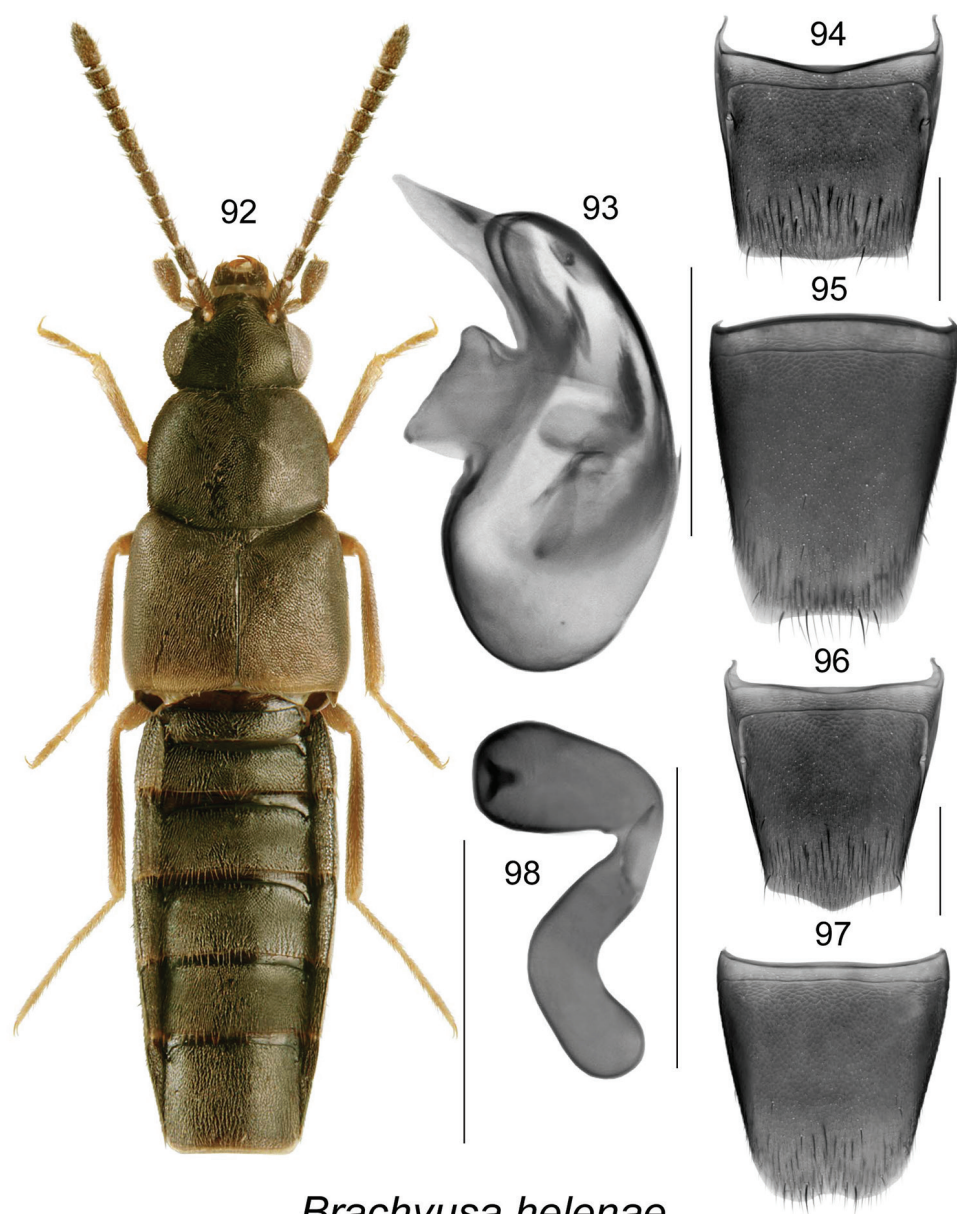
(for diagnosis, see Klimaszewski et al. 2011)  
*Tetralina filitarsus* Casey, 1911: 225. Holotype (male): USA, Montana, Kalispell, June, Wickham, Type USNM 3887 (USNM) 1 male. **New Synonymy.**

**Distribution.**

Origin	Nearctic
Distribution	Canada: LB, NB, NF, NT, ON, <b>SK</b> , YT. USA: AK, MT
New provincial records	CANADA, <b>Saskatchewan</b> , Cypress Hills Park: Center Block, Lodgepole Trail, 18-IX-2012, pine/spruce litter near stream, D. Larson (LFC) 1 female; Loch Lomond, 29-VIII-2011, D. Larson (DLC) 1 female.
References	Casey 1911, Seevers 1978, Klimaszewski et al. 2011, Brunke et al. 2012, Bousquet et al. 2013

**Natural history.** In SK, one specimen was captured in pine/spruce litter near stream, and another in an unspecified habitat in August and September. In LB, adults were collected in July and August on sand and gravel on the banks of the Churchill River (Klimaszewski et al. 2011). Elsewhere, adults were collected near lake and river shorelines, on clay, sand and gravel beaches and sandy and silty river margins (Klimaszewski et al. 2011). The adult activity period is May to August.

**Comments.** The two SK females agree in colour, body shape, morphology of tergite and sternite VIII, and spermatheca with the type of *B. helenae* and the recently examined specimens from NF and NB. We have studied the types of *B. alutacea* (Casey), *B. filitarsis* (Casey) and *B. helenae* (Casey). The genital illustrations of *B. americana* (Fenyés), recorded from BC, are provided by Seevers (1978). We have not found any significant morphological differences between the types of *B. filitarsis* and *B. helenae*, and the two species are synonymous. However, *B. alutacea* clearly differs from *B. helenae/filitarsis* by a very broad body. Seevers' (1978) key to species based on antennae and the length of the basal article of the metatarsus is not accurate.



*Brachyusa helenae*

**Figures 92–98.** *Brachyusa helenae* Klimaszewski & Larson, sp. n.: **92** habitus in dorsal view **93** median lobe of aedeagus in lateral view **94** male tergite VIII **95** male sternite VIII **96** female tergite VIII **97** female sternite VIII **98** spermatheca. Scale bar for habitus = 1 mm, and the remaining scale bars = 0.2 mm.

***Brachyusa saskatchewanae* Klimaszewski & Larson, sp. n.**

<http://zoobank.org/B1B397E3-9706-4BD1-992E-B2210EE12B30>

Figs 99–105

**Holotype (male).** Canada, Saskatchewan, Bear Creek at Crane Lake, near Piapot, 18-VIII-2011, D. Larson (LFC). **Paratypes.** Canada, Saskatchewan, Grasslands National Park, Frenchman River at Ecotour Rd., 26-VII-2004, sandy-clay river bank, D. Larson (DLC) 1 male; Bigstick Lake, 16 km E Golden Prairie, 21-IX-2011, D. Larson (DLC, LFC) 4 females.

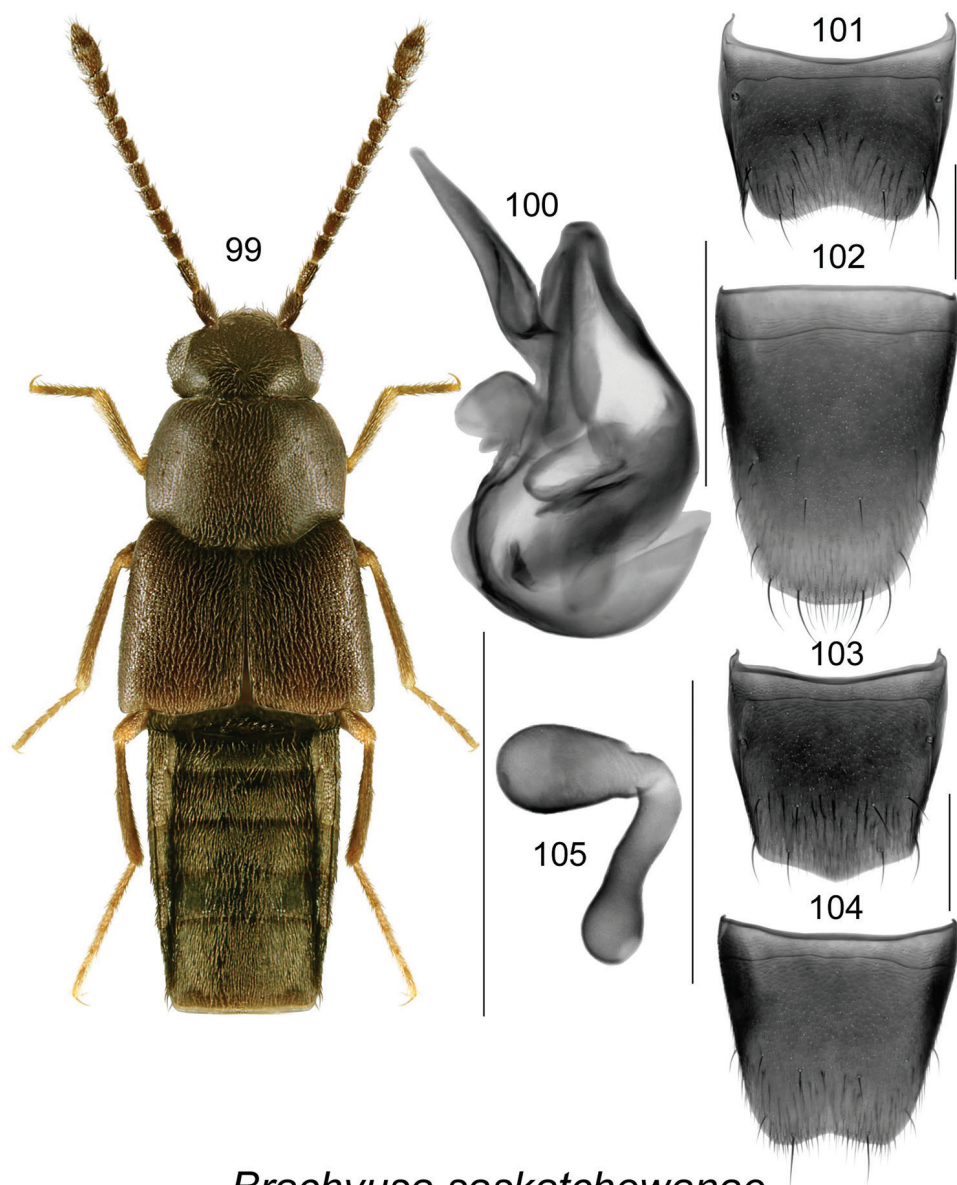
**Etymology.** The name of this species, *saskatchewanae*-, is a feminine adjective derived from the name of the province of Saskatchewan, where the type series was found.

**Diagnosis.** Body narrowly oval, length 2.3–2.5 mm, slightly flattened; uniformly black with light brown tarsi (Fig. 99); integument moderately glossy with short and silky pubescence (Fig. 99); antenna with articles I–VII elongate, VIII–IX subquadrate to slightly transverse (Fig. 99); head distinctly narrower than elytra and with large eyes, postocular region very short and abruptly narrowed basally (Fig. 99); pronotum wider than head but narrower than elytra, sinuate baso-laterally and strongly converging apically in apical third, pubescence directed straight and obliquely posteriad (Fig. 99); elytra at suture about as long as pronotum, pubescence directed straight posteriad, basal margin concave (Fig. 99); abdomen strongly narrowed posteriad, three basal tergites with deep transverse impressions (Fig. 99); metatarsus with basal article less than twice as long as second (Fig. 99). MALE. Tergite VIII transverse with broad apical emargination (Fig. 101); sternite VIII strongly elongate, with wide space between base of disc and antecostal suture, apical margin rounded (Fig. 102); median lobe of aedeagus with very long and narrow tubus in lateral view, bulbous large with large crista apicalis (Fig. 100). FEMALE. Tergite VIII slightly triangularly produced at apex (Fig. 103); sternite VIII with shallow apical emargination (Fig. 104); spermatheca L-shaped, with sac-shaped capsule angularly connected to club-shaped stem (Fig. 105).

*Brachyusa saskatchewanae* may be distinguished from other *Brachyusa* species by its uniformly black and narrow body, sinuate lateral margins of pronotum, and the genitalic features described above (Figs 99, 100, 105).

**Distribution.** Known only from SK.

**Natural history.** All SK specimens were captured near water with some on sandy-clay river bank. They were mainly collected by splashing water onto the bank, which caused the beetles to run up the bank.



### *Brachyusa saskatchewanae*

**Figures 99–105.** *Brachyusa saskatchewanae* Klimaszewski & Larson, sp. n.: **99** habitus in dorsal view **100** median lobe of aedeagus in lateral view **101** male tergite VIII **102** male sternite VIII **103** female tergite VIII **104** female sternite VIII **105** spermatheca. Scale bar for habitus = 1 mm, and the remaining scale bars = 0.2 mm.

