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One new species of the genus *Savarna* Huber, 2005 (Araneae, Pholcidae) from southern Thailand

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Abstract

One new species *Savarna kraburiensis* **sp. n.** (♂♀) is reported from southern Thailand.

Keywords

Taxonomy, morphology, pholcidae, southeast Asia

Introduction

The small genus *Savarna* Huber, 2005 only contains three species: *Savarna baso* (Roewer, 1963) from Sumatra, Indonesia, *S. tesselata* (Simon, 1901) from Malaysia, and *S. thaleban* Huber, 2005 from Thailand (World Spider Catalog 2014). In this paper, we describe one more, a new species from Ranong, Thailand.

Material and methods

Specimens were examined and measured with a Leica M205 C stereomicroscope; details were studied with an Olympus BX51 compound microscope. Male and female copulatory organs were examined and illustrated after they were dissected from the spiders. Epigynes were removed and treated in 10% warm solution of potassium hydroxide (KOH) before illustration. Type specimens were preserved in 75% ethanol solution. Photographs were taken with an Olympus C7070 wide zoom digital camera (7.1 megapixels) mounted on a Leica M205 C stereomicroscope. The images were assembled using Helicon Focus 3.10 image stacking software. All measurements are given in millimeters unless noted otherwise. Leg measurements are shown as: Total length (femur + patella + tibia + metatarsus + tarsus). Leg segments were measured on their dorsal side. Type specimens are deposited in the Thailand Natural History Museum, Pathum Thani, Thailand.

Terminology and taxonomic descriptions follow Huber (2000). The following abbreviations are used in the descriptions: ALE = anterior lateral eye, AME = anterior median eye, PME = posterior median eye, L/d = length/diameter.

Taxonomy

Genus *Savarna* Huber, 2005

Type species. *Savarna thaleban* Huber, 2005

Savarna kraburiensis sp. n.

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Figs 1–2

Type material. Holotype: ♂, near the entrance of Phra Kha Yang Cave (10°19.568'N, 98°45.908'E, elevation 6 m), Kraburi District, Ranong, Thailand, 28 October 2014, P. Wongprom leg. Paratypes: 1♂, 2♀♀, same data as holotype.

Etymology. The specific name refers to the type locality; adjective.

Diagnosis. The species resembles *S. tesselata* (Simon, 1901) (see Huber 2005: 78, figs 129–130, 138–140), but can be distinguished by absence of median apophyses on male clypeus (Fig. 2E), by relatively wide pedipalpal tibia subproximally (Figs 1A–B), and by shape of bifurcated distal apophysis on bulb (Fig. 1A).

Description. Male (holotype). Total length 2.97 (3.13 with clypeus), prosoma 1.04 long, 1.34 wide, opisthosoma 1.93 long, 1.44 wide. Leg I: 27.73 (7.63 + 0.55 + 7.05 + 9.94 + 2.56), leg II: 18.52 (5.45 + 0.48 + 4.62 + 6.50 + 1.47), leg III: 13.52 (4.04 + 0.47 + 3.27 + 4.77 + 0.97), leg IV: 18.36 (5.64 + 0.48 + 4.49 + 6.73 + 1.02). Habitus as in Fig. 2E. Dorsal shield of prosoma yellowish, with black margins and a narrow, dark median line behind ocular area; sternum black. Legs brownish, but slightly whitish on femora (distally) and tibiae (distally), with slightly darker rings on femora (subdistally). Opisthosoma yellowish, with black spots. Distance PME-PME 0.20, diameter PME 0.12, distance PME-ALE 0.04, AME absent. Ocular area slightly elevated and separated from rest of prosoma. Thoracic furrow distinct and deep. Sternum slightly wider than long (0.87/0.78). Chelicerae as in Fig. 2D, with a pair of

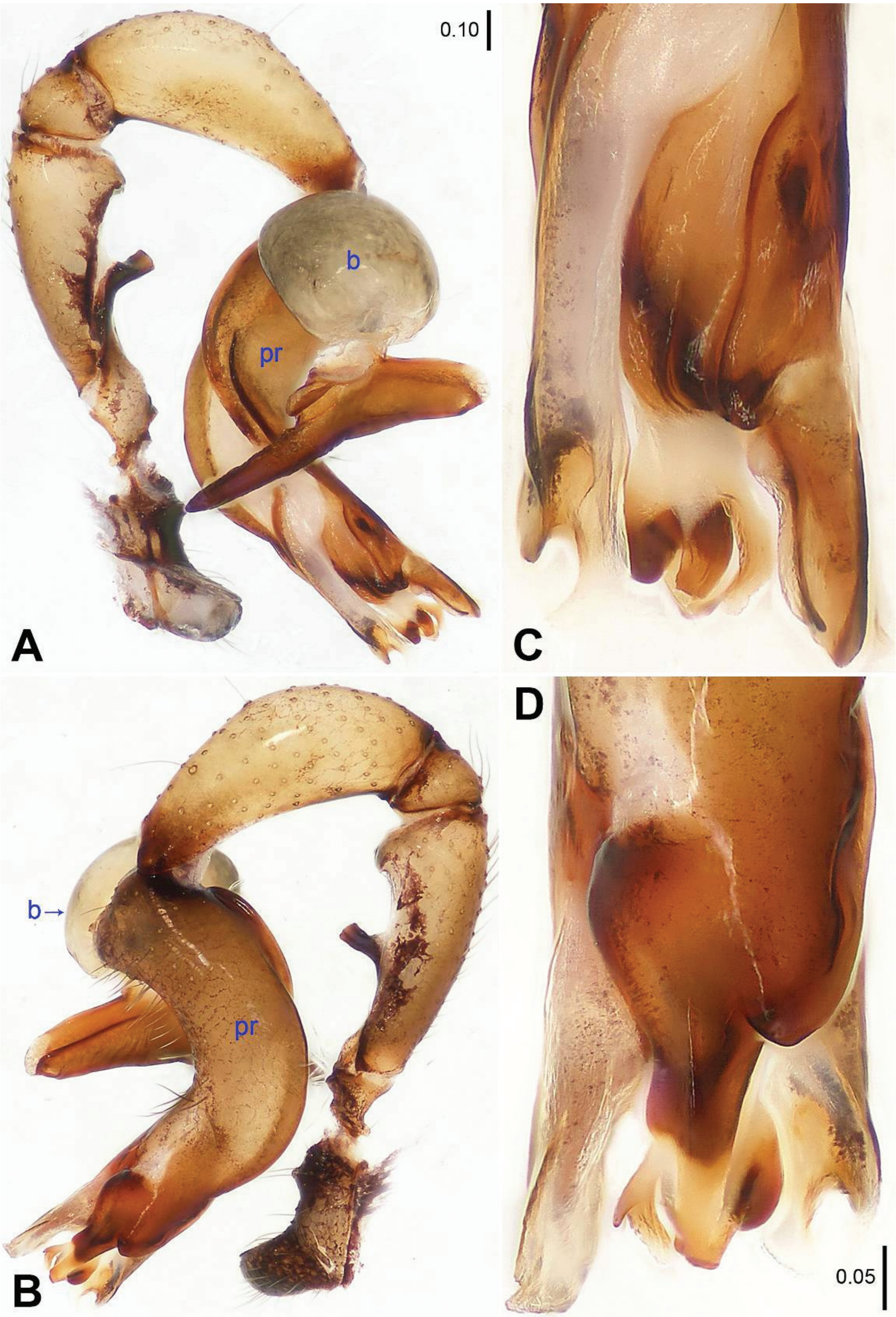

Figure 1. *Savarna kraburiensis* sp. n., holotype male. **A–B** Pedipalp (**A** Prolateral view **B** Retrolateral view) **C–D** Distal part of procursus (**C** Prolateral view **D** Retrolateral view). b = bulb, pr = procursus.

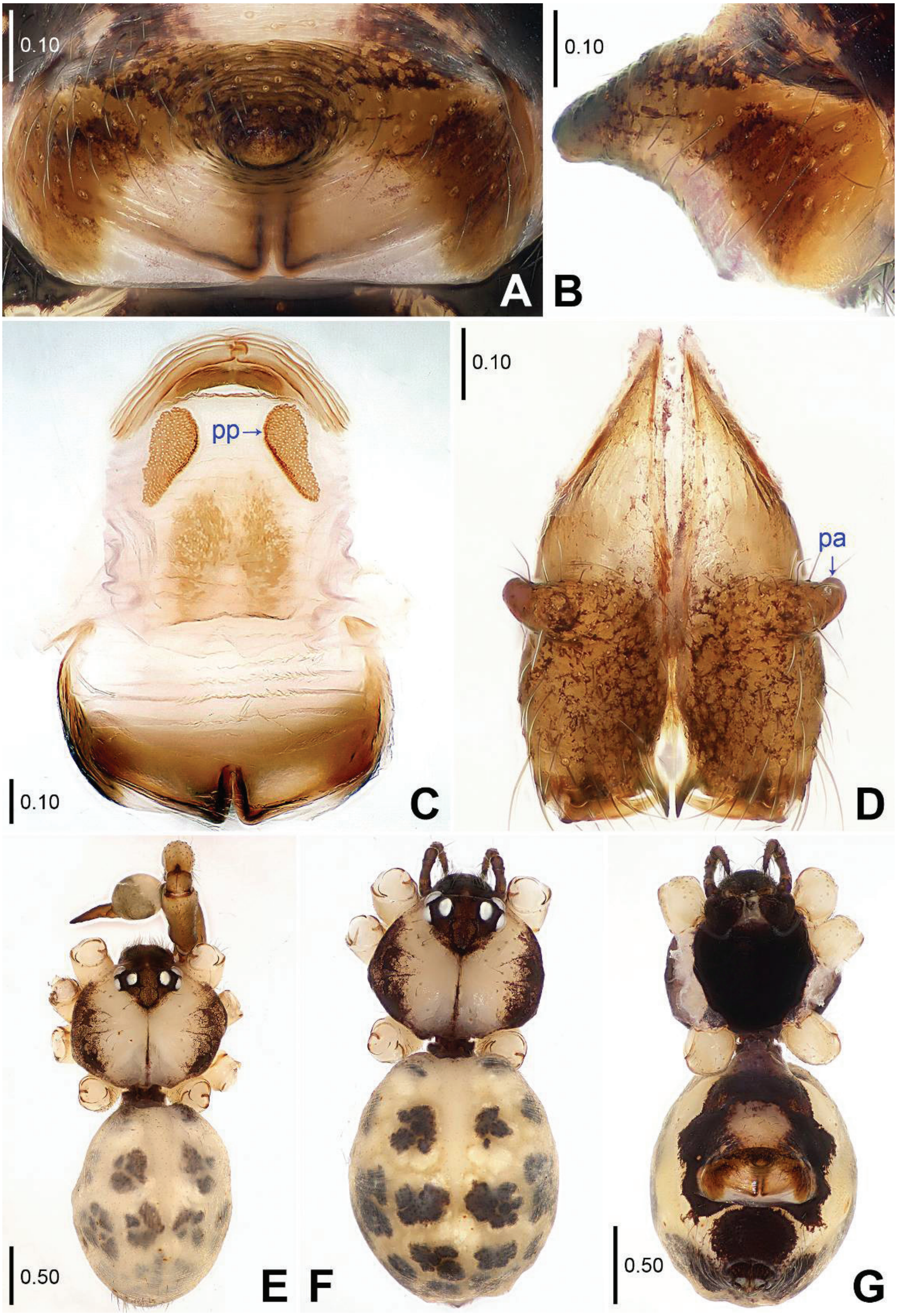

Figure 2. *Savarna kraburiensis* sp. n., holotype male (**D–E**) and paratype female (**A–C, F–G**). **A–B** Epigyne (**A** Ventral view **B** Lateral view) **C** Vulva, dorsal view **D** Chelicerae, frontal view **E–G** Habitus (**E–F** Dorsal view **G** Ventral view). pa = proximo-lateral apophysis, pp = pore plate.

proximo-lateral apophyses. Pedipalps as in Figs 1A–B; trochanter with a curved ventral apophysis lying against femur; procursus simple proximally but complex distally; bulb with a proximal sclerite and a bifurcated distal apophysis. Retrolateral trichobothrium of tibia I at 9%; legs with short vertical hairs on tibiae, without spines and curved hairs; tarsus I with more than 30 distinct pseudosegments.

Variation. Tibia I in another male: 6.73.

Female. Similar to male, habitus as in Figs 2F–G. Tibia I (n=2): 6.22, 6.35. One of the specimens measured: Total length 2.69 (2.81 with clypeus), prosoma 0.89 long, 1.13 wide, opisthosoma 1.80 long, 1.47 wide; tibia I: 6.22. Distance PME-PME 0.18, diameter PME 0.12, distance PME-ALE 0.03, AME absent. Epigyne (Figs 2A–B) strongly protruding, without pockets. Vulva (Fig. 2C) with a pair of pore plates.

Distribution. Known only from the type locality.

Acknowledgments

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References

Huber BA (2000) New World pholcid spiders (Araneae: Pholcidae): A revision at generic level. Bulletin of the American Museum of Natural History 254: 1–348. doi: 10.1206/0003-0090(2000)254<0001:NWPSAP>2.0.CO;2

Huber BA (2005) Revision of the genus *Spermophora* Hentz in Southeast Asia and on the Pacific islands, with descriptions of three new genera (Araneae: Pholcidae). Zoologische Mededelingen, Leiden 79: 61–114.

World Spider Catalog (2014) World Spider Catalog, version 15.5. Natural History Museum Bern. http://wsc.nmbe.ch [accessed 5 December 2014]

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RESEARCH ARTICLE

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A new genus and species of native exotic millipede in Australia (Diplopoda, Polydesmida, Paradoxosomatidae)

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Abstract

Taxidiotisoma portabile **gen. n.**, **sp. n.** is described from scattered populations in New South Wales, Victoria and Tasmania, Australia. Populations of *T. portabile* in Victoria, Tasmania and parts of New South Wales occur in urban, suburban and agricultural areas, with no collections of the species in natural habitats in the same district. *Taxidiotisoma portabile* is likely to be a native exotic species whose home range is in eastern New South Wales.

Keywords

Diplopoda, Polydesmida, Paradoxosomatidae, New South Wales, Victoria, Tasmania, Australia

Introduction

We use the term "native exotic" for a species introduced and established well outside its native range, but still within its broader native region (Mesibov 2008, Car 2009). Three Australian paradoxosomatid millipedes clearly fit this description: *Akamptogonus novarae* (Humbert & de Saussure, 1869), *Heterocladosoma bifalcatum* (Silvestri, 1898) and *Solaenodolichopus pruvoti* (Brolemann, 1931).

Although its original range is still uncertain, *A. novarae* is believed to be native to eastern Australia (Hoffman 1979). It occurs in urban and suburban areas in New South Wales, Tasmania, Victoria and Western Australia (locality records in Mesibov 2006–2015), and has been introduced to New Zealand (Rowe and Sierwald 2006), the Hawaiian Islands (Shelley and Lehtinen 1998) and San Francisco, California, in the United States (Hoffman 1979).

Heterocladosoma bifalcatum is likely to be native to the Brisbane area in southeast Queensland (Mesibov 2008), but it is now found in the Sydney metropolitan area (Rowe and Sierwald 2006) and elsewhere in New South Wales (Mesibov 2006–2015).

Solaenodolichopus pruvoti is also likely to be native to the Brisbane area (Mesibov 2014). It was first described from a town in New Caledonia and is now well established in the Perth metropolitan area in Western Australia, 3600 km from Brisbane (Mesibov 2014).

Here a new genus and species of Australian paradoxosomatid is described which we suspect is native to eastern New South Wales, but which has also been collected in urban, suburban and agricultural areas in New South Wales, Tasmania and Victoria.

Materials and methods

"Male" and "female" in the text refer to adult individuals. In this paper, the labeling of the different structures on the gonopod mainly follows that of Car and Harvey (2013) for convenience, and is not intended to suggest homologies with podomeres nor, necessarily, with similarly labeled structures in other papers (Car and Harvey 2013, Car et al. 2013).

All specimens are stored in 75–80% ethanol in their respective repositories. Gonopod images were generated with a Leica MZ16A automontage imaging system using Leica Application Suite Version 3.7.0. Other photomicrographs are manually stacked composites, taken with a Canon EOS 1000D digital SLR camera mounted on a Nikon SMZ800 binocular dissecting microscope equipped with a beam splitter and processed with Zerene Stacker 1.04 software. Images were prepared for publication using GIMP 2.8. The locality map (Fig. 5) was prepared using ArcView 3.2 GIS.

Suppl. material 1 tabulates data for known specimen lots of the new species as of 30 March 2015 (data also available online in Mesibov 2006–2015). Locality details are given with latitude and longitude based on the WGS84 datum. Our estimate of the uncertainty for a locality is the radius of a circle around the given position, in metres or kilometres.

Abbreviations in text and Suppl. material 1 (all in Australia): AM = Australian Museum, Sydney; NMV = Museum Victoria, Melbourne; NSW = New South Wales; QVMAG = Queen Victoria Museum and Art Gallery, Launceston; Tas = Tasmania; Vic = Victoria.

Results

Order Polydesmida Pocock, 1887
Suborder Strongylosomatidea Brölemann, 1916
Family Paradoxosomatidae Daday, 1889
Subfamily Australiosomatinae Brölemann, 1916
Tribe Antichiropodini Brölemann, 1916

Genus *Taxidiotisoma* Mesibov & Car, gen. n.
http://zoobank.org/5730FE05-EB5B-4C0D-9A75-9E3984549968

Type species. *Taxidiotisoma portabile* Mesibov & Car, sp. n., by present designation.

Other assigned species. None.

Diagnosis. In gonopod structure, *Taxidiotisoma* gen. n. is closest to *Antichiropus* Attems, 1911, *Australodesmus* Chamberlin, 1920, *Pogonosternum* Jeekel, 1965 and *Pseudostrongylosoma* Verhoeff, 1924 in the Australian paradoxosomatid fauna (see Remarks). Differs from *Antichiropus* in lacking a process on the lateral surface of the femorite, from *Pogonosternum* in having the distal portion of the acropodite divided into two rather than three branches, from *Pseudostrongylosoma* in having a divided solenomere, and from *Australodesmus* in having a Y-shaped solenomere rather than a flagellum-and-sheath solenomere.

Name. Greek *taxidiotis*, “traveller” + *soma*, Greek “body’, often used as an ending for generic names in Paradoxosomatidae; neuter gender.

Remarks. The gonopod of *Taxidiotisoma portabile* sp. n. appears most similar to that of species in *Antichiropus* Attems, 1911, *Australodesmus* Chamberlin, 1920, *Pogonosternum* Jeekel, 1965 and *Pseudostrongylosoma* Verhoeff, 1924, all four of which have been assigned to Antichiropodini by Jeekel (1968, 1979). In all five genera a long, well-demarcated femorite abruptly ends in several prominent processes, one of which is the solenomere. In *Antichiropus* there may be more than one non-solenomere process, but there is always one that arises on the lateral surface of the femorite; this lateral process is lacking in *T. portabile* sp. n. In addition, *Antichiropus* species have a long, free solenomere that tends to spiral, whereas that of *T. portabile* sp. n. is short and Y-shaped. In *Pogonosternum* species there are three acropodite branches, while in *Australodesmus*, *Pseudostrongylosoma* and *Taxidiotisoma* gen. n., there are only two, of more or less equal size. *Pseudostrongylosoma sjoestedti* Verhoeff, 1924 has an undivided solenomere. In *T. portabile* sp. n. the solenomere is Y-shaped, i.e. divided into two subbranches spaced well apart and not greatly different in size, while in *Australodesmus divergens* Chamberlin, 1920 the solenomere is divided into a thin, flagellum-like branch carrying the terminus of the prostatic groove and a much larger, flattened, cowl-like branch sheathing the thinner branch.

Taxidiotisoma portabile sp. n. is also characterized by a peculiar flattening of the head in lateral view, the result of depression of the clypeus.

Taxidiotisoma portabile Mesibov & Car, sp. n.

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Figs 1–4

Holotype. Male, Munmorah State Reserve, NSW, 0.5 km along beach track opposite National Parks and Wildlife Service Station turnoff, site MUNI01/09, -33.2094 151.5894 ±25 m, pitfall 13–23 May 1998, L. Wilkie, AM KS.94041.

Paratypes. 2 males, 1 female, details as for holotype but 21 April - 1 May 1997, site MUNI01/10, AM KS.93366.

Other material. 100 males, 22 females and 5 juveniles (see Suppl. material 1 for details).

Description. Male/female approximate measurements: length ca 20/20 mm, maximum midbody width 1.5/1.8 mm. Body shiny (Fig. 1), colour in alcohol medium brown, dark brown either side of waist and dorsal portion of sides, dorsally with large, light brown patch spanning rear of metazonite and front of prozonite; antennae medium brown, darker distally; legs tan to pale brown, darker distally.

Male with vertex and frons almost bare, clypeus sparsely setose; clypeus strongly depressed, head truncate in profile (Figs 1D, 1E); vertigial sulcus distinct, ending above level of antennal sockets; post-antennal groove moderately deep; antennal sockets separated by 1.3× socket diameter. Antenna slightly clavate, reaching dorsally only to rear of collum; antennomeres with relative lengths (2=3)>(4=5=6); 6 thickest but 5 and 6 subequal in apical width. Collum with subparallel anterior and posterior margins in dorsal view, strongly convex, lateral corner rounded. Head very slightly narrower than collum; collum to ring 18 nearly uniform in width, rings 2 and 3 slightly narrower. Ring 2 paranotum a thin, longitudinal ridge set low on ring, a little below collum corner; no paranota on other rings. No trace of pleural keels. Prozonites and metazonites (Fig. 1B, C) smooth, bare; transverse furrow at ca 2/3 metazonite length from waist, indistinct, not extending laterally as far as ozopores; waist very short, shallow, indistinctly sculptured with longitudinal ridges; limbus a narrow, thin, continuous sheet. Pore formula normal; ozopore very small, round, opening just above 1/2 ring height and just posterior to 1/2 metazonite length; slight bulging of ring around ozopore. Spiracles on diplosegments above and just anterior to leg bases; anterior spiracle ovoid, long axis subvertical, rim produced anterodorsally as rounded tab; posterior spiracle subtriangular, rim low; spiracular filters slightly emergent. Midbody sternites very sparsely setose, longer than wide, cross impressions subequal in width and depth; no cones or projections on any sternites. Midbody legs with relative podomere lengths (prefemur=femur)>tarsus>(pos tfemur= tibia); femur ca 1.2× as long as tarsus; anterior leg prefemora only very slightly swollen dorsally. Pre-anal ring sparsely setose; epiproct extending past anal valves, in dorsal view tapering and truncate, tip ca 1/4 width of pre-anal ring; hypoproct broadly paraboloid; spinnerets in rectangular array, wider than long. Leg 1 (Fig. 2A) with large, pointed process on medial femur surface, directed mediodistally and slightly anteriorly.

Gonopore small, round, opening on slight distomedial bulge of leg 2 coxa. Sternal lamella (Fig. 2B) wide, >90% of width between leg 4 bases on ring 5, strongly leaning

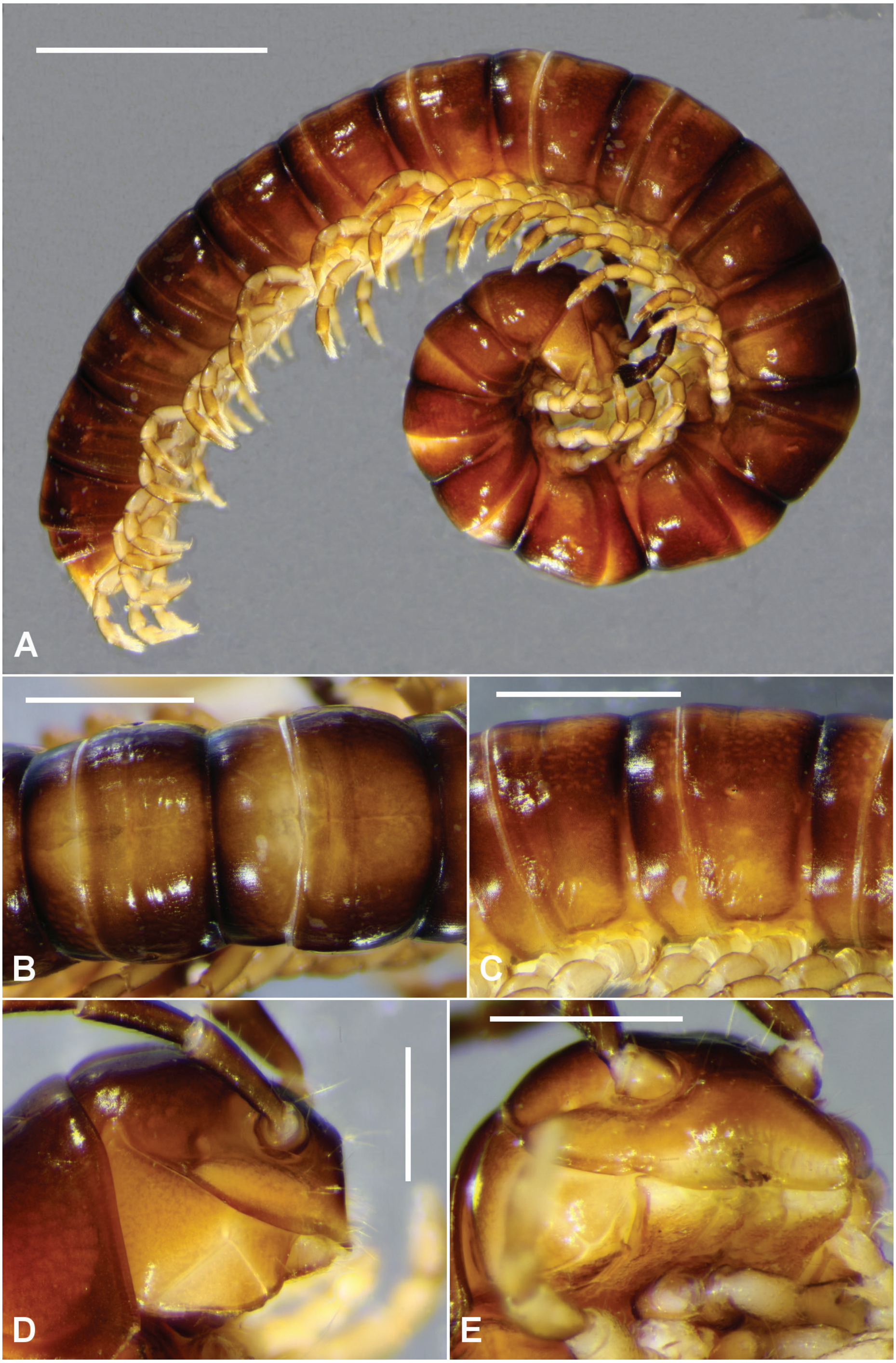

Figure 1. *Taxidiotisoma portabile* sp. n., male ex NMV K-12071. **A** Habitus **B** dorsal views of midbody rings **C** lateral views of midbody rings; anterior to right **D** Lateral views of head **E** oblique views of head. Scale bars: 2.5 mm (**A**); 1 mm (**B, C**); 0.5 mm (**D, E**).

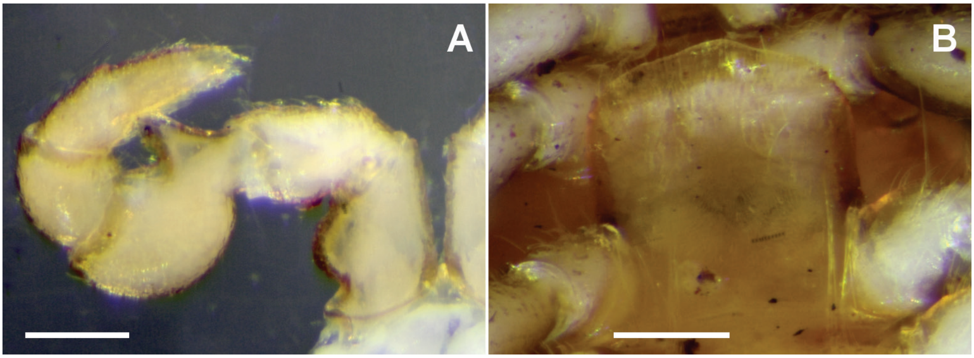

Figure 2. *Taxidiotisoma portabile* sp. n., male ex NMV K-12071. **A** Leg 1 **B** Sternal lamella on ring 5, posterior view. Scale bars: 0.2 mm.

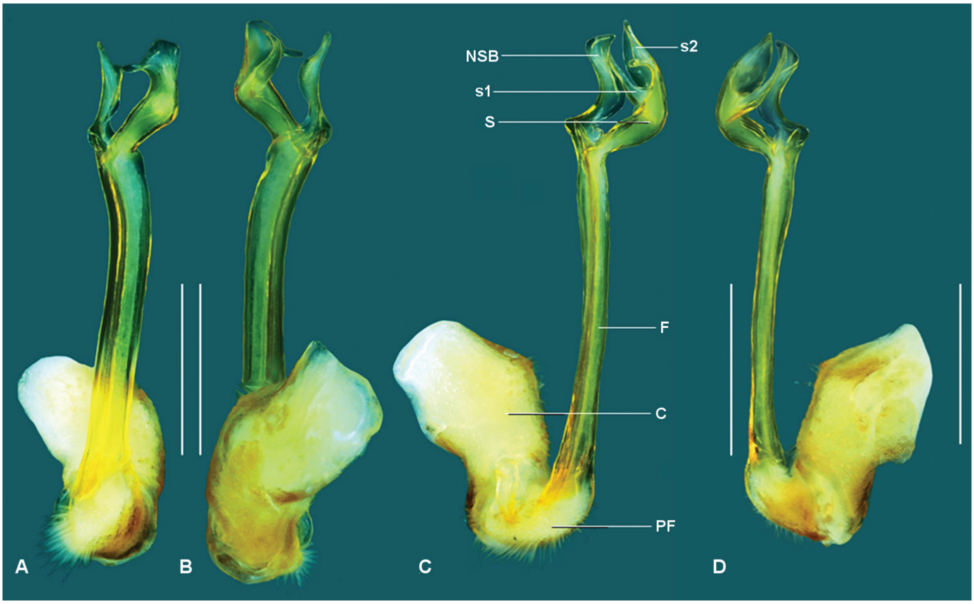

Figure 3. *Taxidiotisoma portabile* sp. n., holotype male (AM KS. 94041), left gonopod. **A** posterior **B** anterior **C** medial and **D** lateral views. Abbreviations: **C** coxa, **F** femorite, **NSB** non-seminiferous branch, **PF** prefemur, **S** solenomere, **s1** process with prostatic groove, **s2** cowl-shaped process. Scale bars: 0.5 mm.

anteriorly; lateral margins straight, vertical; corners rounded; ventral margin slightly raised medially. Dense brush setae on tibiae and tarsi of all legpairs except legpair 1 and last 2 legpairs; brush setae long, fine, curving distally.

Gonopod aperture just wide enough to accommodate gonocoxae, ca 1/2 ring 7 prozonite width. Gonopod telopodites (Figs 3, 4) straight, parallel, reaching leg 6 bases when retracted; sternite between legpairs 6 and 7 excavate. Gonocoxa (**C**) robust, much thicker than femorite but shorter, ca 1/2 femorite length; prefemur (**PF**) ovoid, ca 1/3 femorite length, leading directly into femorite with no noticeable process at femo-

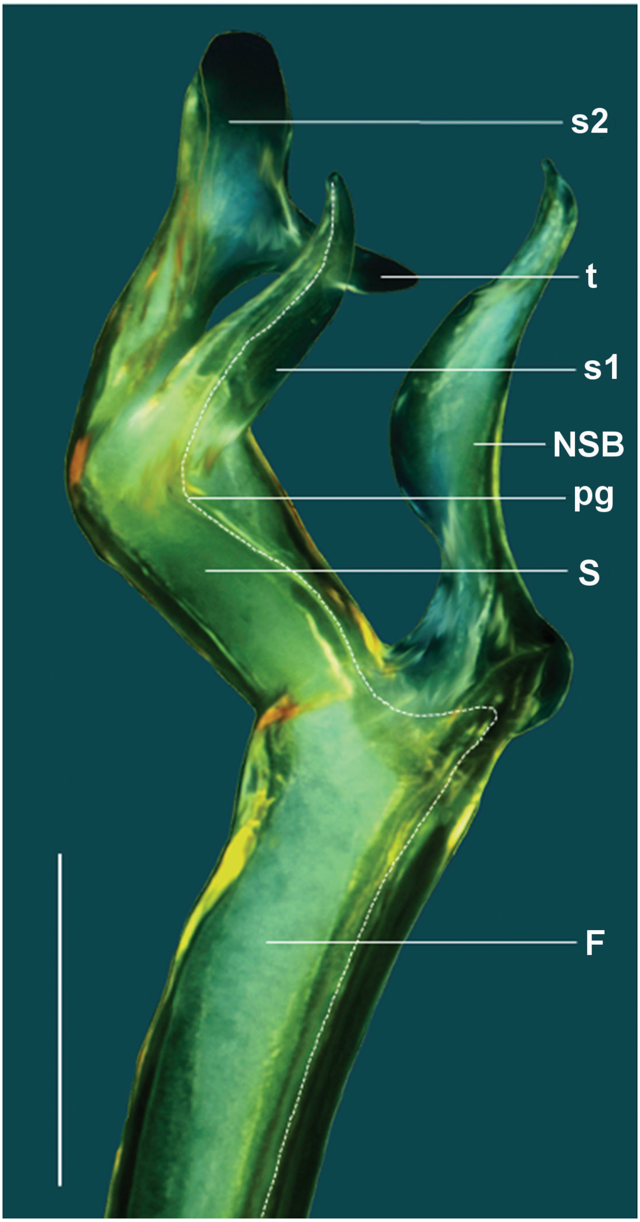

Figure 4. *Taxidiotisoma portabile* sp. n., holotype male (AM KS. 94041), detail of left gonopod tip, anterior view. Abbreviations: **F** femorite, **NSB** non-seminiferous branch, **S** solenomere, **s1** process with prostatic groove, **s2** cowl-shaped process, **pg** prostatic groove, **t** tooth. Dotted line denotes path of prostatic groove. Scale bar: 0.2 mm.

rite base; femorite (**F**) ca 2/3 acropodite length, upright, cylindrical; non-seminiferous branch (**NSB**) slightly shorter than solenomere (**S**), curved, thickest mid-length with asymmetrical pointed tip and distinct "elbow" at base; **S** broad, proximal end as thick

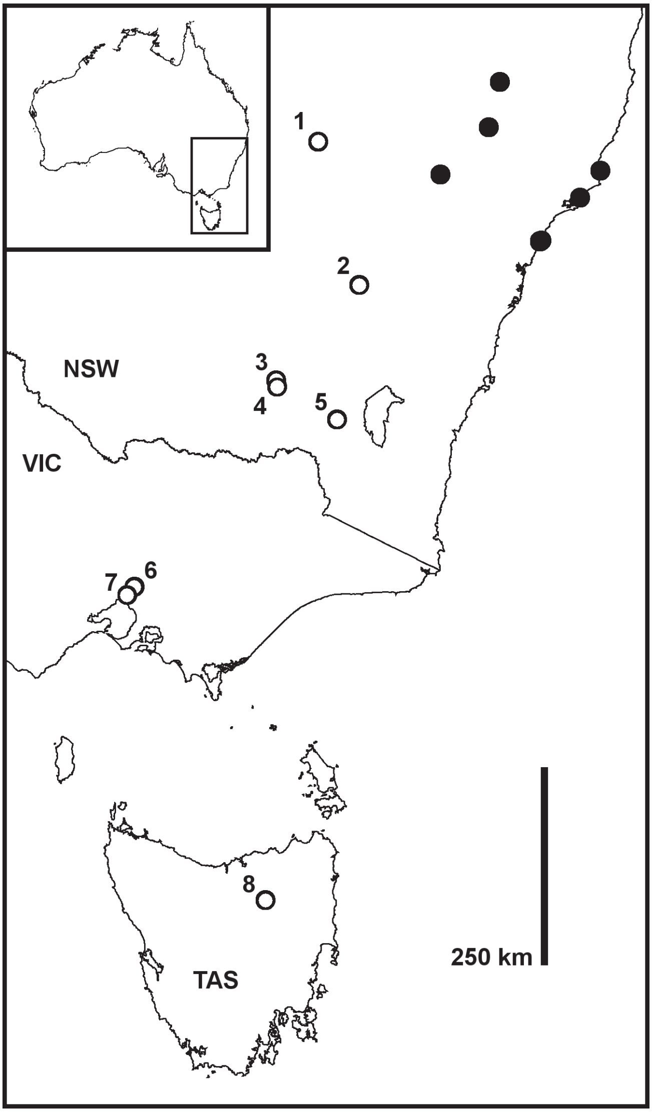

Figure 5. Known localities for *Taxidiotisoma portabile* sp. n. as of 30 March 2015 (filled and open circles). The eight numbered localities are discussed in the text. Geographic projection; inset shows location of main map.

as femorite, curved, divided at mid-length into shorter, pointed process (**s1**) carrying prostatic groove, finger-like in anterior view, and longer, broader, cowl-shaped process (**s2**) carrying noticeable tooth (**t**) at about mid-length. Prostatic groove running straight along anteromedial surface of telopodite, looping slightly into base of **NSB** before touching base of **S**, then running on medial surface of **S** to tip of **s1** (Fig. 4).

Female with depressed clypeus, without leg modifications; epigynum not raised, nearly straight, ca 1/4 ring 2 width; cyphopods not examined.

Distribution. *Taxidiotisoma portabile* sp. n. has been collected over a north-south range of ca 1000 km in eastern Australia (Fig. 5). A set of localities in eastern New South Wales (filled circles in Fig. 5) are in natural habitats in national parks or partly disturbed rangeland. Eight localities outside that set (unfilled circles in Fig. 5) are in cities, towns or long-cleared agricultural areas. These eight localities are numbered in Fig. 5 as follows:

(1) A small area of riparian vegetation on the Macquarie River, surrounded by farmland;
(2) The town of Cowra (collecting site not more exactly known), surrounded by farmland;
(3) The campus of Charles Sturt University in the city of Wagga Wagga;
(4) A small area of remnant native vegetation in the city of Wagga Wagga;
(5) Disturbed native vegetation on a roadside adjoining a large artificial lake;
(6) A recreation reserve in the suburbs of the city of Melbourne;
(7) A park in the centre of the city of Melbourne;
(8) Riparian parkland under a highway bridge in the town of Perth, surrounded by farmland.

Sampling in the areas surrounding and between these eight locations, both by the authors and by other collectors, has not yet yielded any specimens of *T. portabile* sp. n. We therefore suspect that the species was introduced to these locations from its native range in eastern New South Wales.

Name. Latin *portabilis*, "portable", adjective. This species is almost certainly being transported to new areas in Australia by cars or trucks.

Remarks. We do not know whether the eight "outlying" New South Wales, Tasmanian and Victorian samples (Fig. 5) represent long-established populations or ephemeral colonies, but the broad scattering of records suggests that this species will be found elsewhere in Australia in coming years.

Acknowledgements

We thank Graham Milledge (Australian Museum) and Peter Lillywhite and Catriona McPhee (Museum Victoria) for the loan of specimens, Wade Clarkson (Riverside, Tasmania) for alerting RM to the Tasmanian specimen of *T. portabile* sp. n., and Henrik Enghoff and Sergei Golovatch for valuable comments on a draft of the manuscript. This study was funded by the authors.

References

Car CA (2009) Keeled millipedes (Diplopoda: Polydesmida: Paradoxosomatidae) in New South Wales. General and Applied Entomology 38: 1–7.

Car CA, Harvey MS (2013) A review of the Western Australian genus *Boreohesperus* (Diplopoda, Polydesmida, Paradoxosomatidae). ZooKeys 290: 1–19. doi: 10.3897/zookeys.290.5114

Car CA, Wojcieszek JM, Harvey MS (2013) The millipede genus *Antichiropus* (Diplopoda: Polydesmida: Paradoxosomatidae, part 1: redefinition of the genus and redescriptions of existing species. Records of the Western Australian Museum 28(2): 83–118. http://museum.wa.gov.au/research/records-supplements/records/millipede-genus-antichiropus-diplopoda-polydesmida-paradoxosoma

Hoffman RL (1979) An Australian polydesmoid milliped in San Francisco (Paradoxosomatidae). Wasmann Journal of Biology 37(1–2): 55–58.

Jeekel CAW (1968) On the Classification and Geographical Distribution of the Family Paradoxosomatidae (Diplopoda, Polydesmida). C.A.W. Jeekel, Rotterdam, 162 pp.

Jeekel CAW (1979) Notes on the classification of some little-known Australian paradoxosomatid genera (Diplopoda, Polydesmida). Journal of Natural History 13: 649–658. doi: 10.1080/00222937900770481

Mesibov R (2006–2015) Millipedes of Australia [online catalogue]. http://www.polydesmida.info/millipedesofaustralia/ [accessed 31 March 2015]

Mesibov R (2008) Diversity of Queensland paradoxosomatid millipedes (Diplopoda: Polydesmida: Paradoxosomatidae). Australian Entomologist 35: 37–46.

Mesibov R (2014) The millipede genus *Solaenodolichopus* Verhoeff, 1924 (Diplopoda, Polydesmida, Paradoxosomatidae). 1. New genus diagnosis and redescriptions of named species. European Journal of Taxonomy 83: 1–36. doi: 10.5852/ejt.2014.83

Rowe M, Sierwald P (2006) Morphological and systematic study of the tribe Australiosomatini (Diplopoda: Polydesmida: Paradoxosomatidea: Paradoxosomatidae) and a revision of the genus *Australiosoma* Brölemann. Invertebrate Systematics 20: 527–556. doi: 10.1071/IS05034

Shelley RM, Lehtinen PT (1998) Introduced millipeds of the family Paradoxosomatidae on Pacific Islands (Diplopoda: Polydesmida). Arthropoda Selecta 7(2): 81–94.