***Gnypeta minuta* Klimaszewski & Webster**

(for diagnosis and illustrations, see Klimaszewski et al. 2008c)

**Distribution.**

Origin	Nearctic
Distribution	Canada: NB, <b>SK</b>
New provincial records	CANADA, <b>Saskatchewan</b> , Cypress Hills Park, West Block, 5 km E AB border, 30-VI-2012, sandy-clay river bank, D. Larson (DLC) 1 female.
References	Klimaszewski et al. 2008c, Bousquet et al. 2013

**Natural history.** In SK, one female was captured in June from sandy-clay river bank. In NB, two specimens were captured in June, one from under debris on muddy soil near a small pool in a silver maple forest, and the other from under debris on clay and sand mix at river margin (Klimaszewski et al. 2008c)

***Gnypeta saccharina* Klimaszewski & Webster**

(for diagnosis and illustrations, see Klimaszewski et al. 2008c)

**Distribution.**

Origin	Nearctic
Distribution	Canada: NB, <b>SK</b>
New provincial records	CANADA, <b>Saskatchewan</b> , Grassland National Park, W Block, oxbow N jct Ecotour Tr-Frenchman River, 13-VI-2009, D. Larson (DLC) 2 males, 3 females; Grassland National Park, W Block, Ecotour stop 3, shallow oxbow pond, 11-VI-2009, D. Larson (DLC) 1 male, 2 females; Bigstick Lake, N Maple Creek, 4-VIII-2012, organic mud/sedges, rushes, etc. near water, D. Larson (DLC, LFC) 2 males, 4 females; Bigstick Lake, 16 km E Golden Prairie, 21-IX-2011, D. Larson (DLC, LFC) 4 males, 4 females; Larson Ranch, Hwy 21, 16 km S Maple Creek: 10-VI-1998, D. Larson (DLC) 1 male; dam, 28-VIII-2011, D. Larson (DLC) 1 male; 3-IX-2011, D. Larson (DLC) 1 male; Harris Res., 10 km S Maple Creek, wind-drift, 12-V-2012, D. Larson (DLC) 1 male; Cypress Hills Park, C Block, fire break, 10-VI-2011, under bark of lodgepole pine, D. Larson (DLC) 1 male; Cypress Lake, east dam, 12-VI-1998, D. Larson (DLC) 1 male; Cypress Lake Park, sifting wrack, 16-VI-2011, D. Larson (DLC) 1 male; Cypress Lake E end, sifting wrack, 31-VII-2012, D. Larson (DLC) 2 males, 1 female; Cypress Lake E dam, wind-drift, 9-V-2012, DE Larson (DLC) 1 male, 2 females.
References	Klimaszewski et al. 2008c, Bousquet et al. 2013

**Natural history.** In SK, specimens were captured from May through September from shallow oxbow pond, organic mud/sedges, rushes, etc. near water, under bark of lodgepole pine, wind-drift, and by sifting wrack. In NB, adults were captured in May from moist leaves near margin of vernal pond in silver maple (*Acer saccharinum* L.) swamp, and in June from flood debris at the margin of the Saint John River (Klimaszewski et al. 2008c).



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# A new species of frog of the genus *Pristimantis* from Tingo María National Park, Huánuco Department, central Peru (Anura, Craugastoridae)

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## Abstract

A new species of Craugastoridae frog encountered from 1000–1700 m in elevation in the premontane forests of the Peruvian central Andes is described. The new species is similar in appearance to many other species of *Pristimantis*, but is easily distinguishable from these species by having bright red coloration on the groin, posterior surface of thighs, and shanks. The new species is only known for two localities 27 km apart in the Huánuco Region.

## Resumen

Describimos una nueva especie de rana de la familia Craugastoridae de los bosques premontanos de los Andes centrales peruanos, los especímenes fueron encontrados entre los 1000 – 1700 metros de elevación. Esta especie es similar en apariencia a muchas especies de *Pristimantis*, sin embargo es fácilmente distinguible por tener ingles, superficie posterior de los muslos y de la tibia rojo brillante. La nueva especie es conocida solo de dos localidades en la Región Huánuco, ambas separadas por alrededor de 27 km.

## Keywords

Amphibian, Andes, Craugastoridae, premontane forests, taxonomy

## Palabras clave

Anfibio, bosques premontanos, Craugastoridae, Andes, taxonomía

## Introduction

Frogs of the genus *Pristimantis* (Craugastoridae) comprise one of the most striking, richest, and understudied groups in the Neotropics (Hedges et al. 2008; Padial and De la Riva 2009; Ortega–Andrade et al. 2015). Likewise, 131 species of *Pristimantis* are known to occur in Peru where they are distributed in many habitats on the western and eastern versants of the Andes (Frost 2016).

Although several species of Craugastoridae have been described from the eastern Andean slopes of central Peru over the last 15 years (Lehr et al. 2000; Lehr 2001; Lehr and Aguilar 2002; Lehr et al. 2002; Lehr and Aguilar 2003; Duellman and Hedges 2005; Boano et al. 2008; Duellman and Chaparro 2008; Lehr and Oroz 2012; Chávez et al. 2015), amphibian taxonomic research in one of main drainages of the area: the Upper Huallaga river has focused on species of Bufonidae, Hylidae, Centrolenidae and Dendrobatidae (Duellman and Toft 1979; Aichinger 1991, Castroviejo–Fisher et al. 2009) with only one Pristimantinae (Craugastoridae) species recently described from this region (Duellman and Hedges 2007).

Tingo María National Park (TMNP) is a small protected area covering 4777 ha (SERNANP 2015) located in the Huallaga river basin on the eastern versant of the Peruvian central Andes. The landscape is dominated by a chain of small, isolated mountains commonly called “La Bella Durmiente” (“The sleeping beauty”), and belongs to lower montane forest (Gentry 1993). Few biological surveys have been conducted within this park, and its biological diversity is poorly known because terrorism and drug trafficking made the area inaccessible during the decades of the 80’s and 90’s. A rapid biological inventory was realized in 2014, 50 years after the creation by Peruvian law of TMNP, and resulted in an amphibian collection obtained by GC. Morphological analysis of collected specimens, and comparisons with similar species, led us to the discovery of a new species of frogs of the genus *Pristimantis*, which is described herein.

## Material and methods

Format for diagnosis and description of the new species follow those of Lynch and Duellman (1997). For systematic of Craugastoridae we follow Hedges et al. (2008), Pyron and Wiens (2011), and Padial et al. (2014). Specimens collected were sacrificed with a 20% benzocaine solution and fixed in 10% formalin, then stored in 70% ethanol and deposited in the herpetological collection at Centro de Ornitología y Biodiversidad (CORBIDI). The following variables were taken as described in Duellman and Lehr (2009) and were measured to the nearest 0.1 mm with digital calipers under a stereoscope: snout–vent length (SVL); eye–nostril distance (EN); head length (HL); head width (HW); interorbital distance (IOD); internarial distance (IND); tibia length (TL); foot length (FL); eye diameter (ED); upper eyelid width (EW).



Fingers and toes are numbered preaxially to postaxially from I–IV and I–V respectively. We determined comparative lengths of toes III and V by addressing both toes against Toe IV; lengths of fingers I and II were determined by addressing the fingers against each other. Specimens were sexed based on external sexual characteristics (e.g., presence of vocal sacs in males), all specimens were collected when they were calling, thus are considered adult males. Photographs were taken in the field and laboratory by GC, and used for descriptions of coloration in life and in preserved condition respectively. In addition to the type series of the new species, specimens examined are listed in Appendix I.

The advertisement calls of a chorus of males (CORBIDI 15563–68, 15577–78) were recorded at the type locality on 21 November 2014 ( $T_{\text{air}} = 23.0\text{ }^{\circ}\text{C}$ ; taken with a digital thermo hygrometer to the nearest  $0.1\text{ }^{\circ}\text{C}$ ). A digital recorder (Marantz PM-D661MK2) and unidirectional microphone (Sennheiser ME64) were used for field recording, and Raven Pro version 1.4 (Cornell Laboratory of Ornithology, Ithaca, NY) to analyze call variables. A total of 48 calls were analyzed. The following variables were measured from oscillograms: note, duration, and rate, interval between notes or calls, number of pulses, and presence of amplitude modulation. Variables measured from spectrograms included dominant frequency, and presence of frequency modulation or harmonics. Spectral parameters were calculated through fast Fourier transform (FFT) set at a length of 512 points (Hann window, 50% overlap). Averages are reported  $\pm$  SD.

Genetic distances were estimated to confirm generic placement of the new species within *Pristimantis* through analysis of the non-coding 16S rRNA mitochondrial fragment. Tissues from two paratopotypes, CORBIDI 15563 and 15566, were used to obtain DNA sequences for the new species (deposited in GenBank; Appendix 2). Sequences of closely related, congeneric species were downloaded from GenBank (Appendix 2). Extraction, amplification, and sequencing of DNA followed standard protocols (Hedges et al. 2008; Catenazzi and Tito 2016). The 16Sar (forward) primer (5'-3' sequence: CGCCTGTTTATCAAAAACAT) and the 16Sbr (reverse) primer (5'-3' sequence: CCGGTCTGAACTCAGATCACGT) (Palumbi et al. 2002) were used; the following thermocycling conditions during the polymerase chain reaction (PCR) with a Veriti thermal cycler (Applied Biosystems) were employed: one cycle of  $96\text{ }^{\circ}\text{C}/3\text{ min}$ ; 35 cycles of  $95\text{ }^{\circ}\text{C}/30\text{ s}$ ,  $55\text{ }^{\circ}\text{C}/45\text{ s}$ ,  $72\text{ }^{\circ}\text{C}/1.5\text{ min}$ ; one cycle  $72\text{ }^{\circ}\text{C}/7\text{ min}$ . PCR products were purified with Exosap-IT (Affymetrix, Santa Clara, CA) and shipped to MCLAB (San Francisco, CA) for sequencing. Geneious R8, version 8.1.6 (Biomatters, <http://www.geneious.com/>) was used to align the sequences with the MAFFT, version 7.017 alignment program (Katoh and Standley 2013). Uncorrected p-distances (i.e., the proportion of nucleotide sites at which any two sequences are different) were estimated with the R package “ape” (Paradis et al. 2004).

## Results

### *Pristimantis pulchridormientes* sp. n.

<http://zoobank.org/4DCDA666-2217-48A0-9E6D-C1681544BDD5>

Proposed standard English name: Sleeping beauty rain frog

Proposed standard Spanish name: Rana de lluvia de la Bella Durmiente

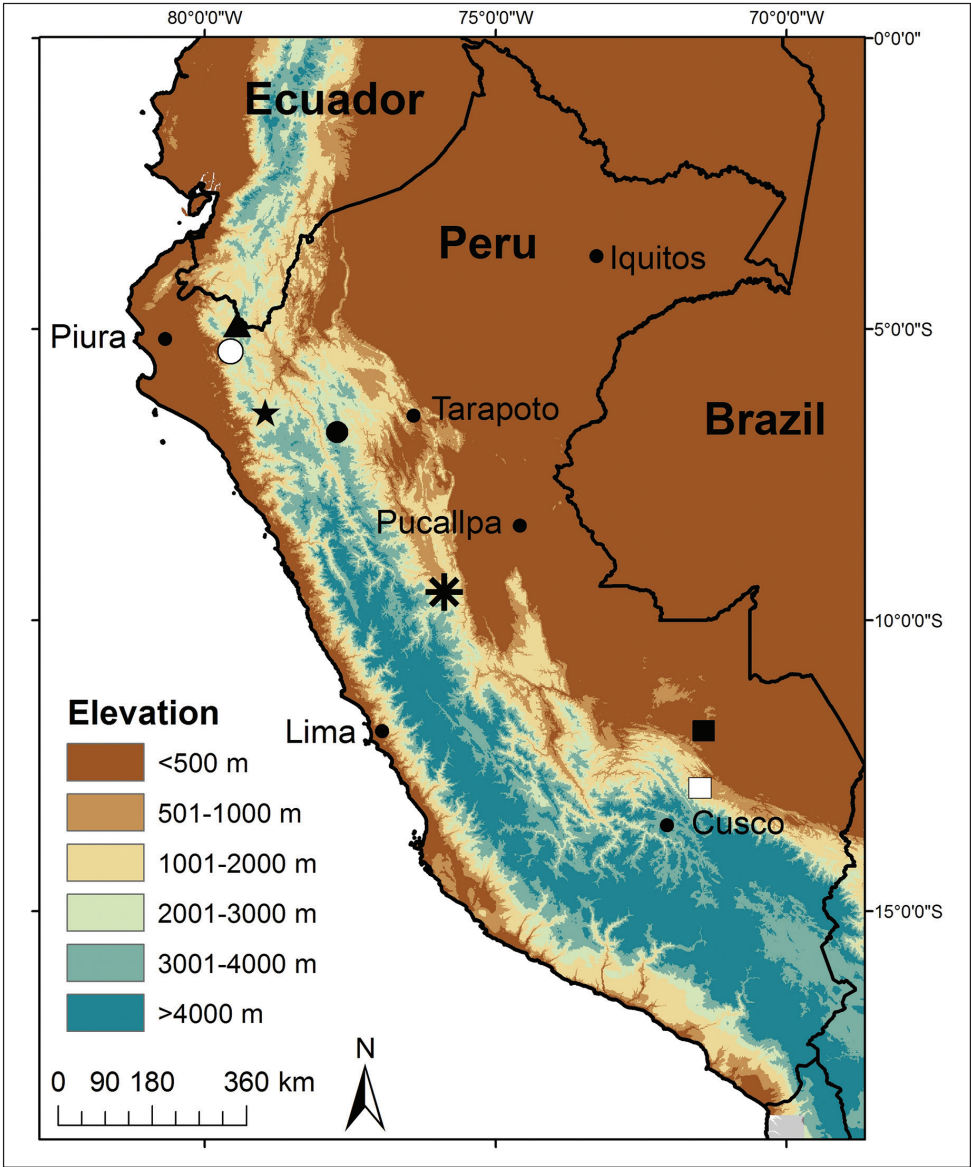
**Holotype.** CORBIDI 15578 (Figures 1–3), an adult male collected by G. Chávez and D. Vásquez at Campamento La Garganta de la Bella, Tingo María National Park, (9°20'18.3"W, 76°0'7.4"S; 1095 m above sea level (asl), Provincia Leoncio Prado, Departamento Huánuco, Peru, on 21 November 2014.

Paratopotypes. Seven adult males (Fig. 4): CORBIDI 15563–68, 15577, collected along with the holotype.

Paratype. Adult male, CORBIDI 16606 collected at Sharco (9°35'58.6"W, 75°54'1.1" S; altitude 1700 m asl), Provincia Pachitea, Departamento Huánuco, Peru, on 28 November 2015 by Juan Carlos Chávez-Arribasplata.

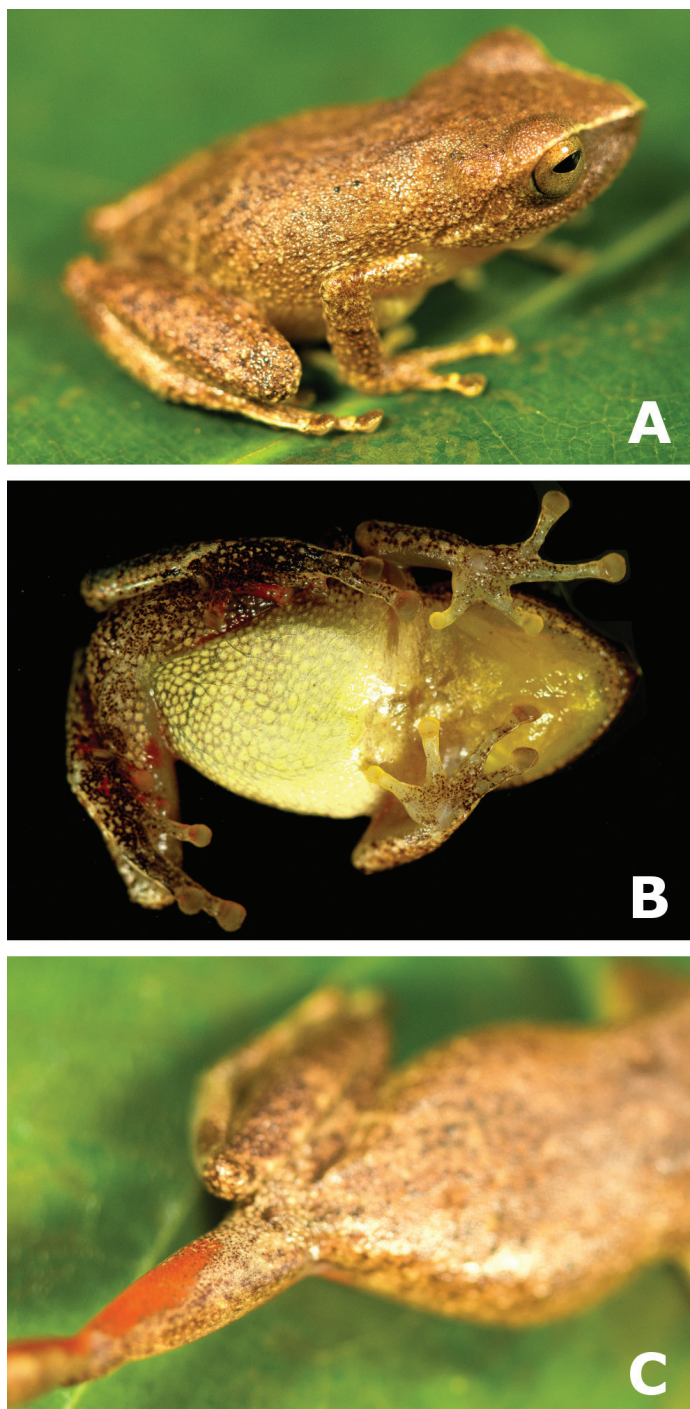
**Diagnosis.** The new species is distinguished by the following combination of characters: (1) skin on dorsum finely shagreen, that on venter areolate, discoidal fold absent, dorsolateral folds absent; (2) tympanic membrane and tympanic annulus distinct, weak supratympanic fold covering dorsal and posterior edges of tympanum, horizontal diameter of eye 3x the diameter of tympanum; (3) snout acuminate in dorsal view, truncated and posteroventrally inclined in lateral view, canthus rostralis weakly concave in dorsal view, angular in lateral view, loreal region concave, rostral papilla absent; (4) upper eyelid lacking tubercles, cranial crests absent; (5) dentigerous process of vomers absent; (6) males with vocal sacs and vocal slits, nuptial excrescences absent; (7) finger I and finger II of equal length, fingers II and III bearing rounded discs about 1.5 times wider than digits, finger IV bearing a rounded disc about twice as wide as its digit; (8) fingers with narrow lateral fringes; (9) antebrachial tubercle absent; (10) ulnar and tarsal tubercles absent (11) inner metatarsal tubercle oval twice as long as round outer metatarsal tubercle, low supernumerary plantar tubercles at the base of toes I, II, and III; (12) toes with narrow lateral fringes, webbing absent, toe V longer than toe III; (13) in life, males with dorsum creamy yellow or yellowish brown with dark blotches; canthal stripe creamy white extending to the orbits; throat yellow; belly creamy white; groins, posterior surfaces of thighs, and shanks bright red; iris cream with brown flecks; (14) SVL in adult males 19.1–21.9 mm; SVL in females unknown.

**Comparisons.** *Pristimantis pulchridormientes* sp. n. is morphologically similar to *P. acuminatus*, *P. bromeliaceus*, *P. enigmaticus*, *P. lacrimosus*, *P. limoncochensis*, *P. mendax*, *P. olivaceus*, *P. omeviridis*, *P. padiali*, *P. pardalinus*, *P. pluvialis*, *P. pseudoacuminatus*, *P. rhodostichus*, *P. schultei*, and *P. tantanti* in having the head and body slightly compressed dorso–ventrally, but differs from all of them by having bright red coloration on groins, and on the posterior surfaces of thighs and shanks. Furthermore, *P. pulchridormientes* lacks a rostral papilla, which is present in *P. acuminatus*, *P. brome-*

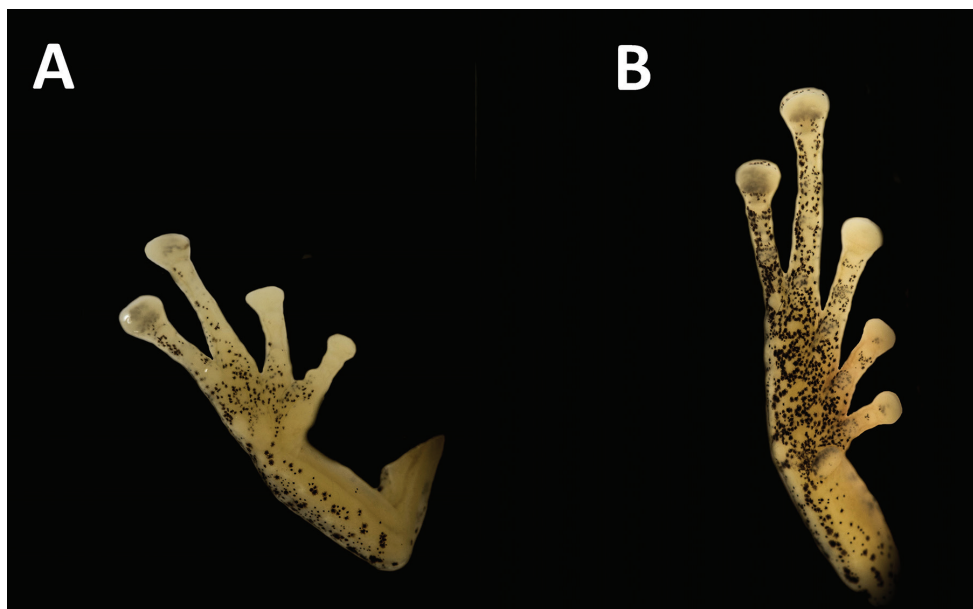


**Figure 1.** Map of Peru indicating the type locality of *Pristimantis pulchridormientes* sp. n. (asterisk), the two most closely related species according to analysis of genetic distances, *P. pluvialis* and *Pristimantis* sp. (white square; see text for analysis), and of other Peruvian species of *Pristimantis* with red shanks or thighs: *P. buccinator* (black square), *P. cajamarcensis* (black star), *P. ceuthospilus* and *P. rhodoplichus* (white circle), *P. coronatus* (triangle), *P. corrugatus* (black circle).

*liaceus*, *P. lacrimosus* (variable), *P. olivaceus*, *P. omeviridis*, *P. pardalinus*, *P. pluvialis*, *P. rhodostichus*, and *P. schultei*. Other species further differ by the following characters: *P. enigmaticus* has a tarsal fold (absent) and is lacking vocal slits (present); *P. limoncochen-*



**Figure 2.** Dorsolateral and ventral views (**A**, **B**) of the holotype of *Pristimantis pulchridormientes* sp. n., male CORBIDI 15578, SVL = 21.9 mm, showing detail of (**C**) coloration on shanks and thighs. Photographs by G. Chávez.

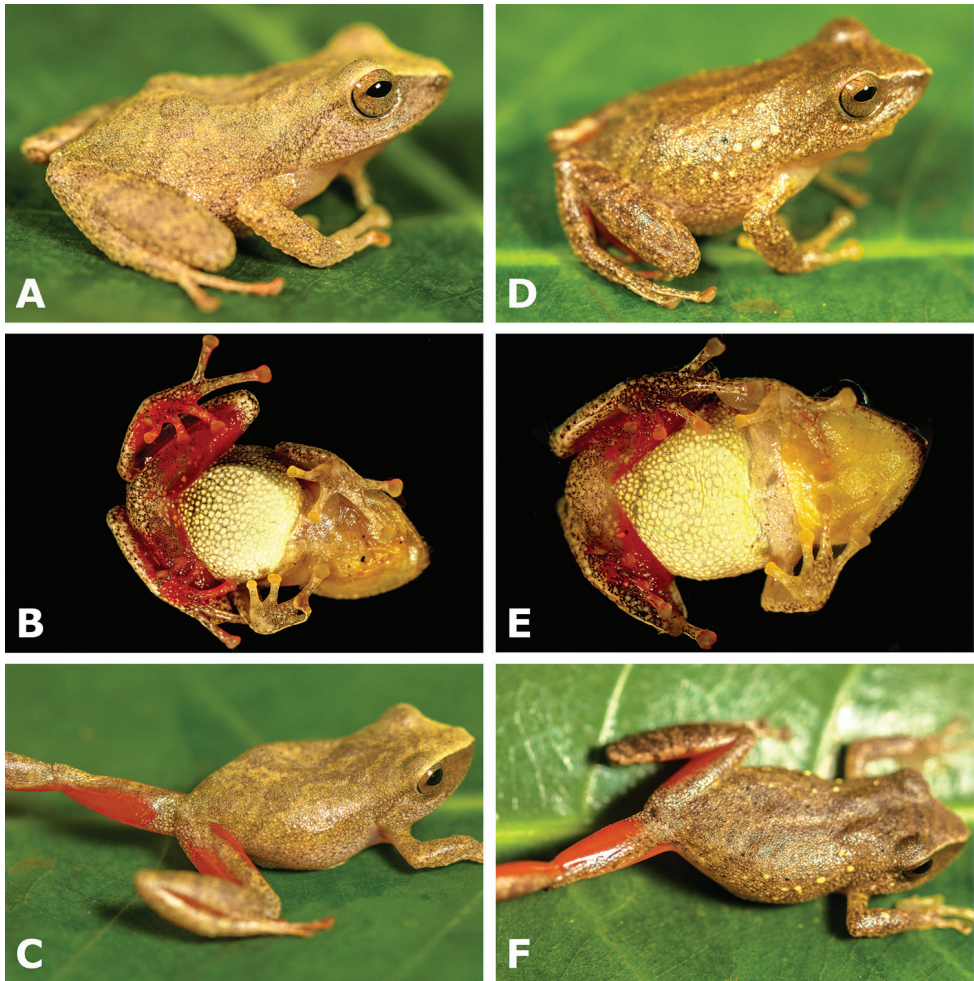


**Figure 3.** Ventral view of **A** hand (hand length = 8.5 mm) and **B** foot (foot length = 9.2 mm) of the holotype of *Pristimantis pulchridormientes* sp. n., (CORBIDI 15578). Photographs by Germán Chávez.