Supplementary material 1

Specimen records of Taxidiotisoma portabile

Authors: Robert Mesibov, Catherine A. Car

Data type: Tab Separated Value File (tsv).

Explanation note: Specimen records of Taxidiotisoma portabile as of 30 March 2015.

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Two new species of *Coecobrya* (Collembola, Entomobryidae) from China, with an updated key to the Chinese species of the genus

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Abstract

Two new *Coecobrya* species, which were newly collected in 2014, are described from China. *Coecobrya sanmingensis* **sp. n.** from southeast China (Fujian) is the fourth 1+1 eyed species in the genus; it can be distinguished from other three species by the ciliate chaetae X and X_{2-4} on the ventral side of head, the abundant chaetae on the trochanteral organ, a large outer tooth on the unguiculus, the absence of smooth manubrial chaetae, and the dorsal chaetotaxy. *Coecobrya qinae* **sp. n.** from southwest China (Yunnan) is characterized by paddle-like S-chaetae of Ant. III organ, ciliate chaetae X, X_2 and X_4 posterior to labium, medial macrochaetae on the mesothorax, and 5+5 central and 2+2 lateral macrochaetae on the fourth abdominal segment. An updated key to the Chinese species of *Coecobrya* is given.

Keywords

Coecobrya sanmingensis sp. n., *Coecobrya qinae* sp. n., chaetotaxy

Introduction

Deharveng (1990), Chen and Christiansen (1997) and Zhang et al. (2009, 2011a) made great contributions to the modern taxonomy of the genus *Coecobrya*. Its members have plurichaetotic chaetotaxy, no labral papillae, an inverted intrusion on the labral margin which is U-shaped, labial chaetae MELL always smooth, reduced eye number (0 to 3 eyes per side), pigment reduced or absent, antennal apical bulb absent, falcate mucro with a basal spine, tenaculum with 4+4 teeth and one large striate chaeta, and scales and dental spines absent (Zhang et al. 2009). The genus is worldwide and very abundant in Southeast and East Asia. So far, about approximately one quarter (12/47) of species have been reported from China. Five of them were discovered during recent expeditions in this country (Xu et al. 2012; Zhang and Dong 2014). Here, two new species, collected in 2014, are described from southern China. An updated key to the Chinese species of *Coecobrya* is also given.

Materials and methods

Specimens were cleared in Nesbitt's fluid, mounted under a coverslip in Marc André II solution, and studied using a Nikon E80i microscope. Photographs were enhanced with Photoshop CS5. The labial chaetae terminology follows Gisin's system (1967). The dorsal and ventral chaetotaxy of head and the Ant. III organ are described after Chen and Christiansen (1993). Dorsal body chaetae are designated following Szeptycki (1979) and Zhang et al. (2011b). The number of macrochaetae is given by half-tergite in the descriptions (left side of tergites drawn in figures). Tergal S-chaetotaxic formula follows Zhang and Deharveng (2014). Type material is deposited in the collections of the Department of Entomology, College of Plant Protection, Nanjing Agricultural University (NJAU), P. R. China.

Abbreviations: Th. – thoracic segment; Abd. – abdominal segment; Ant. – antennal segment; mac – macrochaeta/ae; mic – microchaeta/ae; ms – S-microchaeta/ae; sens – ordinary tergal S-chaeta/ae.

Taxonomy

Coecobrya sanmingensis sp. n.

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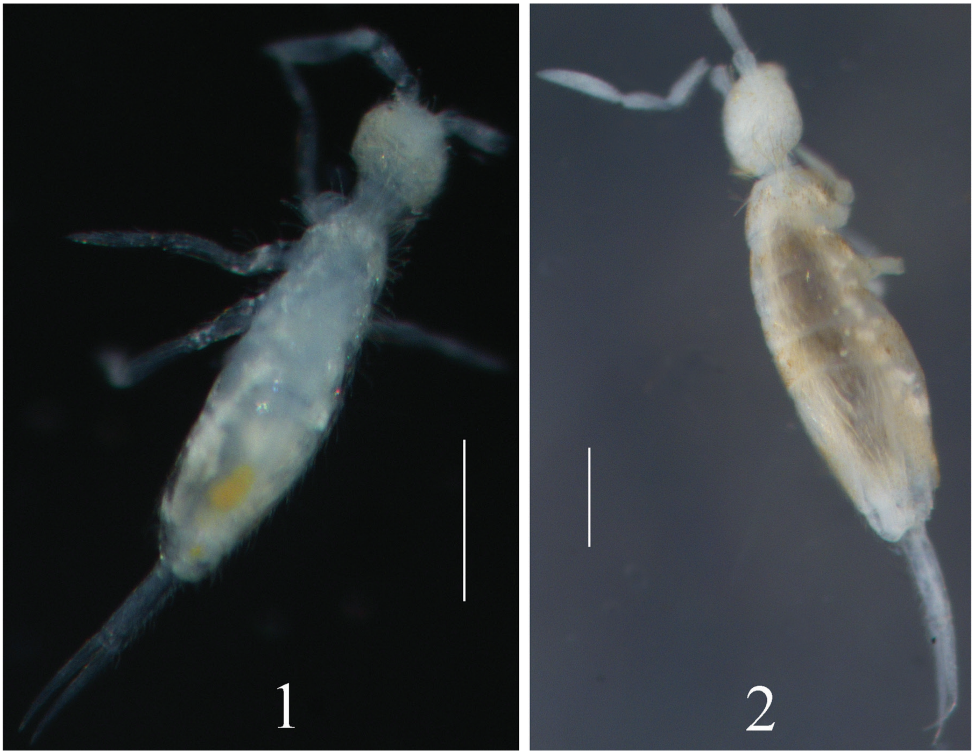
Figs 1, 3–18, Table 1

Type locality. China, Fujian, Sanming, 26.500°N, 117.717°E, altitude 707 m.

Material. Holotype: ♀ on slide, China, Fujian Province, Sanming City, Guanzhuang National Forestry Farm, 26.500°N, 117.717°E, altitude 707 m, 17 September 2014, Daoyuan YU leg. (# Sanming 9-2). Paratypes: 1 ♂, 1 ♀, and 1 juvenile of unclear sex on slides and 5 juveniles in alcohol, same data as holotype.

Description. Body length up to 1.09 mm. Body pale (Fig. 1).

Antenna 1.96–2.02X as long as cephalic diagonal. Antennal segment ratio as I : II : III : IV = 1 : 1.69 : 0.88–1.23: 1.94–3.08. Smooth spiny mic at base of antennae 3 dorsal, 3 ventral on Ant. I, 1 internal, 1 external and 1 ventral on Ant II. Two internal



Figures 1–2. Habitus. **1** *C. sanmingensis* sp. n. **2** *C. qinae* sp. n. Scale bars: 300 µm.

S-chaetae of Ant III organ expanded (Fig. 3). Ant. IV subapical organ thin, distally expanded (Fig. 4). Long smooth straight chaetae absent.

Eyes 1+1. Prelabral and labral chaetae 4/ 5, 5, 4, all smooth; median three chaetae of the first row longer than lateral ones (Fig. 5). Eight clypeal chaetae arranged in three rows; median three ciliate and much smaller (Fig. 6). Dorsal cephalic chaetotaxy with 4 antennal (An), 3 median (M) and 5 sutural (S) mac; Gr. II with 4 mac (Fig. 7). Mandibles 4+5 teeth. Subapical chaeta of maxillary outer lobe larger than apical one; 3 smooth sublobal hairs on maxillary outer lobe (Fig. 22). Papillae A–E of labial palp with 0, 5, 0, 4, 4 guard chaetae respectively; lateral process of papillae E slightly thicker than normal chaetae, with tip beyond apex of labial papilla (Fig. 8). Labial chaetae as $mRel_1l_2$, R ciliate, R/m=0.4; chaetae X and X_{2-4} ciliate. Cephalic groove with 8(7) chaetae, anterior four smooth and posterior ones ciliate (Fig. 9).

Trochanteral organ with 23 smooth spiny chaetae; 16 in arms and 7 between them (Fig. 10). Partial inner differentiated tibiotarsal chaetae “smooth” with ciliations closely appressed to axis. Tibiotarsi most distally with 11 chaetae in a whorl. Unguis with 3 inner teeth; 2 paired teeth unequal, outer one larger. Unguiculus with a large outer tooth. All tenent hairs pointed (Fig. 11). Abd. IV 3.56–3.83X as long as Abd. III along dorsal midline. Ventral tube anteriorly with 3+3 large ciliate chaetae; posteriorly with 4 distal and 4–5 proximal smooth chaetae; each lateral flap with 7 smooth chaetae (Fig. 12).

Table 1. Comparison among the four 1+1 eyed *Coecobrya* species. (?, unknown; +, present; -, absent).

Characters	*sanmingensis* sp. n.	*boneti*	*indonesiensis*	*tukmeas*
Antennal long smooth straight chaetae	-	+	?	+
Gr. II on dorsal head	4	4	5	4
Labial chaeta R	short, ciliate	tiny, smooth	long, smooth	tiny, smooth
Chaetae posterior to labium				
X	ciliate	smooth	smooth	smooth
X_2	ciliate	tiny	-	-
X_3	ciliate	-	-	-
X_4	ciliate	tiny	Smooth	tiny
Trochanteral organ	23	11–15	9	11–14
Large outer tooth on unguiculus	+	-	-	-
Chaetae of ventral tube				
anterior face	?	6	10	5–6
posterior face	8–9	8	?	6
lateral flap	7	9	9–10	8
Manubrial smooth chaetae	-	+	+	+
Ciliate chaetae on manubrial plaque	3+3	3+3	3+3	2+2
Chaetotaxy of Th. II				
medio-lateral (m4+)	3	3	2	2
Gr. VI (p4+)	0	2	2	2
p5	0	1	0	0
Mac m5i on Th. III	-	-	-	+
Chaetotaxy of Abd. I	5+5	6+6	6+6	4+4
Chaetotaxy of Abd. II	3	4	4(5)	3
inner to arch	0	1	1(2)	1
M-arch	3	3	3	2
ms on Abd. III	-	+	?	-
Central mac on Abd. IV	7	6	7	6

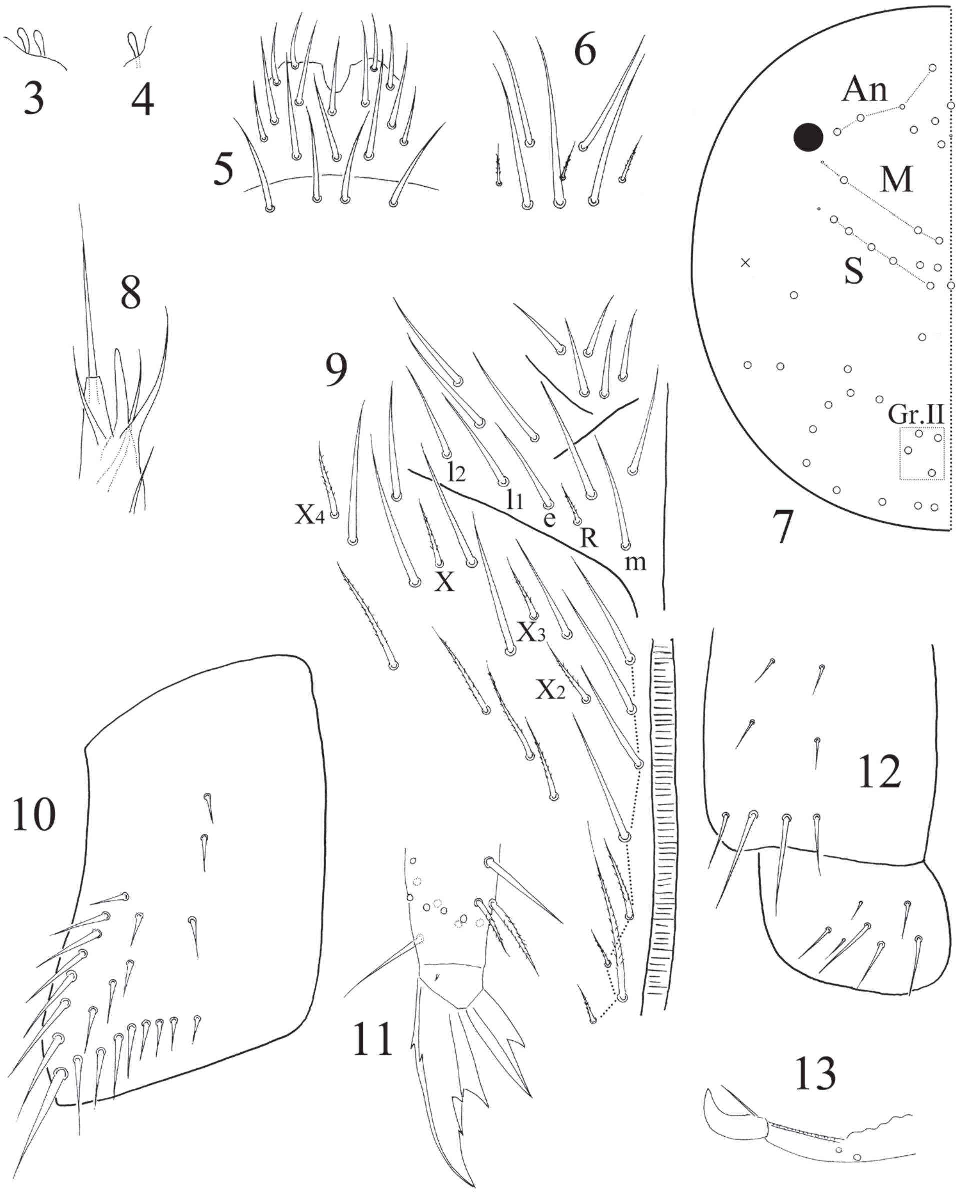
Manubrium without smooth chaetae. Manubrial plaque with 2+2 pseudopores and 3+3 ciliate chaetae. Distal smooth part of dens 1.0X as long as mucro. Mucro falcate (Fig. 13).

Th. II with 3 (m1, m2, m2i) medio-medial, 3 (m4, m4i, m4p) medio-lateral, about 15 posterior mac, 1 ms and 2 sens. Th. III with 25 mac and 2 lateral sens; mac m5i absent; p5 and m6i as mac (Fig. 14). Abd. I with 5 (m2–4, m2i, m4p) mac, 1 ms and 1 sens; sens inner to ms. Abd. II with 3 (m3, m3e, m3ep) central, 1 (m5) lateral mac and 2 sens. Abd. III with 1 (m3) central, 3 (am6, pm6, p6) lateral mac, and 2 sens; ms absent (Fig. 15). Abd. IV with 7 (I, M, A4, A6, B4–6) central, 6 lateral mac (D3, E2–4, E2p, F1) (Fig. 16) and 17 sens; two lateral sens (as, ps) of normal length and others elongate (Fig. 17). Abd. V with 3 sens (Fig. 18).

Etymology. Named after the type locality.

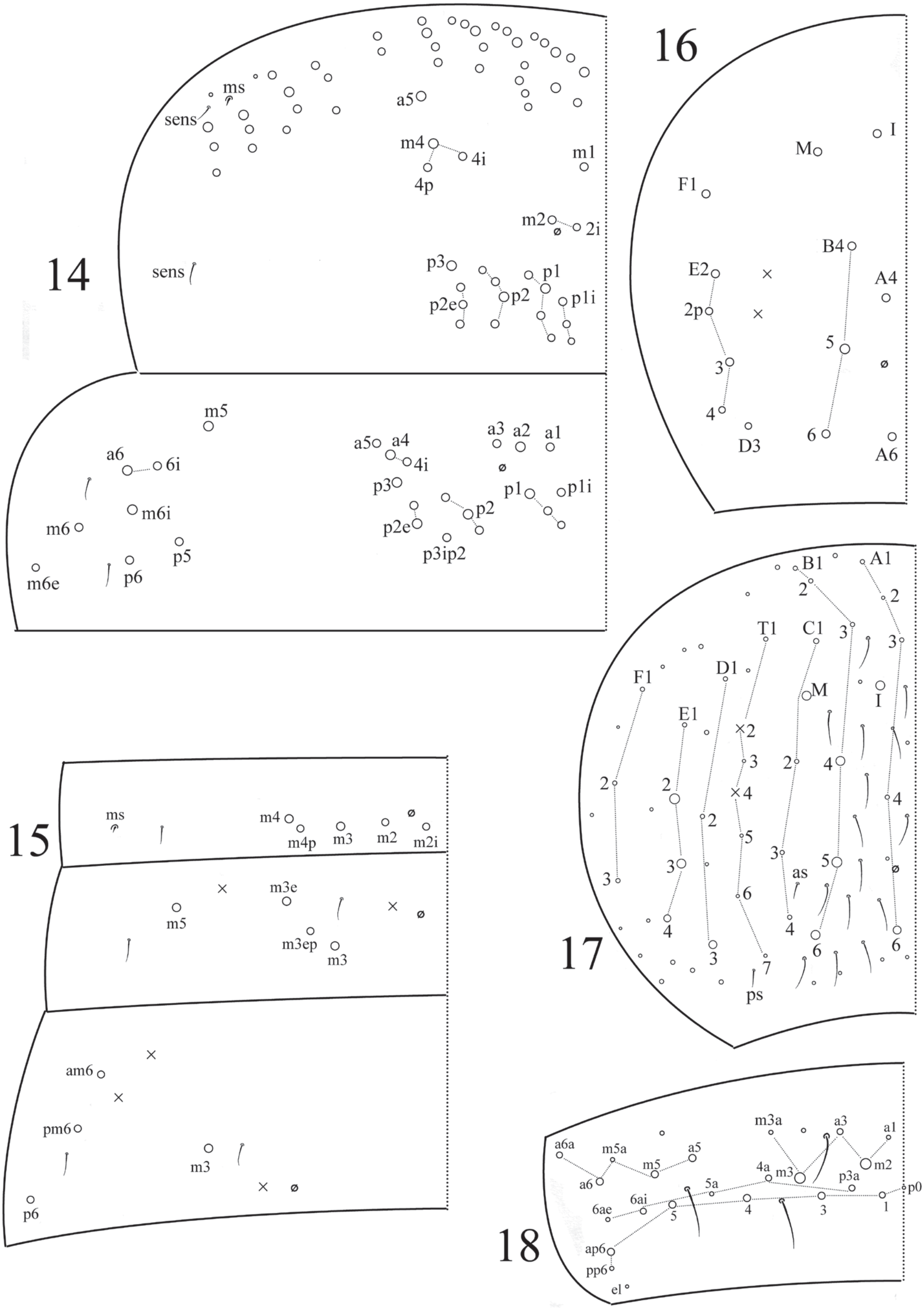
Ecology. In soil.

Remarks. *C. sanmingensis* sp. n. is the fourth 1+1 eyed species of the genus. These eyed species share many features such as the presence of eyes, tip of lateral process of labial palp E beyond the same papillae, dorsal cephalic chaetotaxy (4An, 3M, 5S), partial inner differentiated tibiotarsal chaetae "smooth", 2+2 pseudopores on the manubrial



Figures 3–13. *C. sanmingensis* sp. n. **3** Ant. III organ **4** Ant. IV subapical organ **5** labrum **6** clypeal chaetae **7** dorsal cephalic chaetotaxy **8** lateral process of labial palp E **9** chaetae on the ventral side of head **10** trochanteral organ **11** hind claw **12** ventral face and lateral flap of ventral tube **13** mucro.

plaque, 3+3 medio-medial mac on Th. II, 1+1 central and 3+3 lateral mac on Abd. III, and 6 lateral mac on Abd. IV. They can be separated by antennal long smooth chaetae, chaetae on the ventral side of head, trochanteral organ, unguiculus outer edge, smooth manubrial chaetae, and dorsal chaetotaxy (Table 1).



Figures 14–18. Tergal chaetotaxy in *C. sanmingensis* sp. n. **14** thorax **15** Abd. I–III **16** Abd. IV of adults **17** Abd. IV of juveniles (possibly 2nd instar) **18** Abd. V of juveniles.

Coecobrya qinae **sp. n.**

http://zoobank.org/A5C29F1B-B569-4BF7-B236-5BBF960ECAE1
Figs 2, 19–30

Type locality. China, Yunnan, 26.643°N, 98.905°E, altitude 1149 m.

Material. Holotype: ♀ on slide, China, Yunnan Province, 228 Provincial Highway, 26.643°N, 98.905°E, altitude 1149 m, 11 October 2014, Chunyan QIN leg. (# 14YN2). Paratype: ♀ on slide, same data as holotype.

Description. Body length up to 1.49 mm. Body with light orange pigment (Fig. 2).

Antenna 1.80X as long as cephalic diagonal. Antennal segment ratio as I : II : III : IV = 1 : 2.06 : 2.00: 3.06. Smooth spiny mic at base of antennae 3 dorsal, 3 ventral on Ant. I, 1 internal, 1 external and 1 ventral on Ant. II. Ant. II distally with 1 expanded S-chaeta. Two internal S-chaetae of Ant. III organ paddle-like, expanded; chaeta 8 dagger-like (Fig. 19). Long smooth straight chaetae absent.

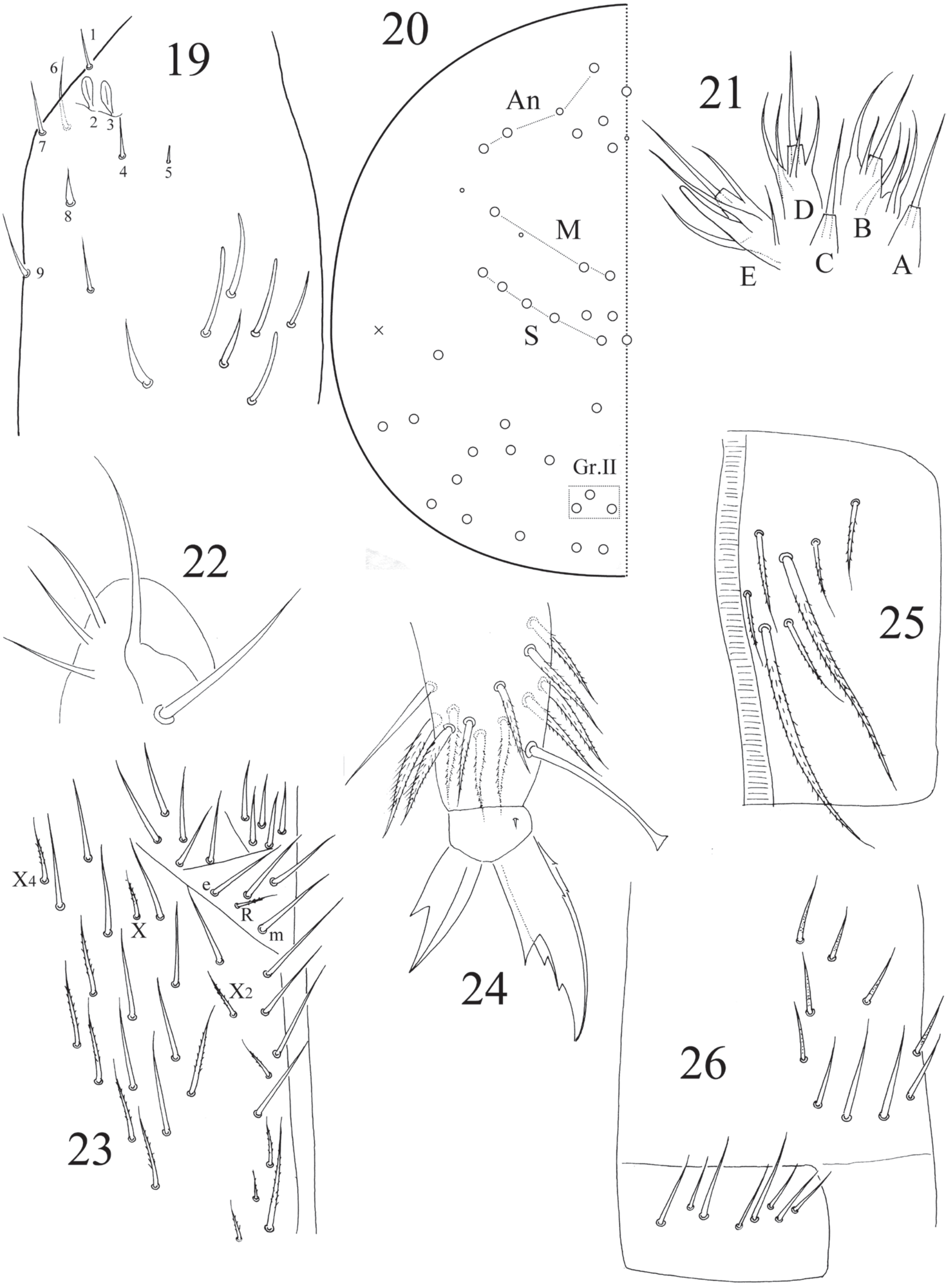
Eyes absent. Prelabral and labral chaetae 4/ 5, 5, 4, all smooth. Clypeal chaetae not clearly seen. Dorsal cephalic chaetotaxy with 4 antennal (An), 3 median (M) and 5 sutural (S) mac; Gr. II with 3 mac (Fig. 20). Mandibles 4+5 teeth. Papillae A–E of labial palp with 0, 5, 0, 4, 4 guard chaetae respectively; lateral process of papillae E thicker than normal chaetae, with tip beyond apex of labial papilla E (Fig. 21). Subapical chaeta of maxillary outer lobe slightly larger than apical one; 3 smooth sublobal hairs on maxillary outer lobe (Fig. 22). Labial chaetae as $mRel_1l_2$, R ciliate, R/m=0.5; chaetae X, X_2 and X_4 ciliate. Cephalic groove with 8 chaetae, four of them smooth and others ciliate (Fig. 23).

Trochanteral organ not clearly seen. Partial inner differentiated tibiotarsal chaetae ciliate with ciliations not closely appressed to axis. Tibiotarsi most distally with 11 chaetae in a whorl. Unguis with 3 inner teeth; 2 paired teeth unequal, outer one larger. Unguiculus with a large outer tooth. All tenent hairs clavate (Fig. 24). Abd. IV 3.65X as long as Abd. III along dorsal midline. Ventral tube anteriorly with 7+7 ciliate chaetae; two of them much larger than others (Fig. 25); posteriorly with 4 distal smooth and 6 proximal weakly ciliate chaetae; each lateral flap with 8 smooth chaetae (Fig. 26). Manubrium without smooth chaetae. Manubrial plaque with 2+2 pseudopores and 2+2 ciliate chaetae. Distal smooth part of dens 1.2X as long as mucro. Mucro falcate.

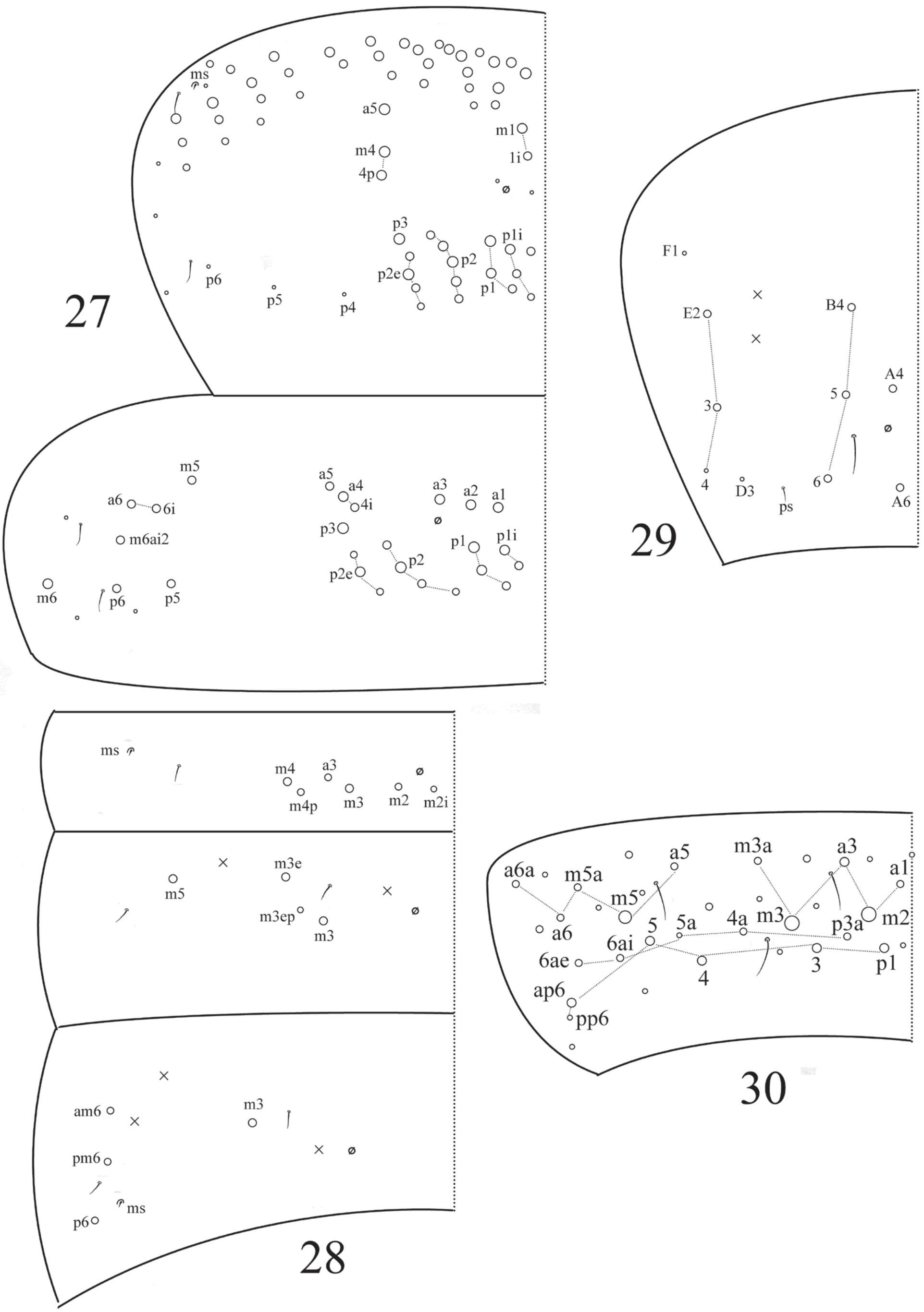
Th. II with 2(1) (m1, m1i) medio-medial, 2 (m4, m4p) medio-lateral, 16–17 posterior mac, 1 ms and 2 sens; mac m1i sometimes absent; mac m2 and p4–6 as mic. Th. III with 24–26 mac and 2 lateral sens; mac m5i absent; p5 and m6ai2 as mac (Fig. 27). Abd. I with 6 (a3, m2–4, m2i, m4p) mac, 1 ms and 1 sens; sens inner to ms. Abd. II with 3 (m3, m3e, m3ep) central, 1 (m5) lateral mac and 2 sens. Abd. III with 1 (m3) central, 3 (am6, pm6, p6) lateral mac, 1 ms and 2 sens (Fig. 28). Abd. IV with 5 central (A4, A6, B4–6) and 2 lateral mac (E2–3); number of sens not clearly seen (Fig. 29). Abd. V with 3 sens (Fig. 30).

Etymology. Named after the collector of the specimens.

Ecology. Among the decompositing leaf litter.



Figures 19–26. *C. qinae* sp. n. **19** Ant. III organ **20** dorsal cephalic chaetotaxy **21** labial palp **22** maxillary outer lobe, same as *C. sanmingensis* sp. n. **23** chaetae on the ventral side of head **24** hind claw **25** anterior face of ventral tube **26** posterior face and lateral flap of ventral tube.



Figures 27–30. Tergal chaetotaxy in *C. qinae* sp. n. **27** thorax **28** Abd. I–III **29** Abd. IV **30** Abd. V.

Table 2. Comparison between *C. qinae* sp. n. and *C. tropicalis*.

Characters	*C. qinae* sp. n.	*C. tropicalis* Qu et al., 2007
Ant. III organ	paddle-like	rod-like
lateral process of labial palp	thick	thin
Chaetae posterior to labium X X_2 X_4	 ciliate ciliate ciliate	 smooth mic absent smooth mic
Chaetae on manubrial plaque	2+2	3+3
Chaetotaxy of Th. II m1+ m2+	2 2 0	3(2) 1 2
Inner mac on Abd. II	3	2(3)
Chaetotaxy of And. IV I M B4 Lateral mac	5+5 absent absent present 2+2	5+5 present present absent 4+4

Remarks. *C. qinae* sp. n. is characterized by paddle-like S-chaetae of Ant. III organ, ciliate chaetae X, X_2 and X_4 posterior to labium, medial mac on Th. II, and 5+5 (mac I, M absent) central and 2+2 lateral mac on Abd. IV. It is most similar to *Coecobrya tropicalis* Qu, Chen & Greenslade, 2007 in absence of eyes, smooth manubrial chaetae absent, inner differentiated tibiotarsal chaetae, and chaetotaxy of Abd. I–III. It differs from it in paddle-like S-chaetae on Ant. III organ, thicker lateral process of labial palp, presence of ciliate chaetae X, X_2 and X_4 posterior to labium, 2+2 ciliate chaetae on manubrial plaque, absence of mac m2, m2i and p4 on Th. II, and unusual arrangement of central mac on Abd. IV.

Key to the Chinese species of *Coecobrya*

1 Eyes present **2**
– Eyes absent **4**
2 Eyes 1+1 .... ***sanmingensis* sp. n.**
– Eyes 3+3 .... **3**
3 Body violet-bluish; unguiculus outer edge smooth .... ***mulun* Zhang, Qu & Deharveng, 2010**
– Body whitish; unguiculus outer edge with a large tooth .... ***qin* Zhang & Dong, 2014**
4 Manubrium with dorsal smooth chaetae **5**
– Manubrium without dorsal smooth chaetae **8**
5 Tibiotarsus with rows of "smooth" differentiated chaetae **6**
– Tibiotarsus without rows of "smooth" differentiated chaetae **7**

6 Abd. I with 6+6 central mac; Th. II with 3+3 medio-medial mac.. ***tenebricosa* (Folsom, 1902)**

– Abd. I with 4(3)+4(3) central mac; Th. II with 1+1 medio-medial mac .... ***brevis* Xu, Yu & Zhang, 2012**

7 Abd. IV with 3+3 central and 4+4 lateral mac .... ***oligoseta* Chen & Christiansen, 1997**

– Abd. IV with 4+4 central and 3+3 lateral mac..... ***pani* Xu, Yu & Zhang, 2012**

8 Abd. III with 1+1 central mac.. **9**

– Abd. III with 2+2 central mac.. **11**

9 Unguiculus truncate; Abd. IV with 4+4 central mac.. ***draconis* Zhang & Dong, 2014**

– Unguiculus acuminate; Abd. IV with more than 4+4 central mac............ **10**

10 Abd. IV with 7+7 central and 6+6 lateral mac .... ***communis* Chen & Christiansen, 1997**

– Abd. IV with 5+5 central and 2+2 lateral mac .... ***qinae* sp. n.**

11 Abd. IV with 5+5 central mac.. **12**

– Abd. IV with at least 7+7 central mac.. **13**

12 Dorsal head with 5+5 sutural mac; Th. II with 3+3 medio-lateral mac.. ***huangi* Chen & Christiansen, 1997**

– Dorsal head with 3+3 sutural mac; Th. II with 2+2 medio-lateral mac.. ***xui* Zhang & Dong, 2014**

13 Abd. IV with 7+7 central mac....... ***liui* Wang, Chen & Christiansen, 2002**

– Abd. IV with at least 8+8 central mac.... ***tibetensis* Chen & Christiansen, 1997**

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References

Chen J-X, Christiansen KA (1993) The genus *Sinella* with special reference to *Sinella s. s.* (Collembola: Entomobryidae) of China. Oriental Insects 27: 1–54. doi: 10.1080/00305316.1993.10432236

Chen J-X, Christiansen KA (1997) Subgenus Coecobrya of the genus *Sinella* (Collembola: Entomobryidae) with special reference to the species of China. Annals of the Entomological Society of America 90: 1–19. doi: 10.1093/aesa/90.1.1

Deharveng L (1990) Fauna of Thai caves. II. New Entomobryoidea Collembola from Chiang Dao cave, Thailand. Occasional Papers of the Bernice P. Bishop Museum 30: 279–287.

Folsom JW (1902) Collembola of the grave. Psyche 9: 363–367. doi: 10.1155/1902/42417

Gisin H (1967) Espèces nouvelles et lignées évolutives de *Pseudosinella* endogés (Collembola). Memórias e Estudos do Museu Zoológico da Universidade de Coimbra 301: 1–25.

Qu J-Q, Chen J-X, Greenslade P (2007) Australian species of *Sinella* (Coecobrya) Brook (Collembola: Entomobryidae). Journal of Natural History 41: 1301–1311. doi: 10.1080/00222930701414179

Szeptycki A (1979) Morpho-systematic studies on Collembola. IV. Chaetotaxy of the Entomobryidae and its phylogenetical significance. Polska Akademia Nauk, Kraków, Poland, 219 pp.

Wang F, Chen J-X, Christiansen KA (2002) A new species of the subgenus *Coecobrya* (Collembola: Entomobryidae) from China. Journal of Entomological Science 37: 213–218.

Xu G-L, Yu D-Y, Zhang F (2012) Two new species of the *Coecobrya* (Collembola: Entomobryidae: Entomobryinae) from China, with a key to the Chinese species of the genus. Zootaxa 3399: 61–68. http://www.mapress.com/zootaxa/2012/f/z03399p068f.pdf

Zhang F, Deharveng L (2014) Systematic revision of Entomobryidae (Collembola) by integrating molecular and new morphological evidence. Zoologica Scripta. doi: 10.1111/zsc.12100

Zhang F, Deharveng L, Chen J-X (2009) New species and rediagnosis of *Coecobrya* (Collembola: Entomobryidae), with a key to the species of the genus. Journal of Natural History 43: 2597–2615. doi: 10.1080/00222930903243970

Zhang F, Dong R-R (2014) Three new species of *Coecobrya* (Collembola: Entomobryidae) from southern and northwest China. Zootaxa 3760: 260–274. doi: 10.11646/zootaxa.3760.2.6

Zhang F, Man LC, Deharveng L (2011a) A review of the *boneti*-group of the genus *Coecobrya* (Collembola: Entomobryidae). Zootaxa 2748: 61–68. http://www.mapress.com/zootaxa/2011/f/z02748p068f.pdf

Zhang F, Qu JQ, Deharveng L (2010) Two syntopic and remarkably similar new species of *Sinella* and *Coecobrya* from South China (Collembola: Entomobryidae). Zoosystema 32: 469–477. doi: 10.5252/z2010n3a8

Zhang F, Yu D-Y, Xu G-L (2011b) Transformational homology of the tergal setae during postembryonic development in the *Sinella*-*Coecobrya* group (Collembola: Entomobryidae). Contributions to Zoology 80: 213–230. http://www.ctoz.nl/cgi/t/text/get-pdf?c=ctz;idno=8004a01

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Two new species of *Oobius* Trjapitzin (Hymenoptera, Encyrtidae) egg parasitoids of *Agrilus* spp. (Coleoptera, Buprestidae) from the USA, including a key and taxonomic notes on other congeneric Nearctic taxa

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Abstract

Oobius Trjapitzin (Hymenoptera, Encyrtidae) species are egg parasitoids that are important for the biological control of some Buprestidae and Cerambycidae (Coleoptera). Two species, *O. agrili* Zhang & Huang and *O. longoi* (Siscaro), were introduced into North America for classical biocontrol and have successfully established. Two new native North American species that parasitize eggs of *Agrilus* spp. (Buprestidae) are described and illustrated from the USA: *O. minusculus* Triapitsyn & Petrice, **sp. n.** (Michigan), an egg parasitoid of both *A. subcinctus* Gory on ash (*Fraxinus* spp.) and *A. egenus* Gory on black locust (*Robinia pseudoacacia* L.) trees, and *O. whiteorum* Triapitsyn, **sp. n.** (Pennsylvania), an egg parasitoid of *A. anxius* Gory on European white birch (*Betula pendula* Roth). A taxonomic key and notes on the Nearctic native and introduced *Oobius* species are also included.

Keywords

Emerald ash borer, new species, congener identification key, *Oobius agrili*, Nearctic, egg parasitoid, biological control

Introduction

The rather poorly known encyrtid genus *Oobius* Trjapitzin (Hymenoptera: Encyrtidae) currently includes 41 species worldwide, and seven are known from North America (Noyes 2014). Noyes (2010) recently described 20 of these species from Costa Rica and compared some of these new species to similar Nearctic taxa. Also, in Noyes (2010) the genera *Avetianella* Trjapitzin, *Szelenyiola* Trjapitzin, and *Oophagus* Liao were synonymized under *Oobius*.

As egg parasitoids of Buprestidae, Cerambycidae (Coleoptera; Noyes 2014) and Asilidae (Diptera; Annecke 1967), species of *Oobius* are important for the natural and classical biological control of some coleopteran species. Two species are being used as biological control agents in the USA where they are successfully established: *O. agrili* Zhang & Huang and *O. longoi* (Siscaro). The former was collected from China and was first released into the USA in 2007 as a biocontrol agent of the emerald ash borer, *Agrilus planipennis* Fairmaire (Buprestidae) (Bauer et al. in press). *Agrilus planipennis* is an invasive pest from Asia that attacks ash trees (*Fraxinus* spp.) (Haack et al. 2002; Bray et al. 2011). Releases of *O. agrili* are ongoing throughout infested regions of the USA. As of March 2015, establishment of *O. agrili* has been confirmed in Indiana, Maryland, Michigan, New York, Ohio, and Pennsylvania (Abell et al. 2014; Bauer et al. in press). *Oobius longoi* was introduced from Australia to California, USA, as a biocontrol agent for management of *Phoracantha recurva* Newman and *P. semipunctata* (Fabricius) (Cerambycidae), which are invasive pests of *Eucalyptus* trees in the USA (Hanks et al. 1995; Luhring et al. 2000).