*sis* has a smooth dorsum (finely shagreen), and is lacking vocal slits (present), and a differentiated tympanic annulus and membrane (tympanic annulus and membrane distinct); *P. mendax* has a sigmoid inner tarsal fold (absent) and dorsal skin shagreen with scattered spicules (finely shagreen without spicules); *P. padiali* has an evident supratympanic fold (weakly evident), small dentigerous processes of vomers (absent), tubercles on ulnar and tarsal region (absent) and lacks vocal slits (present); *P. tantanti* has small dentigerous processes of vomers (absent), elongated ulnar tubercles (absent) and lacks tympanic annulus and membrane (present) and vocal slits (present).

Only eight other species of Peruvian *Pristimantis* have red coloration on groins and posterior surfaces of thighs: *Pristimantis buccinator*, *P. cajamarcensis*, *P. ceuthospilus*, *P. coronatus*, *P. corrugatus*, *P. lythroides*, *P. rhodoplichus* and *P. sagittulus*. *Pristimantis pulchridormientes* can be differentiated from these species by having skin on dorsum finely shagreen (shagreen with pustules in *P. cajamarcensis*; shagreen with dermal ridges in *P. coronatus*; shagreen to finely corrugated in *P. lythroides*; coarsely shagreen in *P. rhodoplichus*; shagreen with low tubercles in *P. sagittulus*), skin on venter areolate (smooth in *P. buccinator*), snout acuminate in dorsal view (rounded in *P. cajamarcensis*; subacuminate in *P. lythroides* and *P. rhodoplichus*; acutely rounded in *P. sagittulus*), truncated and posteroventrally inclined in lateral view (acutely rounded in *P. ceuthospilus*; rounded in *P. coronatus* and *P. lythroides*; acuminate in *P. sagittulus*), upper eyelids lacking tubercles (bearing small rounded tubercles in *P. rhodoplichus*, conical tubercles in *P. coronatus* and *P. corrugatus*), tympanic annulus not prominent (prominent in *P. buccinator*, *P. ceuthospilus*, *P. rhodoplichus*, *P. sagittulus*; absent in *P. coronatus*), supratympanic stripe





**Figure 4.** Dorsolateral and ventral views of two paratopotypes of *Pristimantis pulchridormientes* sp. n. showing detail of coloration on shanks and thighs. Male CORBIDI 15563 (**A–C**), SVL = 21.0 mm. Male CORBIDI 15565 (**D–F**), SVL = 21.5 mm. Photographs by G. Chávez.

absent (present in *P. cajamarcensis*), fingers I and II of equal lengths (finger I longer than finger II in *P. buccinator*; finger I shorter than finger II in *P. ceuthospilus*, *P. lythroides* and *P. rhodoplichus*), ulnar tubercles absent (distinct conical ulnar tubercles in *P. corrugatus*), heels lacking tubercles (bearing small subconical tubercles in *P. rhodoplichus* and prominent conical tubercles in *P. corrugatus* and *P. sagittulus*).

The uncorrected genetic distances (Table 2) support the generic placement of the new species and its distinctiveness with respect to superficially similar species. According to these analyses, the most closely related species is *P. pluvialis* (Shepack et al. 2016), which despite sharing a similar body shape can easily be distinguished from *P. pulchridormientes* by the presence of a rostral papilla, larger size, and coloration patterns.

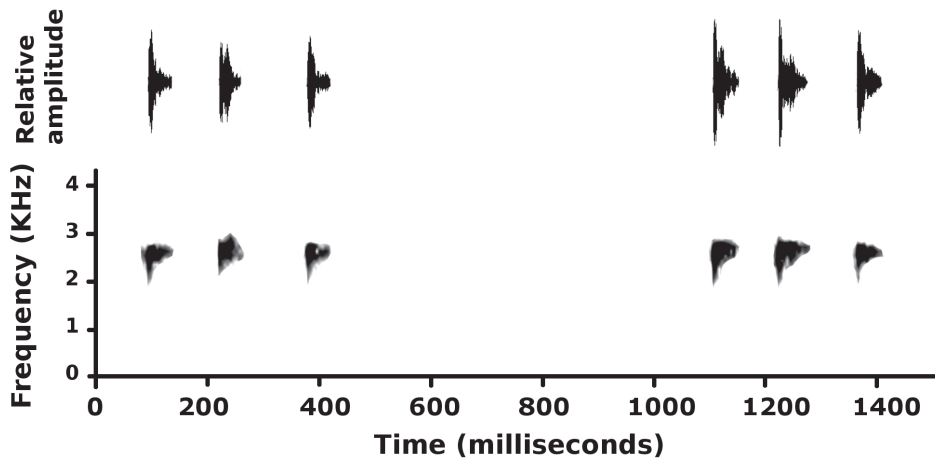


The new species is also similar to the recently described *Pristimantis ardyae* (Reyes-Puig et al. 2013) from Ecuador in having red groins (red or orange in *P. ardyae*), but can be distinguished by the following characters (condition for *P. ardyae* in parentheses): upper eyelid lacking tubercles (bearing two small rounded tubercles), low ulnar tubercles present (absent), and iris cream with brown flecks (orange with fine black reticulations).

**Description of the holotype.** An adult male (CORBIDI 15578) with a SVL of 21.9 mm, head as wide as long; snout subacuminate in dorsal view and truncated in lateral view, relatively short (eye–nostril distance 12% of SVL); canthus rostralis distinct in lateral view; loreal region concave; nostrils protuberant, directed anteriorly; interorbital area flat, broader than upper eyelid (upper eyelid width 59% of interorbital distance); cranial crests absent; upper eyelid lacking tubercles; tympanic membrane distinct, differentiated of surrounding skin; tympanic annulus distinct, round with weak supratympanic fold obscuring upper and posterodorsal edges of annulus (Fig. 2); tympanum diameter 31% of eye diameter; postrictal tubercles absent. Choanae small, rounded, not concealed by palatal shelf of maxillary; tongue longer than wide and granular. Skin texture on dorsum and flanks finely shagreen; dorsolateral folds absent; venter areolate; thoracic fold present, discoidal fold absent, cloacal sheath absent. Forearm slender; ulnar tubercles low, ulnar fold absent; radio–ulnar length 23% of SVL; fingers with narrow lateral fringes; relative lengths of fingers  $I \leq II < IV < III$ ; palmar tubercle bilobed, thenar tubercle oval (Fig. 3); subarticular tubercles round, prominent; supernumerary palmar tubercles present at the base of all fingers; disc cover finger I slightly expanded, those of fingers III and IV extensively expanded (Fig. 3), outer discs of fingers as wide as those of toes; discs covered with elliptical ventral pads defined by circummarginal grooves. Hind limbs slender; tibia length 50% of SVL; foot length 85% of tibia length; tarsal fold absent, tarsal tubercles low; heel lacking tubercles; toes with narrow lateral fringes; subarticular tubercles round, prominent; inner metatarsal tubercle oval, about 2.4 times the size of subconical outer tubercle; supernumerary plantar tubercles low at the base of all toes; discs covers slightly expanded; toes with defined pads; discs pads nearly elliptical; relative length of toes  $I < II < III < V < IV$ ; tip of toe V reaching proximal border of distal subarticular tubercle IV; tip of toe II reaching distal border of medial subarticular tubercle of Toe IV.

**Measurements and proportions of the holotype (in millimeters).** SVL = 21.9; HL = 8.5; HW = 8.5; ED = 2.7; EN = 2.5; TD = 0.5; IOD = 3.1; EW = 1.8; IND = 1.9; TL = 10.8; FL = 9.2; HL/SVL = 0.3; HW/SVL = 0.3; EW/IOD = 0.5; TL/SVL = 0.4; FL/SVL = 0.4; FL/TL = 0.8.

**Coloration in life.** At night, dorsum, flanks, and dorsal surface of limbs are yellowish-brown with diagonal brown blotches and tiny brown flecks; dorsal surface of head of the same color and bearing a fine creamy yellow canthal stripe which extends to the medial portion of the upper eyelids. Throat yellow, chest and belly are creamy-white with tiny dark flecks; ventral surface of hands, and exterior portion of the ventral surface of feet yellowish-brown; groins, posterior surface of thighs, posterior surface of shanks, and inner portion of the ventral surface of hands bright red. Anterior surface



**Figure 5.** Oscillogram (above) and spectrogram and of the advertisement call of an uncollected male of *Pristimantis pulchridormientes* sp. n., recorded at the type locality on 21 November 2014 ( $T_{\text{air}} = 23.0^{\circ}\text{C}$ ).

of thighs are pinkish-gray with irregular red blotches. Iris golden with fine dark flecks. In daytime, yellowish-brown coloration turns into pale yellow.

**Coloration in preservative.** As described above, but yellowish-brown coloration turns creamy-yellow with tiny dark flecks on dorsum, limbs and ventral surfaces of hands and feet; red coloration turned pinkish-white, and venter creamy-yellow; iris gray.

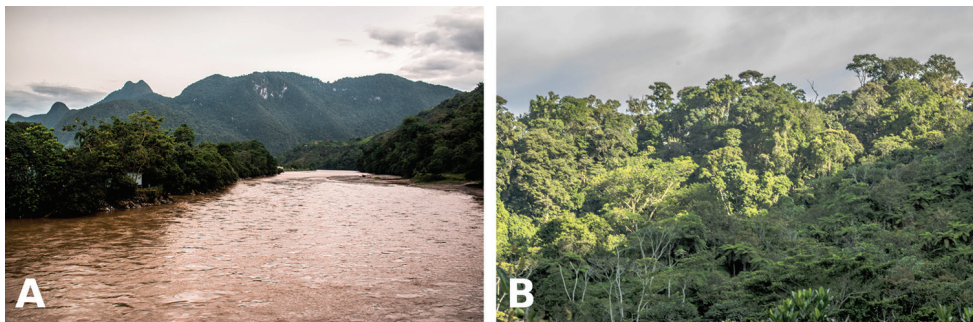
**Advertisement call.** A chorus of several males (CORBIDI 15563–68, 15577–78) was recorded at a distance of 1 meter from the microphone; thus the description refers to such context. The general structure of calls in this chorus (2'45" recording) is that calls include a variable number of single-pulse notes (Fig. 5). It is possible, considering advertisement calls in similar *Pristimantis* species, that males emit simpler vocalizations, i.e., single notes separated by longer durations, outside of choruses. Males in the chorus produced calls with  $3.3 \pm 0.7$  notes (range 2–5 notes). Note duration averaged  $45.9 \pm 12.6$  ms (range 31–75 ms). Fundamental frequency averaged  $2763 \pm 133$  ms (range 2531–3094 Hz) and did not vary within or among notes; likely the main source of variation in fundamental frequency was among individuals. Within single notes, much of the energy was concentrated in the first half of the note.

**Variation.** Measurements and proportions of the specimens examined are given in Table 1. Dorsal coloration pattern is paler in CORBIDI 15563–64, 15568 than the holotype. Specimen CORBIDI 15565 (Figure 4, D–F) has a minute dorsolateral yellow spot. Specimens CORBIDI 15563–66 have a darker yellow throat.

**Etymology.** The name is composed of two words in Latin, “pulcher” which means beautiful, and “dormientes” = sleeping, in reference to the chain of mountains located within Tingo María National Park, above the city of Tingo Maria, locally known as Sleeping Beauty (Bella Durmiente), because it looks like a sleeping reclined woman (Figure 6A).

**Table 1.** Measurements and morphological proportions of *Pristimantis pulchridormientes* sp. n. Range is followed by mean value and standard deviation in parenthesis (n = 9 adult males).

Snout-vent length (SVL)	19.1–21.9 (20.5 ± 0.8)
Head length (HL)	7.0–8.5 (7.8 ± 0.5)
Head width (HW)	7.2–8.5 (7.8 ± 0.5)
Upper-eyelid width (EW)	1.8–1.9 (1.8 ± 0.1)
Interorbital distance (IOD)	2.2–3.1 (2.8 ± 0.3)
Eye diameter (ED)	2.3–2.7 (2.6 ± 0.1)
Eye-nostril distance (EN)	2.2–2.5 (2.3 ± 0.1)
Internarial distance (IND)	1.6–1.9 (1.7 ± 0.1)
Tibia length (TL)	9.6–10.8 (10.3 ± 0.4)
Foot length (FL)	7.7 – 9.2 (8.3 ± 0.5)
HL/SVL	0.3–0.4 (0.3 ± 0.1)
HW/SVL	0.3–0.4 (0.3 ± 0.1)
FL/SVL	0.3–0.4 (0.3 ± 0.1)
EN/SVL	0.1 (0.1 ± 0.0)
FL/TL	0.7–0.8 (0.8 ± 0.0)
EW/IOD	0.5–0.8 (0.6 ± 0.0)

**Figure 6.** Habitat of *Pristimantis pulchridormientes* sp. n. in Tingo María National Park: **A** panoramic view of the Bella Durmiente (Sleeping Beauty) chain of mountains, and **B** premontane forest at the type locality. Photographs by G. Chávez.