Here two new species of *Oobius* are reported and a taxonomic key to the known native and introduced species of *Oobius* in North America is provided. One of the newly described species was reared initially from eggs of the native buprestid *Agrilus subcinctus* Gory in Michigan, whose larvae feed on the dead twigs of ash trees. This parasitoid was previously reported by Petrice et al. (2009) as *Avetianella* sp. Later, the second author of the current paper also reared this same species from eggs of *A. egenus* Gory on black locust trees (*Robinia pseudoacacia* L.) in Michigan. *Agrilus egenus* is a native species that oviposits on dead or dying branches of black locust (Nelson et al. 2008; MacRae 1991). The second newly described *Oobius* species was reared from *A. anxius* Gory eggs on European white birch (*Betula pendula* Roth) in Pennsylvania, based on the voucher specimens from the study by Loerch and Cameron (1983). *Agrilus anxius* is a native species that attacks both native and introduced birch trees (*Betula* spp.) in North America (Nelson et al. 2008).

Material and methods

Collecting and rearing new species of *Oobius*. Ash tree twigs with *A. subcinctus* eggs and black locust twigs with *A. egenus* eggs were collected in the field in Ingham and Clinton counties, Michigan in 2013 and 2014. Eggs were monitored in the laboratory for parasitoid emergence. Voucher specimens of the parasitoids were preserved in 95% ethanol and sent to the senior author for identification. See Loerch and Cameron (1983) for collection of parasitoids from *A. anxius*.

Taxonomic studies. Parasitoid specimens used in the taxonomic studies were critical point dried from ethanol and point-mounted. Selected specimens were then dissected and slide-mounted in Canada balsam, examined under a Zeiss®™ Axioskop 2 plus compound microscope using Nomarski differential interference contrast optics. Stereomicroscopic images were compiled with Auto-Montage 4.02 (Synchroscopy®™) to illustrate select specimens. Images of specimens were produced by scanning electron microscopy (SEM) and an EntoVision Imaging Suite. A Nikon®™ SMZ1500 and Leica®™ MZ 9.5 stereomicroscope with 10X oculars (Nikon C-W10X/22) and Chiu Technical Corp.®™ Lumina 1 FO-150 and fiber optic light source was used for pinned specimen observation. Mylar film was placed over the ends of the light source to reduce glare. Scanning electron microscope (SEM) images were taken with a Hitachi®™ TM3000 desktop unit (Tungsten source). Some specimens were manually cleaned of external debris with forceps or brushes and affixed to 12.7X 3.2 mm Leica/Cambridge aluminum SEM stubs with carbon adhesive tabs (Electron Microscopy Sciences, #77825-12). Stub-mounted specimens were imaged uncoated or sputter coated using a Cressington Scientific 108 Auto with a gold-palladium mixture from at least three different angles to ensure complete coverage (~20–30nm coating). Color images were obtained using an EntoVision Imaging Suite, which includes a firewire JVC KY-75 3CCD digital camera mounted to a Leica M16 zoom lens via a Leica z-step microscope stand. Slides of *O. buprestidis* and *O. dahlsteni* were imaged with a Leica DMRB compound microscope fitted with Leica HCX PL "Fluotar" 5× and 10× metallurgical grade lenses. Both systems fed image data to a desktop computer where Cartograph 5.6.0 (Microvision Instruments®™, France) was used to capture a fixed number of focal planes (based on magnification); the resulting focal planes (manually captured via Archimed 5.5.0 on the DMRB) were merged into a single, in-focus composite image. Uniform lighting was achieved using a LED illumination dome with all four quadrants set to 99.6% intensity. The images were then retouched where necessary using Adobe Photoshop®™ CS4/CS6 with plates assembled using InDesign CS4/CS6.

Terms used for morphological features are those of Gibson (1997). Abbreviations used are: F = antennal funicle segment; mps = multiporous plate sensillum or sensilla on the antennal flagellar segments (= longitudinal sensillum or sensilla or sensory ridge(s) of authors). Body length was measured without the exserted part of the ovipositor.

Acronyms for depositories of specimens are as follows: BMNH, The Natural History Museum, London, England, UK; EMEC, Essig Museum of Entomology, University of California, Berkeley, California, USA; IZCAS, Institute of Zoology, Chinese Academy of Sciences, Beijing, China; MSUC, Albert J. Cook Arthropod Research Collection, Department of Entomology, Michigan State University, East Lansing, Michigan, USA; PSUC, Frost Entomological Museum, Pennsylvania State University, University Park, State College, Pennsylvania, USA; UANL, Universidad Autónoma de

Nuevo León, San Nicolás de los Garza, Monterrey, Mexico; UCRC, Entomology Research Museum, University of California, Riverside, California, USA; UNCA, Institute of Agricultural Entomology, University of Catania, Catania, Sicily, Italy; USNM, National Museum of Natural History, Washington, District of Columbia, USA.

Taxonomy

Oobius Trjapitzin, 1963

Oobius Trjapitzin 1963: 544–545. Type species: *Tyndarichus rudnevi* Nowicki, by original designation.

Avetianella Trjapitzin 1968: 97–99. Type species: *Avetianella capnodiobia* Trjapitzin, by monotypy. Synonymized under *Oobius* by Noyes 2010: 660–662.

Szelenyiola Trjapitzin 1977: 160. Type species: *Szelenyiola nearctica* Trjapitzin, by original designation and monotypy. Synonymized under *Oobius* by Noyes 2010: 660–662.

Oobius: Trjapitzin 1977: 161 (key to genera of the subtribe Oobiina of the tribe Discodini of the subfamily Encyrtinae); Noyes 2010: 660–662 (synonymy, diagnosis, host associations, comments); Trjapitzin and Volkovitsh 2011: 670–672 (diagnosis of *Oobius* s. str., taxonomic position, key to world species).

Avetianella: Gordh and Trjapitzin 1981: 6 (comments); Trjapitzin 2001: 734–735 (comments, key to world species).

Oophagus Liao in Liao et al. 1987: 184. Type species: *Oophagus batocerae* Liao, by original designation and monotypy. Synonymized under *Avetianella* by Zhang and Huang 2004: 34–35, and under *Oobius* by Noyes 2010: 660.

Szelepyiola: Trjapitzin and Volkovitsh 2011: 671 (misspelled).

Comments. *Oobius* is a cosmopolitan genus as defined by Noyes (2010) who provided its detailed diagnosis, which is omitted here for brevity. One extralimital species, *O. striatus* Annecke, is also known from eggs of Asilidae (Diptera) in Montenegro and Zimbabwe (Annecke 1967; Noyes 2010, 2014).

Key to the Nearctic species of *Oobius*, females (both native and introduced)

(*Oobius depressus* (Girault) not included)

1 Tarsi 4-segmented (Fig. 1) .... ***O. agrili* Zhang & Huang**

– Tarsi 5-segmented (Figs 7, 13) **2**

2(1) Clava entire (Figs 9, 10) .... ***O. nearcticus* (Trjapitzin)**

– Clava 3-segmented (Figs 2, 6, 8, 12, 22) **3**

3(2) Body length (dry-mounted specimens) at most 0.53 mm; mps only on F6 (Fig. 12) .... ***O. minusculus* sp. n.**

– Body length (dry-mounted specimens) at least 0.66 mm; mps on F6 and other funicle segments (Figs 6, 20, 22) **4**

4(3) Mps on F5 and F6 (Fig. 6) .... ***O. buprestidis* (Gordh & Trjapitzin)**

– Mps on F4–F6 (Figs 8, 22) **5**

5(4) Linea calva “open” posteriorly (Fig. 23), uninterrupted by row of setae .... ***O. longoi* (Siscaro)**

– Linea calva interrupted posteriorly by a line (or lines) of setae (Figs 19, 27)... **6**

6(5) F5 and F6 each notably longer than F4 (Fig. 26), F4 0.8× length of F5........ .... ***O. whiteorum* sp. n.**

– F5 and F6 each subequal in length to F4 (Fig. 8), F4 more than 0.9× length of F5.. ***O. dahlsteni* (Trjapitzin)**

Alphabetical synopsis of the Nearctic species

Oobius agrili Zhang & Huang, 2005

Figures 1–4

Oobius agrili Zhang & Huang in Zhang et al. 2005: 254–258. Holotype female [IZCAS], not examined. Type locality: Changchun, Jilin, China.

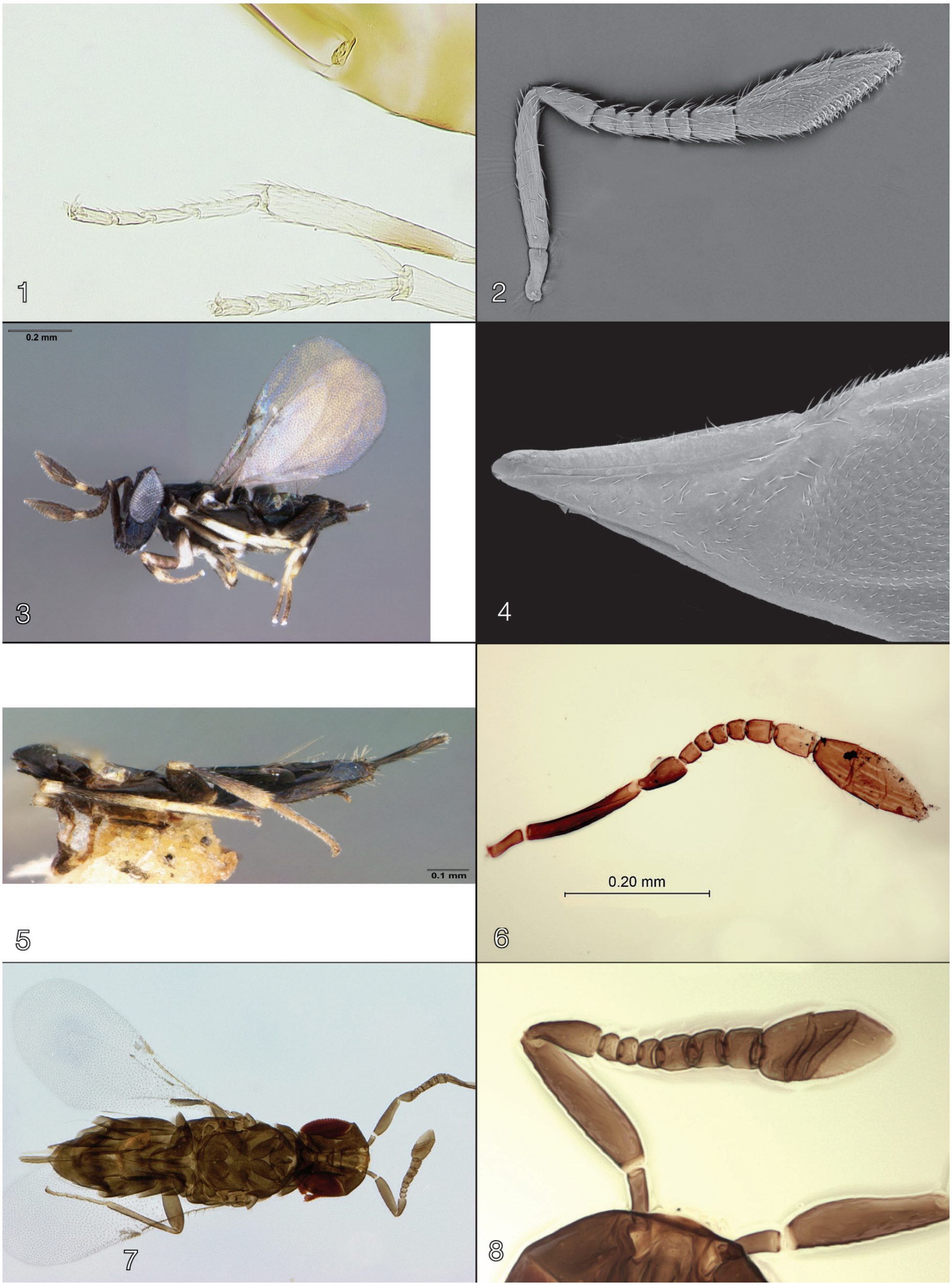
Oobius agrili Zhang & Huang: Trjapitzin and Volkovitsh 2011: 671 (key), 672–673 (taxonomic history, host associations, use in biological control for *A. planipennis*).

Material examined. USA, Michigan, Ingham Co., East Lansing, United States Department of Agriculture (USDA) Forest Service Northern Research Station, laboratory culture of *O. agrili* reared in *Agrilus planipennis* eggs: 37th-generation progeny, emerged 10.viii.2014, D.L. Miller, originally from CHINA, Jilin (Jingyuetan Forest Park, Changchun), 2006, T. Zhao (Zhao Tonghai), from eggs of *A. planipennis* [10 ♀, UCRC]; 6–7th-generation progeny, emerged 31.vii.2014, D.L. Miller, originally from CHINA, Jilin (Jingyuetan Forest Park, Changchun), 2008, T. Zhao, from eggs of *A. planipennis* [11 ♀, UCRC]; 4–8th-generation progeny, emerged 10.viii.2014, D.L. Miller, originally from CHINA, Jilin (Jingyuetan Forest Park, Changchun), 2009, T. Zhao, from eggs of *A. planipennis* [16 ♀, UCRC]; 9th-generation progeny, emerged 18.vii.2014, D.L. Miller, originally from CHINA, Jilin (Jingyuetan Forest Park, Changchun), 2008, T. Zhao, from eggs of *A. planipennis* [11 ♀, UCRC].

Distribution. China (Zhang et al. 2005; Liu et al. 2007); USA (introduced): Indiana, Maryland, Michigan, New York, Ohio, and Pennsylvania, as of March 2015 (Abell et al. 2014; Bauer et al. in press).

Host. *Agrilus planipennis* Fairmaire.

Comments. *Oobius agrili* is a solitary thelytokous egg parasitoid of *A. planipennis*, discovered in 2004 during foreign exploration for natural enemies in northeast China (Zhang et al. 2005; Liu et al. 2007; Trjapitzin and Volkovitsh 2011). Adults *O. agrili* were reared from eggs at the USDA Forest Service Northern Research Station laboratory



Figures 1–8. 1–4 *Oobius agrili* female (from USDA Forest Service laboratory colony, East Lansing, Michigan, USA; of China origin), **1** hind leg **2** antenna **3** lateral habitus **4** forewing base **5–6** *Oobius buprestidis* female (holotype), **5** lateral habitus **6** antenna **7–8** *Oobius dahlsteni* female (holotype) **7** dorsal habitus **8** antenna.

in East Lansing, Michigan, USA. Rearing stock for this colony originated from parasitized *A. planipennis* eggs collected from *Fraxinus pennsylvanica* trees in Jingyuetan Forest Park, Changchun, Jilin Province, China in 2004–2009. In 2007, *O. agrili* introductions began in Michigan, USA, for classical biological control of *A. planipennis.* As of fall 2014, releases of *O. agrili* had expanded to 19 states (Bauer et al. in press). Abell et al. (2014) reported parasitism of *A. planipennis* eggs averaged approximately 20% in 2012–2013 at some sites where *O. agrili* was established, however, more studies are needed to assess the impact of *O. agrili* and other *A. planipennis* biocontrol agents on ash recovery in the USA. Since 2010, stock cultures of *O. agrili* have been provided to the USDA Animal and Plant Health Inspection Service Emerald Ash Borer Biocontrol Facility, Brighton, Michigan, USA, for mass-rearing and releasing as a biocontrol agent of *A. planipennis* in infested regions of the USA (Mapbiocontrol 2014). To distinguish *O. agrili* from the known native and the other introduced *Oobius* species, we provide illustrations of its metatarsus (Fig. 1), female antenna (Fig. 2), lateral habitus of the female (Fig. 3), and base of the forewing (Fig. 4).

Oobius buprestidis **(Gordh & Trjapitzin, 1981)**

Figures 5–6

Avetianella buprestidis Gordh and Trjapitzin 1981: 7–8, 9 (key), 59 (illustrations). Type locality: Portland, Multnomah Co., Oregon, USA.

Avetianella buprestidis: Trjapitzin 2001: 735 (key), 736 (list).

Oobius buprestidis (Gordh & Trjapitzin): Noyes 2010: 662.

Type material examined. Holotype female [USNM] on point mount labeled with following seven labels: “Ex egg of *Bupretus* [sic] *aurulentus*”, “Portland, Ore., F.D. Keen Colr.”, “Hopk. US No. 33150-D”, “Lot No. 41-14524”, “*Habrolepoidea* n. sp. det. Gahan”, “*Avetianella* sp.n. Det Trjapitzin et Gordh”, [red] “Holotypus *Avetianella buprestidis* G. & T.”. The head and antenna are slide mounted separately: [left label] “♀ Holotype, Head & antenna, *Avetianella buprestidis* Gordh & Trjapitzin”, [right label] “Portland, Oregon, Hopkins #33150-D, Lot #41-14524, Ex eggs *Buprestus aurulentus*”. The forewing is mounted on an additional slide with the forewing of a male paratype: [left label] “♂ Forewing, top, *Avetianella buprestidis* G.&T., Portland, Ore., Lot # 41-14524, Hopkins # 33150-D, ♂ paratype”, [right label] “♀ Forewing, bottom, (Holotype) Ex. eggs *Buprestus aurulentus*, F.P. Keen, col. Head & antenna, *Avetianella buprestidis* Gordh & Trjapitzin, [right label] “Portland, Oregon, Hopkins #33150-D, Lot #41-14524, Ex eggs *Buprestus aurulentus*”.

Distribution. USA (Oregon) (Gordh and Trjapitzin 1981).

Host. *Buprestis aurulenta* L. (Gordh and Trjapitzin 1981 [as *Buprestus aurulentus*]; Trjapitzin 2001 [as *Cypriacus aurilentus* L.]).

Comments. The point-mounted portion of the type (Fig. 5) is positioned at the apex of the point. Co-mounted proximally is a complete male paratype. A sliver of wood is pinned in the main collection (USNM) on which are eight eggs of *B. aurulenta* (7 of which have parasitoids emergence holes) bearing the 33150-D Hopkins number designation.

Oobius dahlsteni **(Trjapitzin, 1971)**

Figures 7–8

Avetianella dahlsteni Trjapitzin 1971: 890–892. Type locality: McCloud [Flat], Siskiyou Co., California, USA.

Avetianella dahlsteni: Gordh and Trjapitzin 1981: 9 (key); Trjapitzin and Gordh 1984: 1275; Trjapitzin 2001: 735 (key), 736 (list).

Oobius dahlsteni (Trjapitzin): Noyes 2010: 662.

Type material examined. Holotype female [EMEC] on slide labeled: [left label] "*Avetianella dahlsteni* Trjapitzin ♀, Trjapitzin 1970, CFL III-69, Ch. phenol gum damar, Div. Biol. Conn. Univ. Calif ["holotype" handwritten at top, middle, and bottom of label in red ink]", [right label] "McCloud Flat, Siskiyou Co. Calif., July, 1968, *D. brevicornis* rearing carton, A900, MF2-5 SR., D. L. Dahlsten".

Distribution. USA (California) (Trjapitzin 1971).

Hosts. Unknown.

Comments. The holotype (Fig. 7) is complete and whole mounted; its antenna (Fig. 8) is also illustrated to facilitate recognition of this species.

Oobius depressus **(Girault, 1916)**

Figures 17–18

Habrolepoidea depressa Girault 1916: 343–344. Type locality: Morristown, Henry Co., Illinois, USA.

Avetianella depressa (Girault): Gordh and Trjapitzin 1981: 8; Trjapitzin and Gordh 1984: 1275 (lectotype designation, comments); Trjapitzin 2001: 735 (mentioned), 736 (list). *Oobius depressus* (Girault): Noyes 2010: 662, 690.

Type material examined. Lectotype female [USNM], designated by Trjapitzin & Gordh (1984), on point with following six labels: "Morristown XII-8-14 Ill", "Ex-Eggs Cylene robinae", "JRMalloch Coll.", [red] "Paratype No. 20328 U. S. N. M.", "*Avetianella* Det. Trjapitzin et Gordh", [red] "*Lectotypus* ♀ *Habrolepoidea depressa* Grlt Des. Trjapitzin et Gordh". Paralectotypes, 2 males, 2 females: 1 female [USNM] on point with following six labels: "Morristown XII-8-14 Ill", "ExEggs Cylene robinae", "JRMalloch Coll.", [red] "Paratype No. 20328 U. S. N. M.", [red] "*Paralectotypus* ♀ *Habrolepoidea depressa* Grlt Des. Trjapitzin et Gordh", "*Avetianella depressa* (Girault) ♀ Det. V. Trjapitzin May 1997"; 1 female [USNM] on point with following six labels: "Morristown XII-8-14 Ill", "ExEggs *Cylene robinae*", "JRMalloch Coll.", [red] "Paratype No. 20328 U. S. N. M.", 5. "*Habrolepoidea depressa* Gir Type", "LECTOTYPE *Habrolepoidea depressa* Girault By B.D. Burks"; 2 males [USNM] on points, each with following four labels: "Morristown XII-8-14 Ill", "ExEggs *Cylene robinae*", "JRMalloch Coll.", [red] "Paratype No. 20328 U. S. N. M.". All specimens of the type series lack the heads and antennae (Trjapitzin and Gordh 1984; Trjapitzin 2001).

Distribution. USA (Illinois) (Girault 1916).

Host. *Megacyllene robiniae* (Forster) (Cerambycidae) (Girault 1916 [as *Cyllene robiniæ*]).

Comments. The identity of this species remains unclear because the original description is poor and without any illustrations; unfortunately, the slide with a head and a forewing of each sex (Girault 1916) could not be found in the USNM and is presumed lost. The lectotype label affixed by B. D. Burks was not validly designated and is merely a paralectotype. To facilitate identification of this species, we provide illustrations of its scutellum (Fig. 17) and habitus of the female in dorsal view (Fig. 18).

Oobius longoi (Siscaro, 1992)

Figures 22–23

Avetianella longoi Siscaro 1992: 206–211. Holotype female [UNCA], not examined. Type locality: Grammichele, Catania Prov., Sicily, Italy.

Avetianella longoi: Trjapitzin 2001: 735 (key), 737–738 (taxonomic history, host associations); Wang et al. 2008: 1772–1777 (host associations, morphological and molecular data).

Oobius longoi (Siscaro): Noyes 2010: 662, 692.

Material examined. Australia, New South Wales, Corowa, 22.i.2006, Q. Wang, from eggs of *Phoracantha recurva* [1 ♀, 1 ♂, UCRC]. Portugal: Lisboa, Montijo, Pegões, viii.1992, P. Albino, M. R. Paiva, from eggs of *Phoracantha semipunctata* [9 ♀, 11 ♂, UCRC]. Viseu, Villa Cova à Coelheira, viii.1992, P. Albino, M. R. Paiva, from eggs of *P. semipunctata* [11 ♀, UCRC]. USA, California, Riverside Co., Riverside, University of California campus, Department of Entomology Insectary, laboratory culture on eggs of *P. semipunctata* on *Eucalyptus* sp.: 29.ix.1994, L. Hanks (originally from Australia) [4 ♀, UCRC]; 1998, S. McElfresh, J. Gould (originally from: Australia, Victoria, Melbourne, Bundoora, La Trobe Wildlife Sanctuary, i.1992, Q. Wang, from eggs of *P. semipunctata* on fallen *Eucalyptus* sp.) [25 ♀, 22 ♂, UCRC].

Distribution. Australia (indigenous); introduced (in some cases possibly unintentionally) into Hungary, Italy, Portugal, South Africa, Spain, USA (California), and Zambia (Trjapitzin 2001; Noyes 2014).

Hosts. *Phoracantha recurva* Newman and *P. semipunctata* (Fabricius) (Cerambycidae) in California, USA (Wang et al. 2008); its other longhorned beetle hosts in Australia are listed by Trjapitzin (2001) and Noyes (2014).

Comments. *Oobius longoi* is well known as an effective biological control agent and a successfully established parasitoid of *P. recurva* and *P. semipunctata* in California and elsewhere in the world (Hanks et al. 1995; Luhring et al. 2000; Trjapitzin 2001).

Oobius minusculus **Triapitsyn & Petrice, sp. n.**

http://zoobank.org/A7698FE3-D6BF-4AB1-B796-9D006B040D45
Figures 11a, 12–16, 25, 31, 33–34

Avetianella sp.: Petrice et al. 2009: 179–180 (egg parasitoid of *A. subcinctus* in Livingston Co., Michigan, USA).

Type material. Holotype female [UCRC] on slide (Fig. 11a) with following four labels: "USA: Michigan, Clinton Co., near Bath, 42.812°N, 84.410°W, 255 m, parasitized *Agrilus subcinctus* Gory eggs collected 12.vii.2013, T.R. Petrice, emerged 16-22. vii.2013 in laboratory (Lansing, MI)", "Mounted by V. V. Berezovskiy 2014 in Canada balsam", [magenta] "*Oobius minusculus* Triapitsyn & Petrice HOLOTYPE ♀", [database label] "Univ. Calif. Riverside Ent. Res. Museum UCRC ENT 142420". The holotype is in good condition, complete, dissected under 3 coverslips.

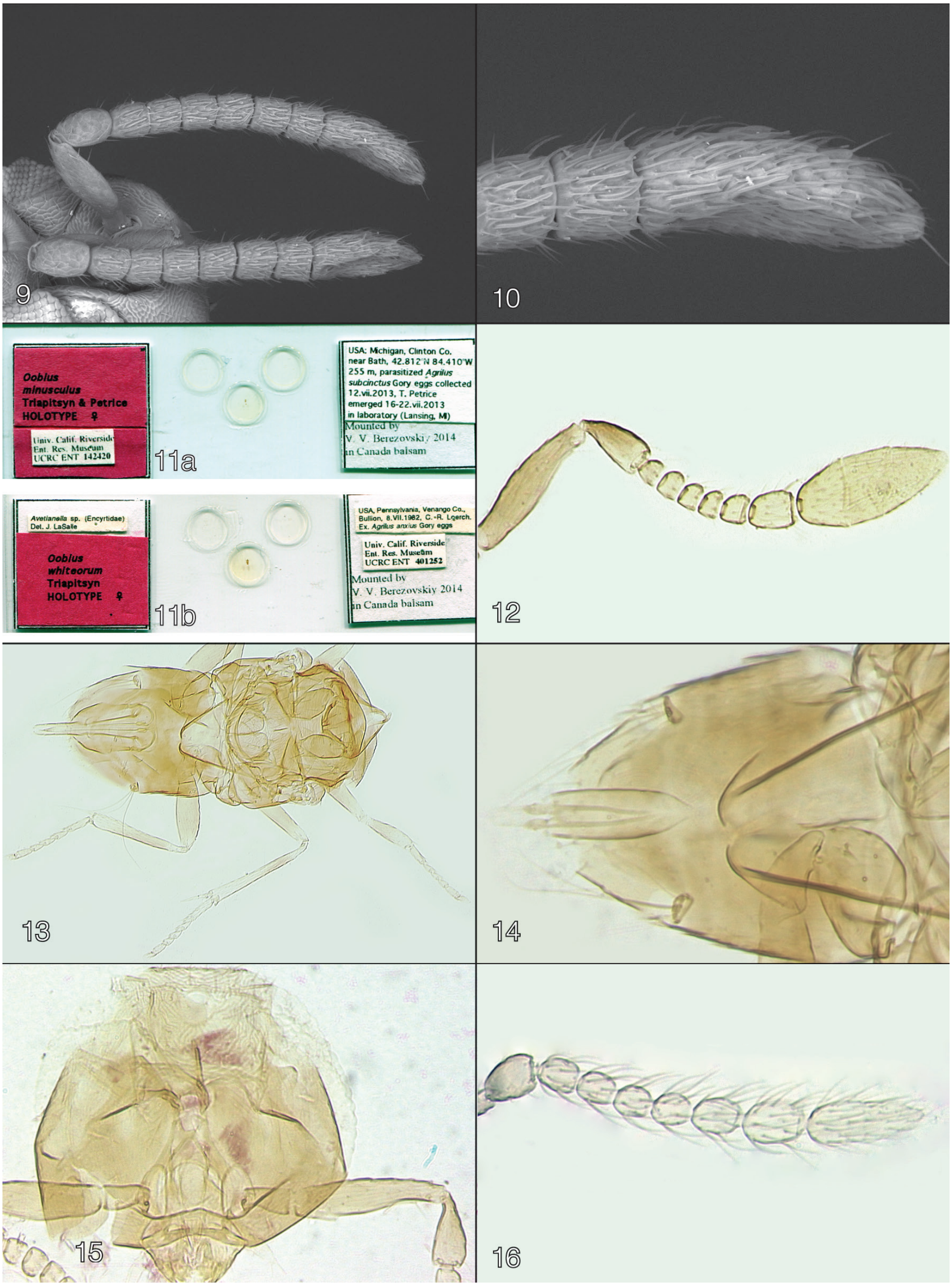
Paratypes: USA, Michigan: Clinton Co. (same data as the holotype), 2 ♀ on points [MSUC, UCRC] and 1 ♀, 1 ♂ on slides [UCRC]. Ingham Co., Michigan State University Tree Research Center, 42°40'12"N, 84°28'12"W, 267 m, 14.viii.2014, T. R. Petrice, emerged in laboratory (East Lansing) from parasitized *Agrilus egenus* Gory eggs on black locust, *Robinia pseudoacacia*, twigs: emerged 22.viii.2014 [3 ♀ on points, MSUC, UCRC, USNM]; emerged 29.viii.2014 [3 ♀ on points, MSUC, UCRC, USNM, and 1 ♂ on slide, UCRC]; emerged 6.ix.2014 [1 ♀ on point, UCRC]; emerged 17.ix.2014 [1 ♂ on slide, UCRC].

Description. FEMALE (holotype). Body dark brown to black except scutellum and propodeum brown; scape and pedicel brown, flagellum light brown; legs whitish or pale yellowish with wide brown bands on coxae, femora, and tibiae.

Frontovertex and mesonotum with faint mesh-like or lineolate sculpture [very difficult to see in dry-mounted specimens, best observed in slide-mounted ones (as in Fig. 25)]. Pronotum, mesoscutum, axillae, and scutellum with short, dusky setae; scutellum also with a pair of long, fine setae near posterior margin.

Head (as in Fig. 15, collapsed when air-dried) with ocelli in an obtuse triangle, posterior ocellus a little less than its diameter away from eye margin. Transfacial and inner orbital sutures present. Mandible 3-dentate, the inner tooth with two denticles; maxillary palpus 4-segmented, labial palpus 1-segmented (i.e., palpal formula 4–1).

Antenna (Fig. 12) inserted below lower eye margin. Radicle about 0.3× total scape length, rest of scape slender, 4.5× as long as wide, a little wider in the middle, with



Figures 9–16. 9–10 *Oobius nearcticus* female (holotype), **9** antenna **10** clava **11a–11b**: **11a** holotype slide of *O. minusculus* **11b** holotype slide of *O. whiteorum* **12–16** *Oobius minusculus* **12** antenna (holotype female) **13** mesosoma and metasoma (holotype female) **14** metasoma (paratype male) **15** head (paratype female) **16** pedicel and flagellum (paratype male).

faint longitudinal sculpture. Pedicel longer than any funicle segment; F1–F5 slightly transverse, F1–F4 subequal in length, F5 a little longer and slightly wider than long; F6 the longest funicle segment, longer than wide; F1–F5 without mps, and F6 with 2 mps. Clava 3-segmented, about 2.3× as long as wide and almost as long as funicle; first claval segment with 1 mps, second and third segments each with 3 mps.

Mesosoma a little shorter than gaster (Fig. 13). Mesoscutum about 1.7× as wide as long. Scutellum a little wider than long, a little shorter than mesoscutum; scutellar placoid sensilla closer to the posterior margin of scutellum and close to each other.

Wings (Fig. 31) not abbreviated, forewing extending far beyond apex of gaster. Forewing 2.1× as long as wide, hyaline; marginal setae very short; disc densely setose, linea calva interrupted posteriorly by an irregular row of setae, filum spinosum present. Hindwing 4.2× as long as wide, hyaline; longest marginal seta 0.3× maximum wing width.

Mesotibial spur a little longer than mesobasitarsus.

Ovipositor occupying a little more than 0.5× length of gaster, exserted markedly beyond gastral apex (by 0.2× own length) (Fig. 13); ovipositor length:metatibia length ratio 1.2:1. Outer plate of ovipositor with two subapical setae.

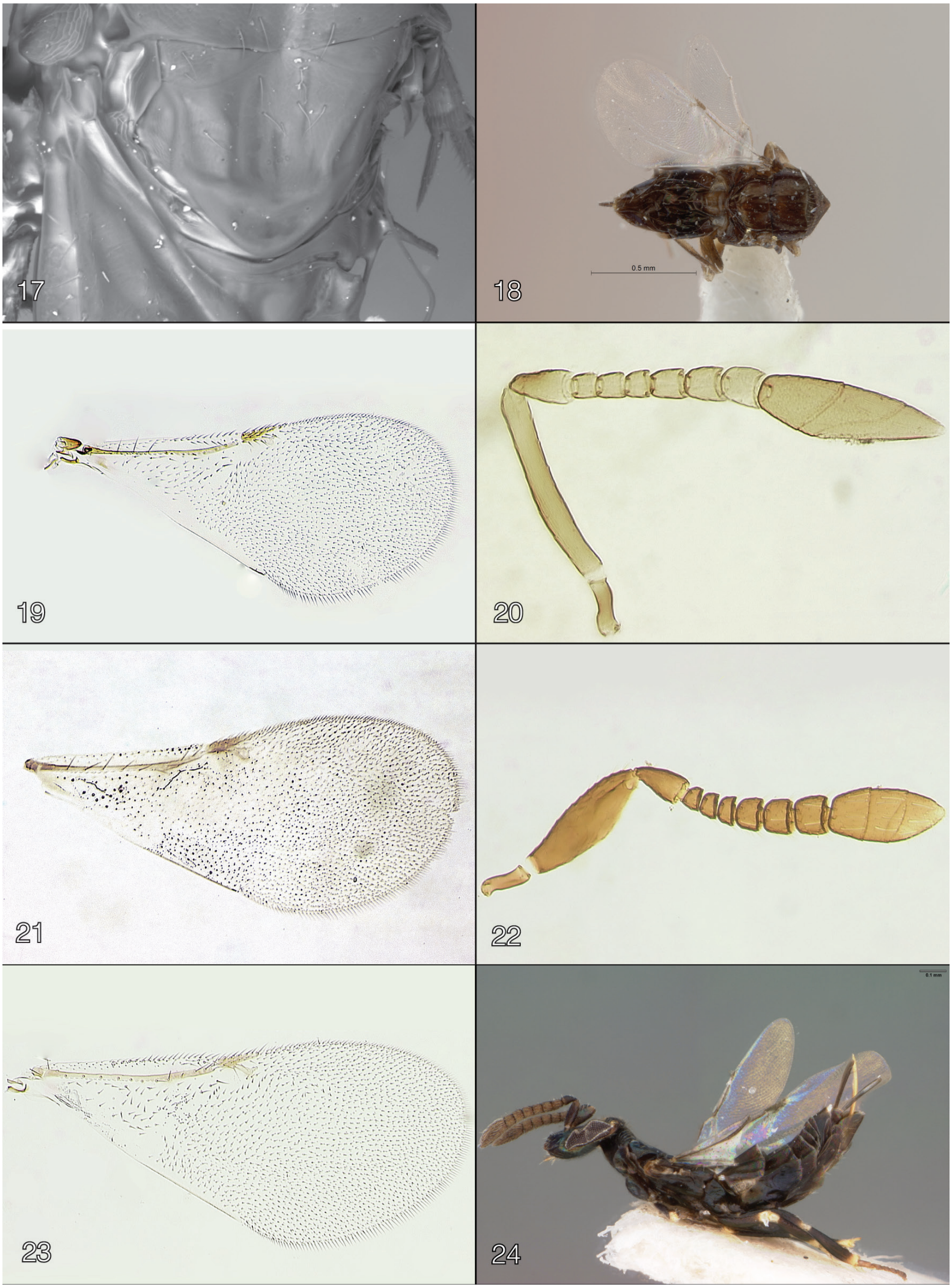
Measurements of the holotype (mm, as length or length:width). Body (of the dry-mounted specimen prior to slide-mounting): 0.462; mesosoma: 0.233; gaster: 0.245; ovipositor: 0.173. Antenna: radicle: 0.03; rest of scape: 0.103; pedicel: 0.045; F1: 0.012; F2: 0.012; F3: 0.011 (0.012); F4: 0.012; F5: 0.015; F6: 0.03; clava: 0.103. Forewing: 0.495:0.234; longest marginal seta: 0.021; hindwing: 0.357:0.085; longest marginal seta: 0.025.

Variation (paratypes). Body length 0.43–0.46 mm (dry-mounted specimens from *A. subcinctus*, Fig. 33) or 0.46–0.53 mm (critical-point dried specimens from *A. egenus*, Fig. 34). In the latter specimens, legs (except tarsi) are somewhat darker (mostly brown), scape (minus radicle) of the female antenna is about 5.0× as long as wide, and clava is about 2.5× as long as wide. Mandibles are identical for specimens reared from both host species, and there is no doubt that they are conspecific. In all specimens, F6 is sometimes slightly paler than other flagellomeres but not contrastingly, still almost concolorous or often concolorous.

MALE (paratype from *A. subcinctus*). Head dark brown, mesosoma and gaster dark brown to black except mesoscutum with a brownish tinge, base of gaster whitish; antenna with scape and pedicel brown to dark brown, flagellum light brown. Antenna (Fig. 16) with scape minus radicle 2.9× as long as wide; F2–F4 more or less subequal in length, F1 and F5 slightly longer, F6 the longest funicle segment; F2–F4 without mps, F1, F5, F6 and clava with mps; flagellar segments with very long setae (slightly longer than each funicle segment's width); clava entire, 2.6× as long as wide, a little wider than funicle segments. Mesosoma (Fig. 25) about as long as gaster. Forewing 2.0× as long as wide, hyaline. Genitalia (Fig. 14) typical for the genus.

Variation (paratypes from *A. egenus*). Body length 0.4–0.5 mm (critical-point dried specimens).

Diagnosis. This species is similar to the European *O. zahaikevitshi* Trjapitzin (Figs 19, 30), whose type locality is Zhuravlivka, Vinnytsia Oblast, Ukraine, where it was



Figures 17–24. 17–18 *Oobius depressus* female **17** dorsal scutellum (lectotype) **18** dorsal habitus (paralectotype) **19** *Oobius zahaikevitshi* female (environs of Volgograd, Krasnoarmeyskiy District, Volgograd Province, Russia), forewing **20–21** *Oobius hasmik* female (paratype) **20** antenna **21** forewing **22–23** *Oobius longoi* female (from University of California laboratory colony, Riverside, California, USA; of Australia origin), **22** antenna **23** forewing **24** *Oobius nearcticus* female (holotype), lateral habitus.

reared from eggs of *Agrilus viridis* (Linnaeus) on *Carpinus betulus* (Trjapitzin 1963). *Oobius zahaikevitshi* was recently well illustrated by Gumovsky et al. (2013). It was recorded from several European countries and *Agrilus* spp. hosts, listed by Trjapitzin and Volkovitsh (2011) and Noyes (2014). However, we are not absolutely confident that all these records are correct: it is quite possible that they might represent a complex of more than one cryptic species that are difficult to distinguish without supporting molecular data and thorough morphological studies based on good quality slide-mounted specimens. Proportions of funicle segments of the female antenna seem to be somewhat different between the specimens of *O. zahaikevitshi* from Ukraine illustrated by Trjapitzin (1963) and Gumovsky et al. (2013), in which F5 is about as long as wide, and the examined specimens from Volgograd Province of Russia, in which F5 is a little wider than long (Fig. 30).

Oobius minusculus differs from *O. zahaikevitshi* in having the palpal formula 4–1, a relatively smaller F5 of the female antenna and also by F6 being longer than wide and almost concolorous or often concolorous with other flagellomeres (Fig. 12). In contrast, the palpal formula for *O. zahaikevitshi* is 3–1, F5 is relatively larger, and F6 is about as long as wide and contrastingly lighter than other flagellomeres (Fig. 30), as also described and illustrated in Trjapitzin (1963) and Gumovsky et al. (2013).