**Distribution and natural history.** *Pristimantis pulchridormientes* is known from two localities (Fig. 1), Garganta de la Bella, the highest point (1095 m asl) along the trail inside Tingo Maria NP, and Sharco (1700 m asl), approximately 27 km south of the type locality (by airline). Male specimens CORBIDI 15563–68, 15577–78 were collected at the beginning of the rainy season, calling at night, perched on leaves 2 meters above ground in the primary montane forest. Although bromeliads were present, individuals were not observed using these plants. Other vegetation included trees *Cecropia* spp. and *Cedrella* spp., bamboo patches, ferns, epiphyte plants and lichens (Figure 6B). The ground was covered with leaf litter and rocks. Sympatric species in-

**Table 2.** Uncorrected p-distances of the mitochondrial 16S rRNA gene. Comparisons between *P. pulchridormientes* and the three taxa with lowest p-distances are indicated in bold.

	<i>P. acuminatus</i> (MC11555)	<i>P. boulengeri</i> (MAV257)	<i>P. bromeliaceus</i> (KU291702)	<i>P. cf. mendax</i> (MTD45080)	<i>P. dorsopictus</i> (MHUAA7638)	<i>P. galdi</i> (QCAZ32368)	<i>P. mindo</i> (MZUT11382)	<i>P. mindo</i> (MZUT11756)	<i>P. moro</i> (AJC1753)	<i>P. moro</i> (AJC1860)	<i>P. omeviridis</i> (QCAZ19664)	<i>P. pluvialis</i> (CORBIDI11862)	<i>P. pluvialis</i> (CORBIDI16695)	<i>P. pulchridormientes</i> (CORBIDI 15563)	<i>P. pulchridormientes</i> (CORBIDI 15566)	<i>P. ridens</i> (AJC1778)	<i>P. sp.</i> (CORBIDI 17473)	<i>P. sp.</i> (ROM43978)	<i>P. subsigillatus</i> (MECN10117)
<i>P. acuminatus</i> (MC11555)	0.00																		
<i>P. boulengeri</i> (MAV257)	0.05	0.00																	
<i>P. bromeliaceus</i> (KU291702)	0.14	0.13	0.00																
<i>P. cf. mendax</i> (MTD45080)	0.14	0.13	0.00	0.00															
<i>P. dorsopictus</i> (MHUAA7638)	0.15	0.13	0.11	0.11	0.00														
<i>P. galdi</i> (QCAZ32368)	0.11	0.11	0.10	0.10	0.08	0.00													
<i>P. mindo</i> (MZUT11382)	0.12	0.11	0.09	0.09	0.08	0.06	0.00												
<i>P. mindo</i> (MZUT11756)	0.12	0.12	0.09	0.09	0.08	0.06	0.00	0.00											
<i>P. moro</i> (AJC1753)	0.11	0.10	0.09	0.10	0.09	0.09	0.08	0.07	0.00										
<i>P. moro</i> (AJC1860)	0.11	0.10	0.09	0.09	0.09	0.09	0.07	0.07	0.05	0.00									
<i>P. omeviridis</i> (QCAZ19664)	0.14	0.13	0.12	0.12	0.12	0.11	0.12	0.11	0.10	0.10	0.00								
<i>P. pluvialis</i> (CORBIDI11862)	0.14	0.14	0.11	0.11	0.11	0.11	0.09	0.09	0.11	0.09	0.13	0.00							
<i>P. pluvialis</i> (CORBIDI16695)	0.14	0.14	0.11	0.11	0.11	0.11	0.09	0.09	0.11	0.09	0.13	0.00	0.00						
<i>P. pulchridormientes</i> (CORBIDI 15563)	0.18	0.17	0.13	0.12	0.13	0.12	0.11	0.10	0.10	0.10	0.14	<b>0.07</b>	<b>0.07</b>	0.00					
<i>P. pulchridormientes</i> (CORBIDI 15566)	0.18	0.17	0.13	0.12	0.13	0.12	0.11	0.10	0.10	0.10	0.14	<b>0.07</b>	<b>0.07</b>	0.00	0.00				
<i>P. ridens</i> (AJC1778)	0.15	0.13	0.14	0.14	0.13	0.16	0.13	0.13	0.14	0.13	0.15	0.15	0.15	0.16	0.16	0.00			
<i>P. sp.</i> (CORBIDI 17473)	0.14	0.14	0.11	0.11	0.10	0.09	0.08	0.08	0.10	0.08	0.12	0.06	0.06	<b>0.07</b>	<b>0.07</b>	0.15	0.00		
<i>P. sp.</i> (ROM43978)	0.14	0.13	0.12	0.12	0.11	0.10	0.09	0.08	0.10	0.10	0.13	0.07	0.07	<b>0.08</b>	<b>0.08</b>	0.17	0.06	0.00	
<i>P. subsigillatus</i> (MECN10117)	0.13	0.13	0.11	0.11	0.09	0.10	0.05	0.05	0.09	0.09	0.12	0.10	0.10	0.12	0.12	0.15	0.09	0.09	0.00

clude the amphibians *Pristimantis diadematus*, *P. mendax*, *P. peruvianus*, *P. ockendeni*, and *Phyllomedusa camba*, and the reptiles *Anolis fuscoauratus*, *Copeoglossum nigropunctatum*, *Phrynonax polylepis*, and *Spillotes sulphureus*. One specimen (CORBIDI 16606) was collected calling at night on a leaf 2 m above the ground in a patch of a secondary forest, the habitat strongly affected by human activities such as cattle grazing and orange plantations. The vegetation consisted of trees of *Cecropia* spp., *Ficus* spp., and the ground was covered by herbs and bushes. Sympatric amphibians include *P. ockendeni* and *Scinax* aff. *ruber*.

## Discussion

The new species is not assigned to any taxonomic group despite the presence of morphological characters (i.e. head and body dorsoventrally compressed; skin on dorsum finely shagreen and that on venter areolate) suggesting a possible inclusion in the *Pristimantis lacrimosus* group. Group assignment is currently avoided because of the unclear taxonomic status of the *P. lacrimosus* group, as shown by recent phylogenetic studies (Padial et al. 2014; Ortega-Andrade et al. 2015). Further hindering group assignments among frogs of the genus *Pristimantis* are high species diversity (Hedges et al., 2008), small genetic distances (i.e. *P. acuminatus* complex; Ortega-Andrade et al. 2015), and limitations of morphological characters in defining species groups (Elmer and Cannatella 2008; Hedges et al. 2008; Padial and De la Riva 2009). Furthermore, phylogenetic relationships proposed by Hedges et al. (2008) for species in the putative *P. lacrimosus* group are not confirmed by recent studies, such as the strongly supported phylogeny published by Padial et al. (2014). In fact, Hedges et al. (2008) placed *P. acuminatus* outside of the *P. lacrimosus* group, but Padial et al. (2014) showed that this species is closely related to species of the putative *P. lacrimosus* group, evidencing the complicated taxonomy of this clade.

The analysis of genetic distances (uncorrected p-distances) shows that *Pristimantis pulchridormientes* sp. n. is closely related to both *P. pluvialis* and an undescribed species (*Pristimantis* sp.) from southeastern Peru (Table 2), which both show clear morphological differences with *P. pulchridormientes* (Shepack et al. 2016). In contrast, other species such as *P. acuminatus*, *P. bromeliaceus*, and *P. omeviridis*, show higher genetic distances exceeding 10%.

At both localities the new species was found in arboreal microhabitats, frequently calling perched on leaves 2 m above the ground. The only other species sharing a similar microhabitat and presumably ecological niche (also nocturnal) was *P.* aff. *mendax*, but this frog was not found in sympatry with *P. pulchridormientes*, because its altitudinal range of 100–900 m asl does not overlap with the range of *P. pulchridormientes* from 1095–1700 m asl.

With only two known localities, it is difficult to predict the potential distribution range of this species. Although the type locality had a large population and was located inside a protected area, the locality where paratype CORBIDI 16606 was collected

had a very fragmented habitat surrounded by orange plantations and corn cropland. Considering that the upper Huallaga drainage is highly disturbed by agriculture activities which fragments the submontane and montane forests (Catenazzi and von May 2014), the distribution of *P. pulchridormientes* is considered to be highly fragmented with the only known protected population living on an isolated slope of Tingo Maria NP. On the basis of our limited knowledge of its distribution, and according to the IUCN Red List guidelines (2016) we recommend the species be placed in the Data Deficient category of the IUCN Red List of Threatened species.

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## Appendix I

### Specimens examined

- Pristimantis acuminatus*.— **PERU: Amazonas:** Provincia Condorcanqui: CORBIDI 11388, 11403, Quebrada Kampankis, 4°02'35.1"S, 77°32'28.3"W, 325 m. **Loreto:** Provincia Loreto: CORBIDI 1128, San Jacinto, 2°19'51.0"S, 75°51'49.3"W, 160 m; CORBIDI 1531, 4720, 4769, Andoas, 2°42'15.6"S, 76°18'46.2"W, 273 m; Provincia Requena: CORBIDI 2204, Sierra del Divisor, 6°55'07.4"S, 73°50'43.0", 205 m.
- Pristimantis bromeliaceus*.— **PERU: Amazonas:** Provincia Bagua: CORBIDI 0778, Chonza Alta, 5°35'18.5"S, 78°21'02.2"W, 2047 m; CORBIDI 1972–73, 2037–39, Catarata de Cañopite, 5°36'57.8"S, 78°19'48.6"W, 2335 m; CORBIDI 5547, 5550, 5557, 5560–61, 5566–67, 5570, 5580, Área Conservación Privada Copallín, 5°36'59.7"S, 78°20'33.9"W, 2046 m. **Ayacucho:** Provincia La Mar: CORBIDI 6934, 6953–54, Chiquintirca – San Antonio road, 12°57'26.3"S, 73°37'03.4"W, 2305 m. **Cajamarca:** Provincia San Ignacio, CORBIDI 14820, El Chaupe, 5°17'48.0"S, 72°02'09.7"W, 1891 m. **Pasco:** Provincia Oxapampa: CORBIDI 3859, Comunidad Campesina Chacos, 10°33'06.2"S, 75°20'18.1"W, 2901 m; CORBIDI 11520–21, 11562, 11567, Bosque de Sho'llet, 10°37'49.3"S, 75°16'58.4"W, 2181 m. **San Martín:** Provincia Moyobamba: CORBIDI 3143–44, 3176, Paitoja 6°21'09.8"S, 77°04'03.6"W, 1731 m; Provincia Rioja: CORBIDI 0510–12, 0516–17, Abra Patricia, 5°41'45.5"S, 77°47'37.2"W, 2189 m.
- Pristimantis buccinator*.— **PERU: Cusco:** Provincia La Convención: CORBIDI 12479, Mipaya 11°34'46.5"S, 73°10'17.1"W, 377 m. **Loreto:** Provincia Requena: CORBIDI 3911–12, 3923, 3446, 3953, 3960, Sierra del Divisor 6°12'49.0"S, 73°14'21.0"W, 500 m.

*Pristimantis cajamarcensis*.— **PERU: Cajamarca:** Provincia San Ignacio: CORBIDI 14811, 14816, 14819, 14823, 14836, 14837, 14838, El chaupe 5°17'48.0"S, 72°02'09.7"W, 1891 m.

*Pristimantis ceuthospilus*.— **PERU: Piura:** Provincia Huancabamba: CORBIDI 4211, Chigña alta 5°35'01.6"S, 79°40'04.1"W, 715 m. **Lambayeque:** Provincia Lambayeque: CORBIDI 4295–99, 4230–46, Quebrada Palacios, Distrito Salas 6°01'15.5"S, 79°32'16.3"W, 1082 m.

*Pristimantis corrugatus*.— **PERU: Amazonas:** Provincia Chachapoyas: CORBIDI 10897–904, Bosque de palmeras de Ocol, Molinopampa, 6°16'03.7"S, 75°35'06.7"W, 2566 m; Provincia Rodríguez de Mendoza: CORBIDI 12877–82, 12884, La Colpa 6°23'37.0"S, 77°13'42.6"W, 2347 m. **San Martín:** Provincia Mariscal Cáceres: CORBIDI 11018, 11024–11028, 11030–39, Quintecocha 6°51'33.0"S, 77°42'14.7"W, 3119 m.

*Pristimantis lacrimosus*.— **PERU: Loreto:** Provincia Requena: CORBIDI 3941, Sierra del Divisor, 6°12'49.0"S, 73°14'21.0"W, 500 m, CORBIDI 12133–38; Río Tápiche, 5°38'07.7"S, 73°55'25.3"W, 121 m; Provincia Putumayo: CORBIDI 5894, 5899, 5903, Campamento Piedras, 2°47'33.9"S, 72°55'00.6"W, 156 m.

*Pristimantis mendax*.— **PERU: Cusco:** Provincia La Convención: CORBIDI 8218, 8255, 8596–97, 8600–01, 8603, 8608, 8610, Alto Shimá, 12°32'32.5"S, 73°07'59.9"W, 1592 m. **Huánuco:** Provincia Huánuco: CORBIDI 14925, 14940–42, Santa Clara, 9°37'46.3"S, 75°49'49.8"W, 1085 m; CORBIDI 14992–93, Quebrada Mallgotingo, 9°36'48.2"S, 75°57'15.3"W, 1318 m; Provincia Leoncio Prado: CORBIDI 15494–95, 15499, 15500, 15520, 15553, Campamento La Quinceañera, Parque Nacional Tingo María, 9°22'16.8"S, 75°59'13.8"W, 1124 m; Provincia Pachitea: CORBIDI 13345–13346, Chaglla, 9°36'08.4"S, 75°54'10.0"W, 883 m; Provincia Puerto Inca: CORBIDI 13945–46, 14434–35, Campamento Peligroso, Serranía del Sira, 9°25'34.2"S, 74°44'06.6"W, 1525 m.