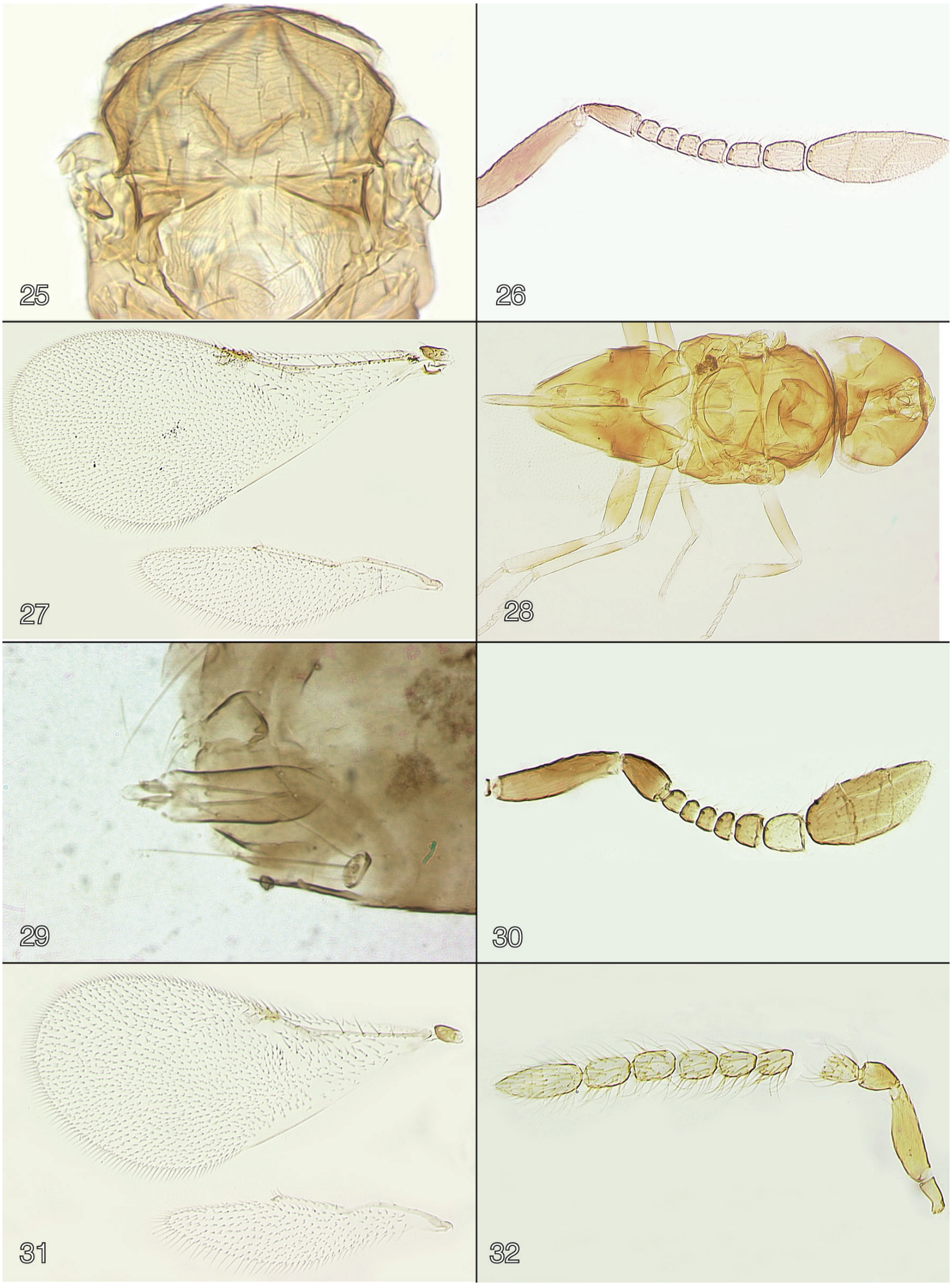
Oobius minusculus is the only described native Nearctic species of *Oobius* s. str., as characterised by Noyes (2010) in having the outer plate of the ovipositor being relatively short and apically rounded with paired subapical setae (one long and one short), in which this new taxon fits well. In the key by Trjapitzin and Volkovitsh (2011) to the world species of *Oobius* (s. str.), it keys to *O. zahaikevitshi*. In Noyes (2010), *O. minusculus* tentatively keys (although it really does not key to any of the included Neotropical species) to the same couplet with *O. xochipili* Noyes and *O. zagan* Noyes from Costa Rica, from both of which it differs by F5 of the female antenna being much less transverse, just slightly wider than long (Fig. 12) whereas in *O. xochipili* and *O. zagan* F5 is anelliform, much wider than long (Noyes 2010).

Etymology. The name of this new taxon is an adjective referring to its small size.

Hosts. *Agrilus subcinctus* on ash (*Fraxinus* spp.) and *A. egenus* on black locust (*Robinia pseudoacacia*).

Notes on biology. Originally reported by Petrice et al. (2009) as *Avetianella* sp. that parasitized *A. subcinctus* eggs. The second author has never found this parasitoid to overwinter in *A. subcinctus* eggs. However, collections of *A. egenus* eggs found overwintering *O. minusculus* larvae in eggs. This species likely attacks other *Agrilus* spp. in North America, and has multiple generations per year.

Comments. The following specimens of *O. zahaikevitshi* were examined: Bulgaria, Plovdiv Prov., Klisura, 27.vi–8.vii.1975, A. Atanasov, from eggs of *Agrilus cuprescens* (Ménétriés) on *Rosa* sp. [1 ♂, BMNH] (det. V. A. Trjapitzin 1977). Russia, Volgograd Prov. (oblast'), Krasnoarmeyskiy District (rayon), environs of Volgograd, vi.1971, A. M. Makhmadziyoev (Makhmadzieev), from eggs of *A. viridis* on *Acer tataricum* [1 ♀, BMNH; 5 ♀, UCRC] (det. V. A. Trjapitzin 1977 and 1975, respectively).



Figures 25–32. 25 *Oobius minusculus* male (paratype), mesosoma **26–29** *Oobius whiteorum* **26** antenna (holotype female) **27** a pair of wings (holotype female) **28** dorsal habitus (holotype female) **29** genitalia (paratype male) **30** *Oobius zahaikevitshi* female (environs of Volgograd, Krasnoarmeyskiy District, Volgograd Province, Russia), antenna **31** *Oobius minusculus* female (holotype), a pair of wings **32** *Oobius whiteorum* (paratype male), antenna.

Oobius nearcticus **(Trjapitzin, 1977)**

Figures 9–10, 24

Szelenyiola nearctica Trjapitzin 1971: 160–161. Type locality: Blodgett Forest (8 mi. E. of Georgetown), University of California Blodgett Forest Research Station, El Dorado Co., California, USA.

Oobius nearcticus (Trjapitzin): Noyes 2010: 662, 668, 671.

Type material examined. Holotype female [EMEC] on point mount with following four labels: "UC Blodgett Forest 8 mi E. Georgetown, El Dorado Co., California Coll. F. M. Stephen 1970", "Traps A-1094", [red] "Holotypus *Szelenyiola nearctica* Trjapitzin", "U.C. Berkeley EMEC 82,322". Paratype female [EMEC] on point with following five labels: "UC Blodgett Forest 8 mi E. Georgetown, El Dorado Co., California Coll. F. M. Stephen 1970 A-1094 Traps", "Head with appendages on slide No. 1955", "Also forewing", "Paratypus", [red] "*Szelenyiola nearctica* Trjapitzin ♀".

Distribution. USA (California) (Trjapitzin 1977).

Hosts. Unknown.

Comments. The holotype (Fig. 24) is missing its left hindwing and the apical 2/3 of the left forewing.

Oobius whiteorum **Triapitsyn, sp. n.**

http://zoobank.org/00F395AF-FD46-4102-A70E-BBD69B5176C1

Figures 11b, 26–29, 32, 35

Avetianella sp.: Loerch and Cameron 1983: 1798–1799 (egg parasitoid, host information); Trjapitzin 2001: 738 (list).

Type material. Holotype female [UCRC] on slide (Fig. 11b) with following five labels: "USA, Pennsylvania, Venango Co., Bullion, 8.VII.1982, C. R. Loerch, Ex. *Agrilus anxius* Gory eggs", "Mounted by V. V. Berezovskiy 2014 in Canada balsam", "*Avetianella* sp. (Encyrtidae) Det. J. LaSalle", [magenta] "*Oobius whiteorum* Triapitsyn HOLOTYPE ♀", [database label] "Univ. Calif. Riverside Ent. Res. Museum UCRC ENT 401252". The holotype is in good condition, complete, dissected under 3 coverslips.

Paratypes: same data as the holotype, 4 ♀ on points and 1 ♂ on slide [UCRC].

Description. FEMALE (holotype). Body somewhat flattened, dark brown to black; appendages brown except tarsi light brown; scape and pedicel a little darker than flagellum, and F6 just slightly lighter than other flagellar segments but still brown.

Frontovertex and mesonotum with faint mesh-like sculpture [very difficult to see in dry-mounted specimens]. Pronotum, mesoscutum, axillae, and scutellum with short, dusky setae; scutellum also with a pair of long, fine setae near posterior margin.

Figures 33–35. 33–34 *Oobius minusculus* (paratype females) **33** dorsal habitus (from *Agrilus subcinctus*) **34** lateral habitus (from *Agrilus egenus*) **35** *Oobius whiteorum* (paratype female), dorsal habitus.

Head (Fig. 28) with ocelli in an obtuse triangle, posterior ocellus about its diameter away from eye margin. Transfacial and inner orbital sutures absent. Mandible 3-dentate; palpal formula 4–3.

Antenna (Fig. 26) inserted below lower eye margin. Radicle about 0.2× total scape length, rest of scape slender, 4.1–4.2× as long as wide, a little wider in the middle, with faint longitudinal sculpture. Pedicel longer than any funicle segment. F1–F3 about as long as wide, F4–F6 longer than wide; F1–F3 subequal, F4–F6 each progressively a little longer than the preceding funicle segment; F1–F3 without mps, F4 with 1 mps, F5 with 2 mps, and F6 with 3 or 4 mps. Clava 2.8× as long as wide, and slightly shorter than combined length of F2–F6; each claval segment with 3 mps; apical claval segment obliquely truncate ventrally.

Mesosoma (Fig. 28) shorter than gaster. Mesoscutum about 1.6× as wide as long. Scutellum wider than long, almost as long as mesoscutum.

Wings (Fig. 27) not abbreviated, forewing extending far beyond apex of gaster. Forewing 2.1× as long as wide, hyaline; marginal setae very short; disc densely setose, linea calva interrupted posteriorly by rows of setae, filum spinosum present. Hindwing 3.7–3.8× as long as wide, hyaline; longest marginal seta 0.18× maximum wing width.

Mesotibial spur as long as mesobasitarsus.

Ovipositor occupying about 0.5× length of gaster, exserted markedly beyond gastral apex (by 0.36× total ovipositor length); ovipositor length:metatibia length ratio 1.3:1. Outer plate of ovipositor with 1 subapical seta.

Measurements of the holotype (mm, as length or length:width). Body (of the dry-mounted specimen prior to slide-mounting): 0.66; head: 0.19; mesosoma: 0.313; gaster: 0.35; ovipositor: 0.283. Antenna: radicle: 0.039; rest of scape: 0.151; pedicel: 0.06; F1: 0.021; F2: 0.021; F3: 0.021; F4: 0.028; F5: 0.035; F6: 0.044; clava: 0.155. Forewing: 0.677:0.314; longest marginal seta: 0.021; hindwing: 0.5:0.133; longest marginal seta: 0.024.

Variation (paratypes). Body (Fig. 35) length 0.66–0.75 mm (dry-mounted specimens).

MALE (paratype). Body length (of the dry-mounted specimen prior to slide-mounting) 0.66 mm. Head and mesosoma dark brown, gaster brown; scape and pedicel brown, flagellum light brown; legs light brown to brown. Antenna (Fig. 32) with scape minus radicle 3.2× as long as wide; funicle segments longer than wide, more or less subequal in length (F5 and particularly F6 slightly longer), F1 and F2 without mps, F3 with or without mps, F4–F6 and clava with mps; flagellar segments with very long setae (slightly longer than each funicle segment's width and about as long as width of clava); clava entire, 2.6–2.7× as long as wide, a little wider than funicle segments. Mesosoma about as long as gaster. Forewing 1.9× as long as wide, hyaline. Hindwing 3.5× as long as wide, hyaline. Genitalia (Fig. 29) typical for the genus.

Diagnosis. Among the Nearctic species of *Oobius*, *O. whiteorum* is most similar to *O. dahlsteni*, from which it differs by the proportions of the funicle segments of the female antenna, as indicated in the key. In Trjapitzin's (2001) key to the world species of the former genus *Avetianella* (s. str.) in which this new species mostly fits, as characterised by Noyes (2010) in having the outer plate of the ovipositor being conspicuously distally elongate and ribbon-like and always with only a single subapical seta, it keys to *O. dahlsteni*. *Oobius whiteorum* differs from *O. depressus*, to which it is also somewhat similar, by a relatively less flattened body and by the much smaller body size in females; according to Girault (1916), the body length of the latter species is 1.15 mm. *Oobius whiteorum* differs from the North American species, but Neotropical species *O. hasmik* (Trjapitzin), known from Mexico (Trjapitzin 2001) and also Costa Rica (Noyes 2010), by the "closed" linea calva (Fig. 27) on the forewing ("open", not interrupted, in *O. hasmik*, Fig. 21) and also by the different proportions of the scape of the female antenna (Figs 26 and 20, respectively). In Noyes (2010), *O. whiteorum* keys to the same couplet with *O. lutron* Noyes from Costa Rica and Brazil, from which it differs by each of F4–F6 of the female antenna being of different length and longer than wide (Fig. 26) whereas in *O. lutron* F4–F6 are subequal and each quadrate or hardly longer than broad (Noyes 2010).

Host. *Agrilus anxius* Gory on European white birch (*Betula pendula*).

Etymology. This species is named in honor of Lisa and Michael White of Chicago, Illinois, USA, good friends of the author's family.

Comments. According to Loerch and Cameron (1983), additional voucher specimens of the egg parasitoids of *A. anxius* were deposited by them in PSUC; any of them belonging to this species are non-type specimens. Unfortunately, due to a renovation of the museum, point-mounted specimens in that collection are now inaccessible (A. Deans, personal communication).

The following paratypes [UCRC] of *O. hasmik* were examined, all collected at Las Barracas (~30 km E of Santiago, 23°28'02"N, 109°27'01"W, 50 m), Baja California Sur, Mexico: 1 ♀ on point with following five labels: "Mex. Baja Cal. Sur Las Barracas 17 - V - 1985", "Coll. P. DeBach Pan trap", "*Avetianella* ♀ Det. V. Trjapitzin May 1997", [red] "Paratypus ♀ *Avetianella hasmik* Trjapitzin", "Praep. micr. 22M" (an antenna, head, and a forewing were detached from this specimen; they are mounted on a slide with following two labels: "*Avetianella hasmik* ♀ Trjapitzin México: Baja California Sur, Las Barracas. Pan trap 17.V.1985 (Coll. P. DeBach) 22M Antena, cabeza, ala anterior", [red] "Paratypus *Avetianella* ♀ *hasmik* Trjapitzin"); also 16 ♀, 1 ♂ on points, all collected by P. DeBach during 1985 and 1986, as indicated by Trjapitzin (2001).

Oobius sp.

(Not included in the key)

Oobius sp. n.: Trjapitzin et al. 2008: 186 (record from Mexico).

Oobius sp. n. aff. *rudnevi* (S. Nowicki, 1928): Trjapitzin and Volkovitsh 2011: 674 (list, Mexico).

Comments. One female [UANL] of this undescribed species from Mexico, which has no host information, was mentioned by Trjapitzin and Volkovitsh (2011); however, they did not indicate the collecting locality so it is unknown from which part of that country it was found (Nearctic or Neotropical).

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References

Abell KJ, Bauer LS, Duan JJ, Van Driesche R (2014) Long-term monitoring of the introduced emerald ash borer (Coleoptera: Buprestidae) egg parasitoid, *Oobius agrili* (Hymenoptera: Encyrtidae), in Michigan, USA and evaluation of a newly developed monitoring technique. Biological Control 79 (1): 36–42. doi: 10.1016/j.biocontrol.2014.08.002

Annecke DP (1967) Three new southern African species of *Oobius* Trjapitzin, 1963 (Hymenoptera: Encyrtidae). Journal of Natural History 1(3): 319–325. doi: 10.1080/00222936700770291

Bauer LS, Duan JJ, Gould J (2014) XVII Emerald ash borer (*Agrilus planipennis* Fairmaire) (Coleoptera: Buprestidae). In: Van Driesche R, Reardon R (Eds) The use of classical biological control to preserve forests in North America. United States Department of Agriculture, Forest Service, FHTET-2013-02, Morgantown, West Virginia, 189–209. http://www.fs.fed.us/foresthealth/technology/pdfs/FHTET-2013-2.pdf

Bauer LS, Duan JJ, Gould JG, Van Driesche RG (in press) Progress in the classical biological control of *Agrilus planipennis* Fairmaire (Coleoptera: Buprestidae) in North America. The Canadian Entomologist.

Bray AM, Bauer LS, Poland TM, Haack RA, Cognato AI, Smith JJ (2011) Genetic analysis of emerald ash borer (*Agrilus planipennis* Fairmaire) populations in Asia and North America. Biological Invasions 13: 2869–2887. doi: 10.1007/s10530-011-9970-5

Gibson GAP (1997) Chapter 2. Morphology and terminology. In: Gibson GAP, Huber JT, Woolley JB (Eds) Annotated keys to the genera of Nearctic Chalcidoidea (Hymenoptera). NRC Research Press, Ottawa, Ontario, Canada, 16–44.

Girault AA (1916) Descriptions of and observations on some chalcidoid Hymenoptera – II. The Canadian Entomologist 48(10): 337–344. doi: 10.4039/Ent48337-10

Gordh G, Trjapitzin VA (1981) Taxonomic studies of the Encyrtidae with descriptions of new species and a new genus (Hymenoptera, Chalcidoidea). University of California Publications in Entomology 93: 1–64.

Gumovsky AV, Simutnik SA, Prokhorov AV (2013) Life-history review of *Oobius zahaikevitshi* Trjapitzin, 1963 (Hymenoptera: Encyrtidae), an egg parasitoid of jewel beetles (Coleoptera: Buprestidae). Russian Entomological Journal 22(3): 181–188.

Haack RA, Jendek E, Liu HP, Marchant K, Petrice T, Poland TM, Ye H (2002) The emerald ash borer: a new exotic pest in North America. Newsletter of the Michigan Entomological Society 47(3–4): 1–5.

Hanks LM, Gould JR, Paine TD, Millar JG, Wang Q (1995) Biology and host relations of *Avetianella longoi* (Hymenoptera: Encyrtidae), an egg parasitoid of the eucalyptus longhorned borer (Coleoptera: Cerambycidae). Annals of the Entomological Society of America 88(5): 666–671. doi: 10.1093/aesa/88.5.666

Liao DX, Li XL, Pang XF, Chen TL (1987) Hymenoptera: Chalcidoidea (1). Economic Insect Fauna of China No 34: x+241 pp.

Liu HP, Bauer LS, Miller DL, Zhao TH, Gao RT, Song L, Luan Q, Jin R, Gao C (2007) Seasonal abundance of *Agrilus planipennis* (Coleoptera: Buprestidae) and its natural enemies *Oobius agrili* (Hymenoptera: Encyrtidae) and *Tetrastichus planipennisi* (Hymenoptera: Eulophidae) in China. Biological Control 42: 61–71. doi: 10.1016/j.biocontrol.2007.03.011

Loerch CR, Cameron EA (1983) Natural enemies of immature stages of the bronze birch borer, *Agrilus anxius* (Coleoptera: Buprestidae), in Pennsylvania. Environmental Entomology 12: 1798–1801. doi: 10.1093/ee/12.6.1798

Luhring KA, Paine TD, Millar JG, Hanks LM (2000) Suitability of the eggs of two species of eucalyptus longhorned borers (*Phoracantha recurva* and *P. semipunctata*) as hosts for the parasitoid *Avetianella longoi* Siscaro. Biological Control 19: 95–104. doi: 10.1006/bcon.2000.0853

MacRae TC (1991) The Buprestidae (Coleoptera) of Missouri. Insecta Mundi 5: 101–126.

Mapbiocontrol (2014) Emerald ash borer biocontrol release and recovery. http://www.mapbiocontrol.org/

Nelson GH, Walters GC, Haines RD, Bellamy CL (2008) A catalog and bibliography of the Buprestoidea of America North of Mexico. The Coleopterists Society Special Publ. No. 4: 1–274.

Noyes JS (2010) Encyrtidae of Costa Rica (Hymenoptera: Chalcidoidea), 3. Subfamily Encyrtinae: Encyrtini, Echthroplexiellini, Discodini, Oobiini and Ixodiphagini, parasitoids associated with bugs (Hemiptera), insect eggs (Hemiptera, Lepidoptera, Coleoptera, Neuroptera) and ticks (Acari). Memoirs of the American Entomological Institute 84: 1–848.

Noyes JS (2014) Universal Chalcidoidea database. WWW publication. The Natural History Museum, London. http://www.nhm.ac.uk/research-curation/projects/chalcidoids/index.html [accessed 12.i.2015]

Petrice TR, Haack RA, Strazanac JA, Lelito JP (2009) Biology and larval morphology of *Agrilus subcinctus* (Coleoptera: Buprestidae), with comparisons to the emerald ash borer, *Agrilus planipennis*. The Great Lakes Entomologist 42: 173–184.

Siscaro G (1992) *Avetianella longoi* sp. n. (Hymenoptera Encyrtidae) egg parasitoid of *Phoracantha semipunctata* F. (Coleoptera Cerambycidae). Bollettino di Zoologia Agraria e Bachicoltura (2) 24(2): 205–212.

Trjapitzin VA (1963) Species of the genus *Oobius* gen. n. (Hymenoptera, Encyrtidae) in the USSR. Acta Entomologica Musei Nationalis Pragae [Sborník Entomologického Oddeleni Národního Musea v Praze] 35: 543–547.

Trjapitzin VA (1968) [A survey of the encyrtid fauna (Hym. Encyrtidae) of the Caucasus]. Trudy Vsesoyuznogo Entomologicheskogo Obshchestva 52: 43–125. [In Russian]

Trjapitzin VA (1971) [A Nearctic representative of the genus *Avetianella* Trjapitzin, 1968 (Hymenoptera, Encyrtidae)]. Entomologicheskoe Obozrenie 50 (4): 890–892. [In Russian]

Trjapitzin VA (1977) New genera and species of parasitic Hymenoptera of the family Encyrtidae (Hymenoptera: Chalcidoidea). Folia Entomologica Hungarica 30 (1): 153–166.