*Pristimantis olivaceus*.— **PERU: Cusco:** Provincia La Convencion: CORBIDI 8086, 10530, Comunidad Nativa Chokoriari, 11°57'25.0"S, 72°56'27.5"W, 434 m; CORBIDI 8296, 9765–66, Comunidad Nativa Puyentimari, 12°11'18.7"S, 73°0'03.3"W, 725 m; CORBIDI 10260, Kinteroni, 11°30'46.3"S, 73°15'06.3"W, 447 m. **Madre de Dios:** Provincia Tambopata: CORBIDI 5238, Lago Tres Chimbadás, 12°47'11.0"S, 69°12'21.1"W, 175 m; CORBIDI 13493–94, El Parador, 12°58'47.0"S, 70°14'06.2"W, 240 m.

*Pristimantis rhodoplichus*.— **PERU: Piura:** Provincia Ayabaca: CORBIDI 0448–49, Bosque de Cuyas, 4°40'01.0"S, 79°34'25.0"W, 2673 m.

*Pristimantis rhodostichus*.— **PERU: Loreto:** Provincia Datem del Marañón: CORBIDI 11430, Cabecera del Wee, Distrito Manseriche, 4°12'14.8"S, 77°31'47.2"W, 1435 m. **San Martín:** Provincia Mariscal Cáceres: CORBIDI 0667–76, 0678–80, Laguna Negra 6°53'29.3"S, 77°23'18.3"W, 1788 m; Provincia Picota: CORBIDI 8867, 9933, Puesto de control 16, Parque Nacional Cordillera Azul 7°04'08.9"S, 76°00'55.2"W, 1122 m.

*Pristimantis schultei*.— **PERU: Amazonas:** Provincia Luya: CORBIDI 0368, Área de Conservación Privada Huiquilla, 6°22'45.0"S, 77°58'42.0"W, 2935 m; CORBIDI 12349–63, 12365–66, 12370–71, Distrito Lonya Chico, 6°14'01.7"S, 78°06'78.3"W, 2826 m; Provincia Bongará: CORBIDI 0452–62, Yuramarca, 6°02'16.7"S, 75°51'05.5"W, 2857 m; Provincia Rodríguez de Mendoza: CORBIDI 11689, 11693–96, 11701, 11708, 11725–33, 11737–38, 11740–41, Quebrada Salas (Distrito Vista Alegre), 6°06'42.9"S, 77°26'24.0"W, 2575 m; CORBIDI 12870–75, 12883, La Colpa 6°23'37.0"S, 77°13'42.6"W, 2347 m. **San Martín:** Provincia Mariscal Cáceres: CORBIDI 0597, 0603–04, 0606–07, 0612, 0614, 0616, Laurel, 6°41'00.4"S, 77°41'39.9"W, 2799 m; CORBIDI 15054, 15056, 15065–66, 15071, 15106–09, 15123, Albazo, 6°42'59.4"S, 77°40'27.5"W, 2404 m.

## Appendix 2

### Gene sequences for molecular analyses

GenBank accession numbers for the taxa and genes sampled in this study. <sup>1</sup>*Pristimantis* sp. (ROM 43978) is treated herein as *Pristimantis* sp. following Padial et al. (2014).

Taxon	Voucher Nbr.	16S
<i>Pristimantis acuminatus</i>	MC 11555	DQ195448
<i>Pristimantis bromeliaceus</i>	KU 291702	EF493351
<i>Pristimantis boulengeri</i>	MAV 257	DQ195452
<i>Pristimantis</i> cf. <i>mendax</i>	MTD45080	EU186659
<i>Pristimantis dorsopictus</i>	MHUA 7638	KP082874
<i>Pristimantis galdi</i>	QCAZ 32368	EU186670
<i>Pristimantis mindo</i>	MZUTI 1382	KF801584
<i>Pristimantis mindo</i>	MZUTI 1756	KF801581
<i>Pristimantis moro</i>	AJC 1860	JN991454
<i>Pristimantis moro</i>	AJC 1753	JN991453
<i>Pristimantis omeviridis</i>	QCAZ19664	EU130579
<i>Pristimantis pluvialis</i>	CORBIDI 11862	KX155577
<i>Pristimantis pluvialis</i>	CORBIDI 16695	KX155578
<i>Pristimantis pulchridormientes</i> sp. n.	CORBIDI 15563	KX664106
<i>Pristimantis pulchridormientes</i> sp. n.	CORBIDI 15566	KX664107
<i>Pristimantis ridens</i>	AJC 1778	KR863320
<i>Pristimantis</i> sp. 1	CORBIDI 17473	KX155579
<i>Pristimantis</i> sp. 2	ROM 43978	EU186678
<i>Pristimantis subsigillatus</i>	MECN 10117	KF801580

# A new species of earth snake (Dipsadidae, *Geophis*) from Mexico

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## Abstract

A new species of the *Geophis dubius* group is described from the mountains of the Sierra Zongolica in west-central Veracruz and the Sierra de Quimixtlán in central-east Puebla. The new species is most similar to *G. duellmani* and *G. turbidus*, which are endemic to the mountains of northern Oaxaca and the Sierra Madre Oriental of Puebla and Hidalgo, respectively. However, the new species differs from *G. duellmani* by the presence of postocular and supraocular scales and from *G. turbidus* by having a bicolor dorsum. With the description of the new species, the species number in the genus increases to 50 and to 12 in the *G. dubius* group. Additionally, a key to the species of the *G. dubius* group is provided.

## Keywords

Dipsadidae, *Geophis dubius* group, *Geophis duellmani*, *Geophis turbidus*, Mexico, New species, Puebla, Veracruz

## Introduction

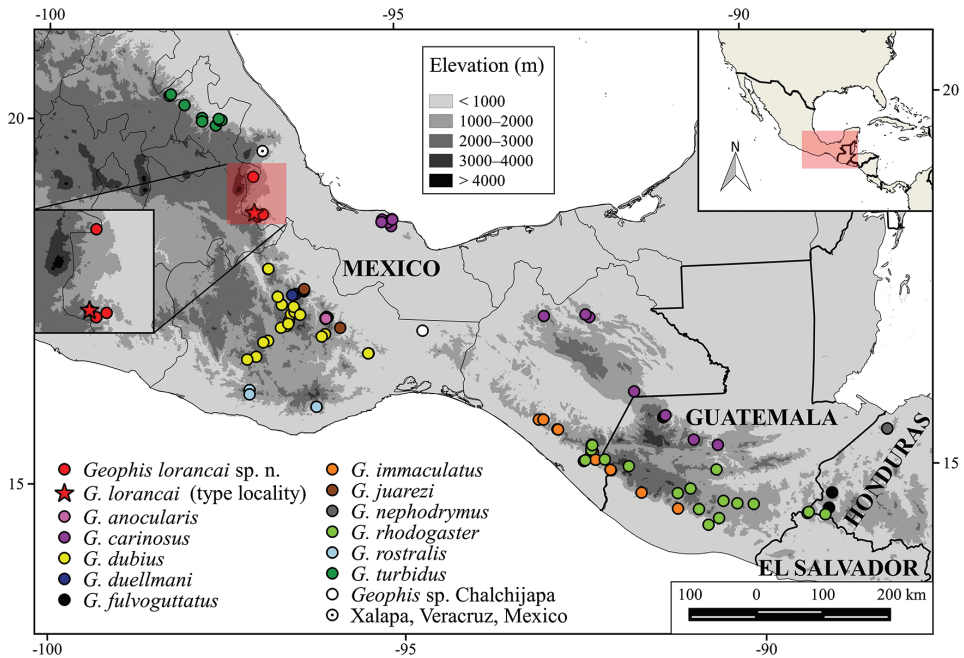
With 49 recognized species (Pavón-Vázquez et al. 2013), the colubrid genus *Geophis* (Dipsadidae) is one of the most speciose genera of snakes in the Western Hemisphere. Its geographic range extends from southwestern Chihuahua and southern Tamaulipas, Mexico, south and east through central and southern Mexico (except for the Yucatán Peninsula) and Central America to northern and western Colombia between 13 and 2744 m elevation (Downs 1967, Wilson and Townsend 2007).

Downs (1967) divided *Geophis* into seven species groups (*chalybeus*, *championi*, *dubius*, *latifrontalis*, *omiltemanus*, *semidoliatus*, and *sieboldi*) mainly on the basis of their external morphology and dentition. The *dubius* group is currently composed of 11 species, which range collectively from northern Puebla and central Veracruz south and east through southeastern Mexico and Guatemala to El Salvador (Fig. 1): *G. anocularis*, from the Sierra Mixe in northern Oaxaca; *G. carinosus*, from the Sierra de Los Tuxtlas in southern Veracruz, the Atlantic slopes of Chiapas, and the Sierra de Los Cuchumatanes in Guatemala; *G. dubius*, from central and northern Oaxaca and perhaps central Veracruz; *G. duellmani*, from the Sierra de Juárez in northern Oaxaca; *G. fulvoguttatus*, from El Salvador and Honduras; *G. immaculatus*, from central Chiapas, Mexico, and the Pacific versant of Guatemala; *G. juarezi*, from the Sierra de Juárez and Sierra Mixe in northern Oaxaca; *G. nephodrymus*, from the Sierra de Omoa, Honduras; *G. rhodogaster*, which ranges from the mountains of southwestern Chiapas, Mexico, east through the western part of the Guatemalan Plateau and southeastern highlands of Guatemala to adjacent El Salvador and Honduras; *G. rostralis*, from southern Oaxaca, and *G. turbidus*, from northern Puebla (Downs 1967, Campbell et al. 1983, Smith 1995, Nieto-Montes de Oca 2003, Wilson and Townsend 2007, Townsend 2009, Pavón-Vázquez et al. 2013). Additionally, a specimen of uncertain status within the *G. dubius* group was reported by Nieto-Montes de Oca (2003) from the Chimalapas region, Oaxaca, Mexico. The *G. dubius* group was defined by Downs (1967) and redefined by Nieto-Montes de Oca (2003).

Most species of the *Geophis dubius* group are uniformly dark dorsally without conspicuous patterns, though a juvenile of *G. turbidus* exhibits a light collar. The only exceptions are *G. fulvoguttatus*, which has 17–22 irregular yellowish-brown to reddish blotches on the posterior part of the body and 3–4 irregular light blotches on the anterior half of the tail on a dark background (Downs 1967); *G. nephodrymus*, which ranges from patternless to extensively marked with bands, laterally offset partial bands, and lateral blotches that range from pale grayish cream to brick red on a gray dorsal background (Townsend 2009); and *G. duellmani*, which has a black head and anteriormost portion of the body and dark saddles on a red or white background on the rest of the body and tail (Campbell et al. 1983).

Herein, a new species of the *Geophis dubius* group is described with black crossbands on an orange-red background color on most of the body and tail from the mountains of east-central Puebla and west-central Veracruz.





**Figure 1.** Distribution of the species of the *Geophis dubius* group. Bold lines represent country limits and narrow lines limits of Mexican states.

## Materials and methods

The sample of the new species ( $n = 8$ ) was compared with specimens of all of the species of the *Geophis dubius* group from Mexico, with the exception of *G. rostralis*. A list of the specimens examined is provided in Supplementary file 1: Table 1. Acronyms for herpetological collections follow Sabaj Pérez (2014), with the addition of ITSZ (Instituto Tecnológico Superior de Zongolica). SMR is an abbreviation for field numbers of uncatalogued specimens in the MZFC.

Scale nomenclature follows Downs (1967) and Savage and Watling (2008). Scale counts were performed with the aid of a dissecting microscope. Ventrals were counted as suggested by Downs (1967). Bilateral characters were scored on both sides. When the condition of a given character was not identical on both sides, the conditions on the left and right sides are given, in that order, separated by a slash (/). Measurements were taken with a ruler, digital calipers, or an ocular micrometer to the nearest 0.1 mm. Head length was measured from the tip of the snout to the posterior end of the parietals. All scale dimensions were measured at their maximum. To examine dentition characters, the maxilla and ectopterygoid were removed from the skull and cleansed in a dilute solution of Proteinase K for approximately one hour. Color codes and descriptions follow Smith (1975). The diagnosis is based on both the specimens examined and the relevant literature (Bogert and Porter 1966, Downs 1967, Smith

and Holland 1969, Campbell and Murphy 1977, Savage 1981, Campbell et al. 1983, Restrepo and Wright 1987, Smith and Chiszar 1992, Smith and Flores-Villela 1993, Lips and Savage 1994, Smith 1995, Wilson et al. 1998, Pérez-Higareda et al. 2001, Myers 2003, Nieto-Montes de Oca 2003, Savage and Watling 2008, Townsend 2009, Townsend and Wilson 2006, Pavón-Vázquez et al. 2011, 2013).

## Results

### *Geophis lorancai* sp. n.

<http://zoobank.org/364ED739-EBD8-4CC5-8124-B87C2E054AB3>

Figs 2, 3

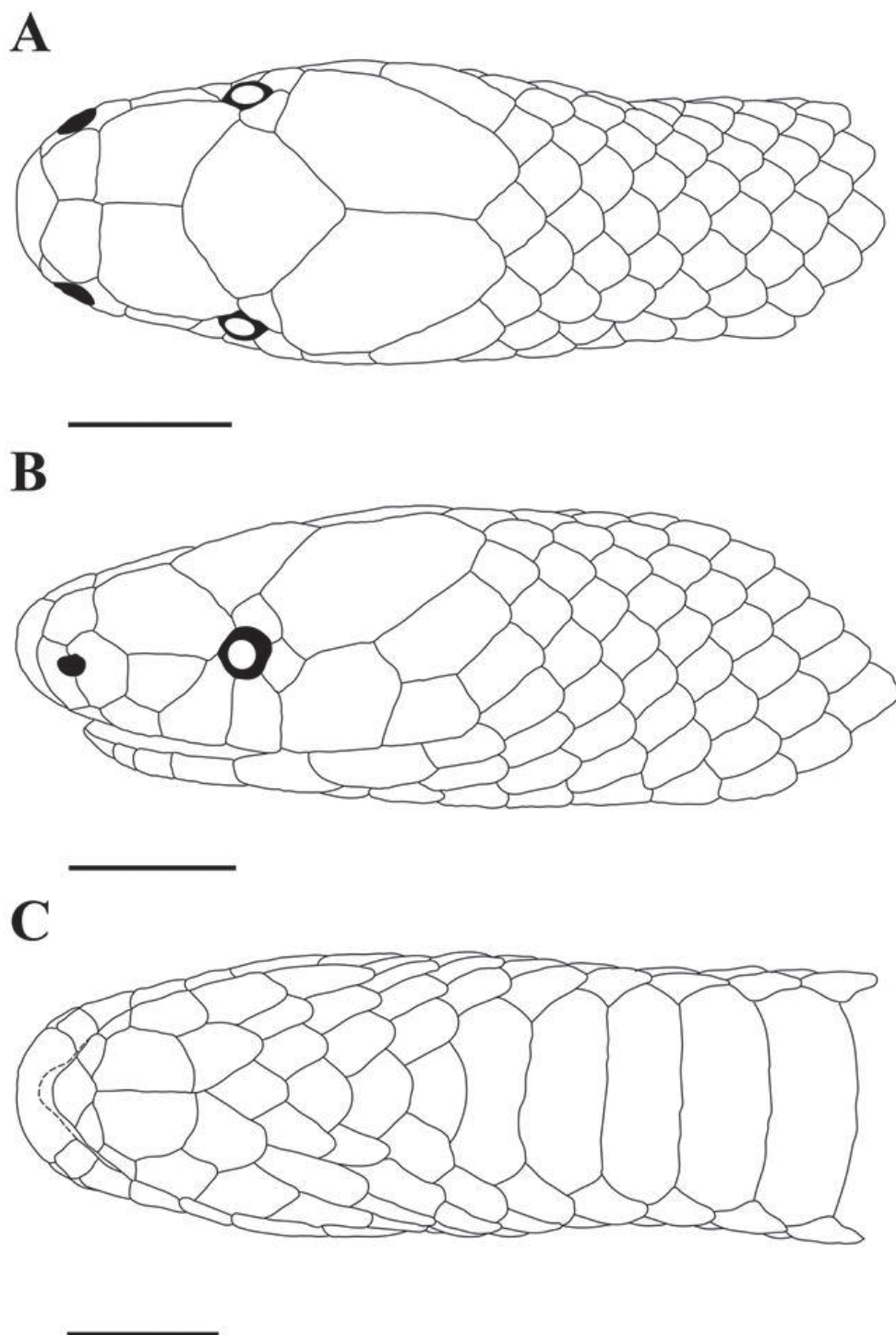
**Holotype** (Fig. 2). MZFC 28401, an adult male from the Instituto Tecnológico Superior de Zongolica, vicinity of Atlanca, municipality of Los Reyes, Sierra de Zongolica, Veracruz, Mexico (18°41'48"N, 97°03'21"W), 1700 m elevation, collected by Miguel Angel de la Torre Loranca on April 6, 2008.

**Paratypes.** Seven specimens, six from the Sierra de Zongolica of west-central Veracruz and one from the Sierra de Quimixtlán of adjacent Puebla, Mexico. Veracruz: Three from the same locality as the holotype (MZFC 28402–03, ITSZ 217); one from Zongolica, 18°39'02"N, 97°00'29"W, 1210 m (ITSZ 071); one from 7 km E Zongolica (MZFC 28405); one from Los Reyes, 18°41'48"N, 97°03'21"W, 1700 m (ITSZ 025). Puebla: Chichiquila, 19°11'35"N, 97°03'57"W, 1700 m (MZFC 28404).

**Diagnosis.** A member of the *Geophis dubius* group characterized by the following combination of traits: eye relatively small (see below); single supraocular and postocular present on each side; fifth supralabial and parietal in contact; mental scale and anterior chinshields in contact; smooth dorsal scales throughout the body arranged in 17 rows; ventrals 130,  $n = 1$ , in females, and 125–130,  $n = 7$ , in males; subcaudals in males 33–35,  $n = 5$ ; dorsal body and tail pattern consisting of dark crossbands on a paler, red-orange background; reddish orange venter; maxillary teeth 7.

*Geophis lorancai* may be distinguished from all of the species in the *championi* and *semidoliatus* groups, and all of the species in the *sieboldi* group except *G. dunni*, *G. nassalis*, *G. occabus*, and *G. sieboldi* by having the dorsal scales arranged in 17 rows (versus dorsal scales arranged in 15 rows in the other species); and from the latter four species by having smooth dorsal scales throughout the body (versus dorsal scales keeled on at least the posterior half of the body in the other species).

*Geophis lorancai* differs from all of the species in the *omiltemanus* and *chalybeus* groups by having a small eye (i.e., its horizontal diameter contained nearly four times in the snout length, versus its horizontal diameter contained less than three times in the snout length in the other species); in addition, it may be distinguished from all of the species in the *omiltemanus* group by having the fifth supralabial and parietal in contact (versus fifth supralabial and parietal separated by one anterior temporal in the other species); from some species in the *chalybeus* group (*G. dugesii*, *G. nigrocinctus*, and



**Figure 2.** *Geophis lorancai*, holotype (MZFC 28401). Head scales in **A** dorsal **B** left lateral, and **C** ventral views. Horizontal lines = 3 mm.

*G. tarascae*) by having the dorsals arranged in 17 rows (versus dorsals arranged in 15 rows in the other species); and from the remaining species in this group (*G. bicolor* and *G. chalybeus*) by having the mental and anterior chinshields in contact (versus mental and anterior chinshields separated by the first pair of infralabials in the other species).

*Geophis lorancai* may be distinguished from the species in the *latifrontalis* group as follows: from *G. blanchardi* and *G. mutitorques*, by having a dorsal body pattern consisting of dark crossbands on a paler, red-orange background (versus dorsum uniformly dark in *G. blanchardi* and adults of *G. mutitorques*—juveniles with yellow collar); from *G. latifrontalis* and *G. mutitorques*, by having the fifth supralabial and parietal in contact (versus fifth supralabial and parietal separated by one anterior temporal in *G. latifrontalis* and *G. mutitorques*); and from *G. blanchardi* and *G. latifrontalis*, by having the mental and anterior chinshields in contact (versus mental and anterior chinshields separated by the first pair of infralabials in *G. blanchardi* and *G. latifrontalis*).

*Geophis lorancai* may be distinguished from the species in the *dubius* group as follows (Supplementary file 2: Table 2): from *G. anocularis*, *G. carinosus*, *G. dubius*, *G. immaculatus*, *G. juarezi*, *G. rhodogaster*, *G. rostralis*, and *G. turbidus* by having a dorsal body and tail pattern consisting of dark crossbands on a paler, red-orange background (versus dorsum uniformly dark in the other species, except for a pink collar present in a juvenile of *G. turbidus*); from *G. duellmani* by having one supraocular and one postocular (versus supraocular and postocular absent in *G. duellmani*); from *G. fulvoguttatus* by having fewer ventrals (130,  $n = 1$ , in females, and 125–130,  $n = 7$ , in males; versus 145–147,  $n = 2$ , in females, and 135–137,  $n = 2$ , in males of *G. fulvoguttatus*); and from *G. nephodrymus* by having fewer maxillary teeth (7,  $n = 3$ ; versus 11,  $n = 1$ , in *G. nephodrymus*), a reddish orange venter (versus venter predominantly gray or yellowish cream in *G. nephodrymus*) and more subcaudals in males (33–35,  $n = 5$ ; versus 22–31,  $n = 6$ , in *G. nephodrymus*).

**Description of holotype** (Fig. 2). Adult male. Head length = 8.9 mm, snout-vent length (SVL) = 268 mm, tail length = 53.4 mm. Head slightly distinct from body. Snout long, contained 2.2 times in head, rounded from above, projecting anteriorly far beyond lower jaw; rostral 0.7 times as broad as high, portion visible from above 0.3 times as long as its distance from frontal, 1.2 times as long as internasals common suture, with posterior end approximately at level of anterior margin of nostrils; internasals broader than long (length / breadth = 0.7/0.8), slightly angulate anteriorly, in lateral contact with anterior and posterior nasals, their length and common suture 0.7/0.8 and 0.5 times as long as prefrontals common suture, respectively. Prefrontals in lateral contact with postnasal, loreal, and eye on each side, and additionally with third supralabial on left side; their length 0.6 times snout length; their common suture 0.5 times frontal length. Frontal slightly broader than long (breadth / length ratio = 1.1). Supraocular large, in contact with prefrontal, frontal, parietal, and postocular; approximately 0.9 times as long as horizontal diameter of eye, 0.6 times as long as loreal, bordering posterior half of dorsal margin of orbit, ventral margin slightly projecting posteriorly beyond posterior margin of orbit. Parietals 1.5/1.6 times as long as broad, their length 0.5 times head length, their common suture 0.8 times as long as frontal.

Nasal divided. Postnasal 1.3/1.1 times as long as prenasal. Combined length of prenasal and postnasal subequal to loreal length. Loreal 1.4/1.5 times as long as deep, contained 2.7/2.5 times in snout length, 1.6 times as long as horizontal diameter of eye, its dorsal margin slightly concave; failing to reach orbit on the left side, in broad contact with anterior margin of orbit on right side. Eye small, contained 4.3 times in snout length, its vertical diameter 0.7 times its distance from lip. One postocular, 1.4/1.3 times as high as long, 1/0.8 times as long as supraocular. Supralabials 6/6, first and second in contact with postnasal, second and third in contact with loreal, third and fourth entering orbit (third contacting prefrontal on left side), fifth largest, in contact with parietal. Ventral margin of third supralabial 1.2/1.6 times that of second supralabial; ventral margin of fifth supralabial 1.9 times that of fourth supralabial, 1.0/1.1 times that of sixth supralabial. Anterior temporal absent. One posterior temporal. Five nuchal scales in contact with parietals.

Mental 1.2 times as broad as long, pointed anteriorly, in posterior contact with anterior chinshields. Infralabials 6/6, first to third in contact with anterior chinshields, third and fourth in contact with posterior chinshields. Anterior chinshields 1.6/1.7 times as long as broad, 1.4 times as long as posterior chinshields. Posterior chinshields in narrow contact with each other anteriorly, separated posteriorly by one midgular scale. Four midgular scales. Infralabials and scales in chin region smooth. Dorsals in 17-17-17 rows, smooth throughout the body; no evident apical pits. Ventrals 128. Subcloacal scute single. Paired subcaudals 34.

*Color in life* (Fig. 3): Dorsal and lateral surfaces of head and anterior end of body (to approximately level of 12<sup>th</sup> middorsal scale) black; those of rest of body and tail with black transverse marks on a reddish orange background color (color 17, Spectrum orange; Smithe, 1975). Fifteen black transverse marks on body; 1<sup>st</sup>–2<sup>nd</sup>, 4<sup>th</sup>–5<sup>th</sup>, 7<sup>th</sup>, 9<sup>th</sup>, 11<sup>th</sup>–12<sup>th</sup>, and 14<sup>th</sup>–15<sup>th</sup> saddle-shaped, about 6–10 scales in length, usually extending laterally to lateral margin of ventral scales (one saddle extending laterally to third dorsal row on right side); remaining five marks consisting each of a transverse band extending on one side of body and bifurcating at midline into two transverse bands on opposite side, forming a Y-shaped mark; Y-shaped marks 7–9 scales in length at their longest. Reddish orange rings between saddles 4–6 scales in length. Eight black transverse marks on tail; anterior three saddle-shaped, about 1.5–4 scales in length, extending laterally to lateral margin of subcaudals or nearly so; 4<sup>th</sup> mark irregular, elongate, presumably formed by fusion of several adjacent transverse marks, 9.5 scales in length at its longest, in lateral contact with first dorsal scale row at three points on each side; remaining marks shorter, irregular; posterior end of tail with black and red checkered pattern. Reddish orange rings between black marks 1–2.5 scales in length. Ventral surface of head pale grey; that of body and tail immaculate reddish orange except for one dark splotch on middle of 7<sup>th</sup> ventral and black lateral ends of those ventrals involved in transverse body marks; tail surface increasingly dark posteriorly.

**Dentition.** The description below is based on the dentition on the right side of paratypes ITSZ 25 and MZFC 28402 and on the left side of paratype MZFC 28403. Scored characters were consistent in all the specimens. Maxilla extending anteriorly





**Figure 3.** Coloration in *Geophis lorancai*: **A** adult male paratype (MZFC 28402), photo by Miguel Ángel de la Torre Loranca; and **B** type series.

to level of suture between 2<sup>nd</sup> and 3<sup>rd</sup> supralabials; posterior fourth of maxilla curved ventrally in lateral view; anterior tip of maxilla toothless, bluntly pointed; maxillary teeth 7, recurved; teeth slightly longer at middle of maxilla; large flange projecting



medially at approximately level of middle of maxilla; posterior end of maxilla laterally compressed into moderate flange. Anterior end of ectopterygoid bifurcate; dorsal branch long, compressed; ventral branch very short, stump-like.

**Variation.** This section is based on the examination of the seven paratypes. We describe only character conditions that differ from those in the holotype. Ranges are given for some characters. When ranges included the holotype, we report its condition. Two males (MZFC 28403–28404) have an incomplete tail; thus, subcaudal and total segmental counts, tail length, tail length / total length ratio, and number of tail black markings are not reported for those specimens.

Posterior temporal divided transversally on both sides in three specimens (ITSZ 71, MZFC 28402, MZFC 28405); nuchal scales in contact with parietals between posterior temporals 3–7,  $\bar{x} = 5.7$  (3, in one specimen; 5, in two; 6, in one; 7, in three with transversally divided posterior temporals). Second and third supralabials fused on both sides in ITSZ 25 (supralabials 5/5); infralabials 7/7 in one specimen (ITSZ 71). Posterior chinshields in medial contact with each other in four specimens, separated by one midgular scale in three. Midgular scales 2–3,  $\bar{x} = 2.9$  (2, in one specimen; 3, in six). Ventrals 130 in single known female; 125–130,  $\bar{x} = 127.7$ ,  $n = 7$ , in males, including holotype (one small scale anterior to subcloacal scute, not reaching lateral-most row of dorsals on one side, excluded from ventral counts in ITSZ 71 and MZFC 28402). Subcaudals 25 in single known female, 33–35,  $\bar{x} = 34$ ,  $n = 5$ , in males, including holotype; total segmental counts 155 in single known female, 159–165,  $\bar{x} = 162.2$ ,  $n = 5$ , in males, including holotype. Apical pits evident over vent region in two specimens (ITSZ 217, MZFC 28403).

**Color pattern** (Fig. 3). General pattern similar to that of holotype in all specimens. Transverse dark marks on body and tail 13–20 and 4–10, respectively. Body pattern composed of dark crossbands and Y-shaped marks in all specimens (10 and 2, in ITSZ 25; 13 and 4, in ITSZ 71; 17 and 3, in ITSZ 217; 12 and 4, in MZFC 28402; 12 and 2, in MZFC 28403; 18 and 1, in MZFC 28404; 15 and 2, in MZFC 28405) and single, unusual marks in some specimens: adjacent transverse bands connected to each other, forming a zigzagging mark, in two specimens (zigzagging mark in contact with lateral edge of ventral scales at three points on each side in ITSZ 25, at four points on one side and three points on opposite side in ITSZ 71); two adjacent transverse bands connected along midline, forming a H-shaped mark, in one specimen (MZFC 28404). Tail pattern composed of black crossbands in all specimens (7, in ITSZ 25; 8, in ITSZ 71; 2, in ITSZ 217; 7, in MZFC 28402; 5, in MZFC 28405) in addition to one Y-shaped mark in ITSZ 71, and one zigzagging mark in contact with lateral edge of ventral scales at two points on one side and three points on opposite side in ITSZ 217; posterior end of tail light in ITSZ 25, dark in MZFC 28402 and MZFC 28405, and checkered with red and black in ITSZ 71 and ITSZ 217. Ventral surface of head and body immaculate, except for black stippling, heavier on anterior portion of body, in ITSZ 71, and dark first ventral, lateral ends of ventrals gradually paler posteriorly, in two specimens (MZFC 28402–28403); ventral surface of tail paler, subcaudals adjacent to black dorsal marks with dark lateral ends; dark pigment gradually heavier pos-

teriorly; dark pigment on posterior edge of most subcaudals in two specimens (MZFC 28402 and 28404).

**Etymology.** The specific name is treated as a noun in the genitive case and honors Biologist Miguel Ángel de la Torre Loranca, who obtained most of the specimens of the new species from the Sierra de Zongolica.

**Distribution and ecology** (Fig. 1). *Geophis lorancai* is known from the Sierra de Zongolica of west-central Veracruz and the Sierra de Quimixtlán in adjacent extreme east-central Puebla between 1210 and 1700 m elevation (Fig. 1). All of the specimens of *G. lorancai* were obtained between October 1996 and April 2013. In these sierras, the terrain is irregular with numerous hills (some of them isolated), ascents and descents, and streams. The terrain shows a general decline towards the Gulf coastal plain (i.e., from west to east). The area is covered with cloud forest and pine-oak associations. In both sierras, *G. lorancai* is sympatric with *G. semidoliatus*, another species with dark crossbands on a red background belonging to the *G. semidoliatus* group.

All of the specimens of *Geophis lorancai* were found in cloud forest. The principal arboreal components of the vegetation at the type locality are *Liquidambar styraciflua*, *Quercus* spp., *Saurauia scabrida*, *Clethra mexicana*, *Lippia myriocephala*, *Heliocarpus appendiculatus*, *Magnolia mexicana*, *Carpinus carolineana*, and *Ternstroemia sylvatica*. The bush stratum is dominated by *Psychotria galeottiana*, *Piper* spp., *Phyllonoma latiscuspis*, and *Miconia* spp. Species found in the herbaceous stratum are *Smilax* spp., *Selaginella* spp., *Begonia* spp., *Monstera deliciosa*, *Philodendron* spp., *Salvia* spp., and *Dhalia coccinea*. Epiphytes of the Bromeliaceae and Orchidaceae families are common in this type of vegetation and mainly represented by the following species: *Tillandsia punctulata*, *T. multicaulis*, *Nidema boothii*, *Lycaste deppei*, and *L. consobrina* (Rzedowski 1978, Cázares Hernández personal communication). The specimens of *G. lorancai* were found either among the leaf litter or under fallen logs.

## Discussion

With the addition of *Geophis lorancai*, the number of species in the genus increases to 50, and the number of species in the *G. dubius* group to 12, of which ten occur in Mexico (Fig. 1): seven are endemic to Mexico (*G. anocularis*, *G. dubius*, *G. duellmani*, *G. juarezi*, *G. lorancai*, *G. rostralis*, and *G. turbidus*), two are shared only with Guatemala (*G. carinosus* and *G. immaculatus*), and one with Guatemala, El Salvador, and Honduras (*G. rhodogaster*). Two species are distributed only in Central America: *G. nephodrymus* in Honduras and *G. fulvoguttatus* in Honduras and El Salvador.

*Geophis lorancai* fills a gap in the distribution of the *G. dubius* group between the ranges of *G. turbidus* and those of the species from northern Oaxaca. Pavón-Vázquez et al. (2013) described *G. turbidus* from northern Puebla. This species has been recently reported also from adjacent Hidalgo (Cruz-Elizalde et al. 2015), and represents the northern limit of the distribution of the *G. dubius* group. With the exception of a

doubtful record of *G. dubius* from “Jalapa” in central Veracruz (see below), the closest records to *G. lorancai* of this group are found in northern Oaxaca, where several endemic species are found (i.e., *G. anocularis*, *G. duellmani*, and *G. juarezi*). Other species found in Oaxaca are *G. dubius*, widely distributed in central and northern Oaxaca, and *G. rostralis*, from the Sierra Madre del Sur.

The validity of the record from Jalapa has been questioned. Bogert and Porter (1966) considered this record as doubtful on the basis that although “Jalapa” was the locality given by Fischer (1886) as the source of the specimen he described as *G. fuscus*, he did not specify the state and there are “at least a dozen” other localities with the same name in Mexico, including two in the state of Oaxaca. For many years central Veracruz has been a collecting site for many herpetologists, yet *G. dubius* has never been found there. The only species of *Geophis* found in central Veracruz are the common *G. semidoliatus* (*semidoliatus* group), *G. blanchardi*, *G. mutitorques* (both belonging to the *latifrontalis* group), and *G. chalybeus* (*chalybeus* group). According to this, and the fact that *G. dubius* is a common species in the state of Oaxaca, it seems possible that the specimen from Jalapa assigned to this species comes from Oaxaca.

*Geophis lorancai* and *G. turbidus* are similar in scalation and relatively close geographically. Thus, it is conceivable that these two taxa represent the same species with two color morphs: one predominantly dark and another one with dark crossbands on a red-orange background, as in the polymorphic species *G. occabus* and *G. brachycephalus* (Pavón-Vázquez et al. 2011). However, a phylogenetic analysis of *Geophis* based on several mitochondrial and nuclear genes shows that *G. lorancai* and *G. turbidus* are considerably divergent genetically and not each other’s sister species (Canseco-Márquez et al. unpublished data).

### Key to the species of the *Geophis dubius* group

- 1 Dorsum uniformly dark—pink collar may be present ..... 2
- Dorsum bearing reddish or whitish bands, blotches, or saddles ..... 10
- 2 Dorsal scales keeled on at least posterior half of body ..... 3
- Dorsal scales smooth throughout body or, if keeled, keeling restricted to posterior fourth of body or less ..... 4
- 3 Supraocular in broad contact with frontal; posterior chinshields in broad medial contact anteriorly; ventrals 116–123 in males, 125–136 in females ..... *G. carinosus*
- Supraocular separated from or in narrow contact with frontal; posterior chinshields usually separated or in narrow medial contact; ventrals 114–115 in males, 118–124 in females ..... *G. juarezi*
- 4 Supraocular absent ..... 5
- Supraocular usually distinct or, if indistinct, indistinctness caused by the obvious fusion with another scale ..... 6

- 5 Postocular absent ..... *G. anocularis*  
 – Postocular present ..... *G. rhodogaster*  
 6 Maxillary teeth usually fewer than 12, anterior tip of maxilla toothless (not from the Sierra Madre of Guatemala and Chiapas, Mexico) ..... 7  
 – Maxillary teeth 12, anteriormost maxillary tooth born at anterior tip of maxilla (Sierra Madre of Guatemala and Chiapas, Mexico) ..... *G. immaculatus*  
 7 Ventrals + subcaudals more than 160 (159 in a single female of *G. turbidus* from northern Puebla, Mexico) ..... 8  
 – Ventrals + subcaudals 160 or less (Sierra de Omoa, Honduras) .....  
 ..... *G. nephodrymus* (in part)  
 8 Internasals and prefrontals usually fused; loreal longer than combined prenasal and postnasal length; 131 ventrals or more ..... *G. dubius*  
 – Not as above ..... 9  
 9 Subcaudals 40 or more; tail length / total length ratio 0.20 or more (Sierra Madre del Sur, Oaxaca, Mexico) ..... *G. rostralis*  
 – Subcaudals fewer than 40; tail length / total length ratio 0.18 or less (Sierra Madre Oriental in Puebla and Hidalgo, Mexico) ..... *G. turbidus*  
 10 Supraocular absent ..... *G. duellmani*  
 – Supraocular usually distinct or, if indistinct, indistinctness caused by the obvious fusion with another scale ..... 11  
 11 Ventrals + subcaudals less than 171 ..... 12  
 – Ventrals + subcaudals 171 or more ..... *G. fulvoguttatus*  
 12 Maxillary teeth 7; ventral surface of body reddish orange; subcaudals 33–35 in males (Sierra de Quimixtlán, Puebla, and Sierra de Zongolica, Veracruz, Mexico) ..... *G. lorancai*  
 – Maxillary teeth 11; ventral surface of body predominantly gray or yellowish cream; subcaudals 22–31 in males (Sierra de Omoa, Honduras) .....  
 ..... *G. nephodrymus* (in part)

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## Supplementary material 1

### Table S1. Specimens examined.

Authors: Luis Canseco-Márquez, Carlos J. Pavón-Vázquez, Marco Antonio López-Luna, Adrián Nieto-Montes de Oca

Data type: MS Word file

Explanation note: All of the specimens are from Mexico. The table is arranged alphabetically by species name and specimen voucher number, in that order.

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## Supplementary material 2

### Table 2. Selected characters in the species of the *G. dubius* group.

Authors: Luis Canseco-Márquez, Carlos J. Pavón-Vázquez, Marco Antonio López-Luna, Adrián Nieto-Montes de Oca

Data type: MS Word file

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