Trjapitzin VA (2001) [A review of encyrtids of the genus *Avetianella* Trjapitzin, 1968 (Hymenoptera, Encyrtidae) of the world fauna with description of a new species from Mexico]. Entomologicheskoe Obozrenie 80 (3): 734–739. [In Russian]

Trjapitzin VA, Gordh G (1984) [Taxonomic notes on the Neotropic genus *Habrolepoidea* (Hymenoptera, Encyrtidae) and on species erroneously referred to it]. Zoologicheskiy Zhurnal 63(8): 1273–1277. [In Russian]

Trjapitzin VA, Myartseva SN, Ruíz-Cancino E, Coronado-Blanco JM (2008) Clave de géneros de Encyrtidae (Hymenoptera: Chalcodoidea) de México y un catálogo de las especies. Serie Avispas parasíticas de plagas y otros insectos. Universidad Autónoma de Tamaulipas, Ciudad Victoria, Tamaulipas, México, 265 pp.

Trjapitzin VA, Volkovitsh MG (2011) A review of species of the genus *Oobius* Trjapitzin, 1963 (Hymenoptera, Encyrtidae) egg parasitoids of jewel beetles, longicorn beetles (Coleoptera, Buprestidae, Cerambycidae), and robber flies (Diptera, Asilidae). Entomological Review 91(5): 670–676. [English translation, originally published in Russian in Entomologicheskoe Obozrenie 90 (1): 226–234]

Zhang Y, Huang D (2004) A review and an illustrated key to genera of Encyrtidae (Hymenoptera: Chalcidoidea) from China. Science Press, Beijing, China, 166 pp.

Zhang Y-Z, Huang D-W, Zhao T-H, Liu H-P, Bauer LS (2005) Two new species of egg parasitoids (Hymenoptera: Encyrtidae) of wood-boring beetle pests from China. Phytoparasitica 33(3): 253–260. doi: 10.1007/BF02979863

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New distribution records for Canadian Aleocharinae (Coleoptera, Staphylinidae), and new synonymies for *Trichiusa*

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Abstract

Fifty-four new Canadian provincial records of aleocharine beetles (Staphylinidae), including three new Canadian records and one new North American record, are presented. Of these, 33 are new provincial records for Saskatchewan, 14 for Alberta, two for British Columbia, three for Manitoba, two for the Northwest Territories and one for the Yukon Territory. The following are new Canadian records: *Trichiusa pilosa* Casey [formerly reported from Nova Scotia and Ontario as *T. postica* Casey], *Acrotona recondita* (Erichson) and the adventive Palaearctic *Atheta nigra* (Kraatz), which is also a new North American record. Bionomics information and new locality records are provided. The following new synonyms of *Trichiusa pilosa* Casey are established: *T. atra* Casey, *T. monticola* Casey, *T. parviceps* Casey, and *T. postica* Casey. The numbers of Aleocharinae remaining to be discovered in Canadian provinces and territories are discussed.

Keywords

Coleoptera, rove beetles, Staphylinidae, new distribution records, new synonymy, species richness, Canada, Alberta, British Columbia, Manitoba, Northwest Territories, Saskatchewan, Yukon Territory

Introduction

Staphylinidae (the rove beetles) are the most species-rich family of beetles in Canada with 1652 species and subspecies recorded, 510 of which are in the Aleocharinae (Bousquet et al. 2013). Aleocharinae are one of the poorest known subfamilies of rove beetles in Canada, although enormous strides have been made in understanding the taxonomy of this group in the last 20 years, especially in eastern Canada. Western and northern Canada (Manitoba to British Columbia, and the three territories), 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. 2008, 2012). Thus the full distribution of many species recorded for Canada is not known because of the large gaps in sampling intensity. Nonetheless, the fauna of these provincial and territorial jurisdictions is starting to receive more attention as many studies in recent years have sampled aleocharines in a large number of habitats, particularly in Alberta. Improved sampling of Staphylinidae and especially Aleocharinae are needed to establish baseline biodiversity composition in areas of the country where ecosystems are undergoing rapid change due to resource extraction and climate change. As well, this family and subfamily are known to be exceptionally good ecological indicators and are increasingly being used to assess ecosystem resistance and resilience in the wake of development and environmental changes (Pohl et al. 2007, 2008, Langor, unpublished data). This paper contributes to improved baseline knowledge of the Aleocharinae in the Canadian west and north by providing 54 new provincial and territorial records for 51 species.

Materials and methods

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 specimens 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).

Depository/institutional abbreviations

BGC	Benoit Godin Collection, Whitehorse, Yukon, Canada.
LFC	Natural Resources Canada, Canadian Forest Service, Laurentian Forestry Centre, R. Martineau Insectarium, Quebec City, Quebec, Canada.
NoFC	Natural Resources Canada, Canadian Forest Service, Northern Forestry Centre, Arthropod Museum, Edmonton, Alberta, Canada.

Abbreviations of Canadian provinces and territories

AB – Alberta;
BC – British Columbia;
LB – Labrador;
MB – Manitoba;
NB – New Brunswick;
NF – Newfoundland;
NS – Nova Scotia;
NT – Northwest Territories;
NU – Nunavut;
ON – Ontario;
PE – Prince Edward Island;
QC – Quebec;
SK – Saskatchewan;
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 ~25 years, faster than for other subfamilies of rove beetles and for most (perhaps all) families of beetles. This increase in knowledge is attributed to a surge in sampling of this subfamily, particularly in eastern Canada, and to a large amount of taxonomic activity (e.g., by Gusarov, Lohse, Klimaszewski, Webster). Of the 463 native species of Aleocharinae recorded in Canada by Bousquet et al. (2013), 32.8% (152 species) were described in the last 25 years. Many other previously described native species were first recorded in Canada over the last 25 years. Of the 47 non-native species in Canada, 10 (21.3%) were detected in the last 25 years (Klimaszewski et al. 2001, 2002, 2006, 2007a, 2010, 2011, Majka and Klimaszewski 2010, McLean et al. 2009a). Furthermore, recent reviews or revisions have resulted in species keys for no less than 35 genera with Canadian representatives.

Despite the great improvements in taxonomic knowledge and availability of diagnostic resources (keys, illustrations, expertly identified reference material), sampling of most of the microhabitats and regions of the country is still woefully incomplete. In recent years, thanks to very active sampling in the Atlantic provinces (especially New Brunswick and Newfoundland and Labrador) and in the Yukon Territory, coupled with large efforts to identify material and publish findings (Klimaszewski et al. 2005, 2007b, 2008, 2009a, b, 2010, 2011, 2012, Majka and Klimaszewski 2010, Webster et al. 2009, 2012), those are undoubtedly the best-studied regions of the country in terms of the aleocharine fauna. 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, 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. This has resulted in the collection of an estimated 50,000–70,000 specimens of Aleocharinae, especially in epigaeic and saproxylic habitats of forests, throughout much of the province. The vast majority of these specimens have not been prepared or identified. The identification of a few specimens from one small study in northwestern Alberta resulted in the 14 new provincial records reported herein. Similarly, dozens of other sites have been subjected to intensive insect trapping, especially in British Columbia, Quebec and northern Canada, resulting in collection of tens of thousands of aleocharine specimens, the vast majority of which remain undetermined. Virtually every insect collection in the country, and many in other countries, have hundreds to many thousands of undetermined aleocharine specimens. Thus, even modest efforts at determination are sure to reveal new provincial, territorial, national and North American records, and undescribed species. Thus it is not surprising nor unusual that examination of a relatively small number of specimens from a few sites in Saskatchewan resulted in 33 new provincial records, including two new Canadian records and one new North American record. This sampling effort more than doubled the previously known species for the province, now numbering 53 species (Table 1).

Estimating the expected number of species of aleocharines in Canada is challenging. One way to do this is to extrapolate based on the species richness patterns for the family Carabidae (ground beetles) that is very well known and surveyed throughout most of Canada. This family frequently co-occurs with aleocharines, especially in epigaeic and saproxylic habitats. The jurisdictions where the aleocharine fauna is best known are Yukon Territory, New Brunswick and Newfoundland and Labrador. For Carabidae, the fauna of these three jurisdictions represent 20.5%, 34.3%, and 19.5% of the total number (972) of carabid species/subspecies in Canada (Bousquet et al. 2013). If it is assumed that the known aleocharine fauna of each of these jurisdictions represents a similar percent of the total Canadian fauna, then an extrapolation based on the currently known fauna of Yukon, New Brunswick and Newfoundland and Labrador estimates 630, 601 and 890 species in the Canadian fauna, respectively. It is likely that the actual number falls somewhere in the middle of this range. Thus, it is reasonable to use the average of these three estimates, 707, as the expected species richness for the Canadian fauna, meaning that at least 200 more aleocharine species are expected to be found in Canada. Likely a large proportion of these will be found in British Columbia and southern Ontario and Quebec.

The expected species richness of aleocharines for each jurisdiction can also be estimated using the proportion of the total Canadian carabid fauna in each territory and province and multiplying that against the expected total Canadian aleocharine species richness (707) (Table 2). By comparing this estimated species richness to the actual one (Bousquet et al. 2013), the percent of each jurisdictional fauna documented to date can be calculated. In terms of the percent of fauna documented at the time Bousquet et al. (2013) was published, the most poorly known jurisdictions were Saskatchewan (11%) and Prince Edward

Table 1. Species of Aleocharinae recorded from SK and their provincial and territorial distribution within Canada and new records of species from AB, BC, MB and YT. 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.

Tribe ALEOCHARINI	
Aleochara assiniboin Klimaszewski	BC, MB, ON, SK, YT
Aleochara bilineata Gyllenhal†	AB, BC, MB, NB, NF, NS, ON, PE, QC,SK
Aleochara bimaculata Gravenhorst	AB, BC, LB, MB, NB, NF, NS, ON, QC, SK, NT
Aleochara gracilicornis Bernhauer	BC, MB, NB, NS, NT, ON, QC, SK
Aleochara lacertina Sharp	AB, BC, MB, NB, NF, NS, ON, QC, SK
Aleochara lata Gravenhorst†	BC, MB, ON, QC, SK, YT
Aleochara sekanai Klimaszewski	AB, LB, MB, NB, NT, ON, **SK**, YT; USA: AK
Aleochara tahoensis Casey	AB, BC, MB, NB, NS, NT, ON, SK, YT
Aleochara verna Say	AB, BC, LB, MB, NB, NF, NS, ON, PE, QC, SK, YT; USA: AK
Tinotus morion (Gravenhorst) †	AB, BC, NB, NF, NS, ON, QC, **SK**; USA: CT, NV
Tribe ATHETINI	
Acrotona recondita (Erichson) **new country record**	**SK;** USA: AR, CA, NH, NV, PA
Aloconota sulcifrons (Stephens) †	**MB,** NB, NF, ON, QC; USA: AL, IL, IN, KY, MO, NH, NY, TN, VA, WV
Atheta celata (Erichson) *	BC, NB, NF, NS, QC, **SK**; USA: AK
Atheta cryptica (Lohse, 1990)	**BC,** NF, QC, YT
Atheta dadopora C.G. Thomson *	AB, BC, LB, NB, NF, NS, ON, PE, **SK**, YT; USA: AK, NY, PA, RI
Atheta fanatica Casey	**AB**, BC, LB, NB, NS, QC, **SK**, YT; USA: AK, NV
Atheta graminicola (Gravenhorst) *	AB, BC, LB, MB, NB, NF, NT, ON, QC, **SK**, YT; USA: AK, OR
Atheta klagesi Bernhauer	AB, BC, NB, NF, NS, ON, PE, QC, **SK**, YT; USA: IA, ME, MN, NJ, NY, PA
Atheta longicornis (Gravenhorst) †	BC, NB, NF, NS, QC, **SK**; USA: CA, MN
Atheta nigra (Kraatz) † **new North American record**	**SK**
Atheta platonoffi Brundin*	AB, BC, LB, NB, NF, NS, ON, **SK**, YT; USA: AK
Atheta prudhoensis (Lohse)	BC, LB, NB, NF, NS, ON, QC, **SK**, YT; USA: AK, VT
Atheta pseudosubtilis Klimaszewski & Langor	**AB,** LB, NB, NF, QC
Atheta ventricosa Bernhauer	AB, BC, LB, NB, NF, NS, ON, QC, **SK**, YT; USA: AK, DC, NC, NJ, NY, PA, VT
Boreophilia davidgei Klimaszewski & Godin	**AB**, YT
Boreophilia islandica (Kraatz)*	**AB**, NF, NT, NU, YT; USA: AK; Palaearctic: Europe, Asia (Holarctic species)
Boreostiba parvipennis (Bernhauer)	AB, LB, NF, **NT,** QC, YT; USA: AK, NH
Dinaraea pacei Klimaszewski & Langor	AB, BC, LB, NB, NF, QC, **YT**; USA: AK
Dinaraea worki Klimaszewski & Jacobs	**AB,** QC
Liogluta aloconoides Lohse	**AB**, LB, NF, NS, YT
Lypoglossa franclemonti Hoebeke	AB, MB, NB, NF, NS, NT, ON, QC, **SK**, YT; USA: NY, VT
Philhygra botanicarum (Muona) *	BC, LB, NB, NF, NS, ON, **SK**, YT
Philhygra clemens (Casey)	**MB**, NB, NS, ON, QC, YT; USA: WI
Philhygra jarmilae Klimaszewski & Langor	NB, NF, ON, **SK**, YT
Philhygra ripicoloides Lohse	NF, NT, **SK**, YT

Philhygra rostrifera Lohse	LB, **NT**, **SK,** YT; USA: AK
Philhygra sinuipennis Klimaszewski & Langor	NB, LB, NF, **SK**, YT
Philhygra terrestris Klimaszewski & Godin	**SK,** YT
Schistoglossa campbelli Klimaszewski	**AB**, BC
Schistoglossa carexiana Klimaszewski	BC, **SK**?
Schistoglossa hampshirensis Klimaszewski	**AB**, NB, QC; USA: NH
Seeversiella globicollis (Bernhauer)	AB, BC, NB, NF, NS, ON, QC, **SK**; USA: AZ, CO, ID, MN, MT, NH, SD, WI; Mexico; Guatemala
Trichiusa pilosa Casey **new country record under this name**	**AB**, **BC**, NS, ON; USA: ID, IN, KS, OH, RI
Tribe FALAGRINI	
Falagria dissecta Erichson	AB, BC, MB, NB, NS, ON, QC; across USA
Tribe GYMNUSINI	
Gymnusa campbelli Klimaszewski	MB, NB, NF, NT, ON, QC, **SK**, YT; USA: AK
Tribe HOMALOTINI	
Gyrophaena criddlei Casey	LB, MB, NB, ON, **SK**, YT
Gyrophaena insolens Casey	BC, LB, MB, NB, NF, ON, **SK;** USA: MI
Gyrophaena uteana Casey	AB, BC, NB, ON, QC, **SK**; USA: CA, CO, UT
Homalota plana (Gyllenhal) †	**AB**, NB, NF, NS; USA: AK; Palaearctic: Europe, Asia
Tribe LOMECHUSINI	
Xenodusa reflexa (Walker)	AB, BC, MB, NB, NS, QC, ON, SK
Tribe MYLLAENINI	
Myllaena arcana Casey	AB, LB, NB, NF, NS, ON, QC, **SK**; USA: AL, FL, IA, IL, MA, NH, NJ; Mexico
Mylaena insomnis Casey	AB, BC, LB, MB, NB, NF, NS, NT, ON, QC, SK, YT; USA: AK, ID, MA, MN, WI
Tribe OXYPODINI	
Cratarea suturalis (Mannerheim) †	BC, LB, NB, NS, ON, SK; USA: IL, MA, MO, PA, SC, VA, VT; Palaearctic region
Devia prospera (Erichson) *	AB, BC, LB, MB, NB, NT, ON, **SK**, YT; USA: AK, CO, MI, MN, NM, OR, SD, UT, WA, WY; Palaearctic: Europe, Asia
Gnypeta caerula (C.R. Sahlberg) *	AB, BC, LB, MB, NB, NF, NS, NT, ON, PE, QC, SK, YT; USA: AK
Gnypeta carbonaria (Mannerheim)	AB, MB, NB, NF, NT, ON, QC, SK; USA: AK
Gnypeta sellmani Brundin	LB, MB, NF, NT, QC, SK, YT; USA: AK
Ocyusa canadensis Lohse	NB, NF, ON, **SK**, YT; USA: AK
Oxypoda grandipennis (Casey)	AB, BC, LB, NB, NF, NS, ON, QC, **SK**, YT; USA: AK, NH
Oxypoda hiemalis Casey	**AB**, LB, NB, NF, NS, NT, ON, QC; USA: AK
Oxypoda lacustris Casey	AB, BC, LB, **MB**, NB, NF, NS, NT, ON, QC, **SK**, YT; USA: AK
Oxypoda orbicollis Casey	AB, LB, NB, NS, ON, QC, **SK**, YT; USA: WI
Oxypoda pseudolacustris Klimaszewski	AB, NB, NF, NS, ON, QC, **SK**
Tachyusa obsoleta Casey	BC, NB, SK
Tribe PLACUSINI	
Placusa incompleta Sjöberg †	**AB**, BC, NB, NF, NS, ON, QC; USA: WA; Palaearctic: Europe
Placusa pseudosuecica Klimaszewski	**AB**, BC, ON, QC
Placusa tachyporoides (Waltl)	**AB**, BC, NB, NS, ON, QC; Palaearctic: Europe
Number of species: 67 (33 new records for SK, 14 for AB, 2 for BC, 3 for MB, 2 for NT, 1 for YT). 51 species representing 54 new provincial records.	7 adventive and 4 Holarctic species

Table 2. Number of aleocharine species in Canada and projection of yet undiscovered species per province and territory.

	Provinces and territories													
	YK	**NT**	**NU**	**BC**	**AB**	**SK**	**MB**	**ON**	**QC**	**NB**	**NS**	**PE**	**NL**	**Total**
Aleocharinae species richness (Bousquet et al. 2013)	129	55	14	175	89	27	73	228	192	206	124	24	174	510
Proportion of total fauna in each jurisdiction based on carabid data (Bousquet et al. 2013)	0.205	0.223	0.035	0.519	0.428	0.359	0.387	0.547	0.493	0.343	0.300	0.179	0.195	
Expected aleocharine species richness extrapolated from carabid diversity data	145	158	25	367	303	254	274	387	348	242	212	126	174	707
Percent of fauna so far documented	89%	35%	56%	48%	29%	11%	27%	59%	55%	85%	58%	19%	<100%	72%
Number of species awaiting discovery	16	103	11	192	214	227	201	159	156	36	88	102	>0	197

Island (19%), followed by Manitoba, Alberta, Northwest Territories, and British Columbia (Table 2). With the 33 new records provided for Saskatchewan in this paper, the percent of expected fauna documented has now risen to 24%. In terms of the expected number of species remaining to be documented, the three prairie provinces and British Columbia each have about 200 species that are yet to be documented, and Ontario and Quebec each have about 150 species to be discovered. Despite the enormous advances in documenting Aleocharinae diversity in Canada over the last 2-3 decades, clearly much remains to be done.

New records

ALEOCHARINI Fleming

Aleochara (*s. str.*) *sekanai* Klimaszewski

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

Distribution.

Origin	Nearctic
Distribution	Canada: LB, MB, NB, NT, ON, **SK**, YT; USA: AK
New records	New provincial record: **Saskatchewan:** Prince Albert, sandy beach, 53.9804°, -106.28°, 532 m, 4.VI.2013 (LFC) 1 female
References	Klimaszewski 1984, Gouix and Klimaszewski 2007, Majka and Klimaszewski 2010, Klimaszewski et al. 2011, Bousquet et al. 2013

Natural history. In Saskatchewan, one female was captured on a sandy beach. In Labrador, adults were collected in carrion traps and flight intercept traps in spruce-moss forests (Klimaszewski et al. 2011). Elsewhere, adults were captured from animal carcasses and some from *Carex* and moss near a lake (Klimaszewski 1984). The adults were collected from May to August.

Tinotus morion Gravenhorst

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

Distribution.

Origin	Palaearctic, adventive in North America
Distribution	Canada: AB, BC, NB, NF, ON, QC, **SK**; USA: CT, NV
New records	New provincial record: **Saskatchewan:** Maple Creek, horse manure, 49.9037°, -109.5909°, 764 m, 2.IX.2012 (BGC) 1 male
References	Klimaszewski et al. 2002, 2005, 2011, Gouix and Klimaszewski 2007, Majka and Klimaszewski 2010

Natural history. In Saskatchewan, one male was captured in horse manure. Elsewhere, adults were collected from decaying organic matter, fungi, animal droppings, human feces, and carrion (Klimaszewski et al. 2002). Larvae are parasitic on fly pupae (Klimaszewski et al. 2002). The adults were collected from June to September.

ATHETINI Casey

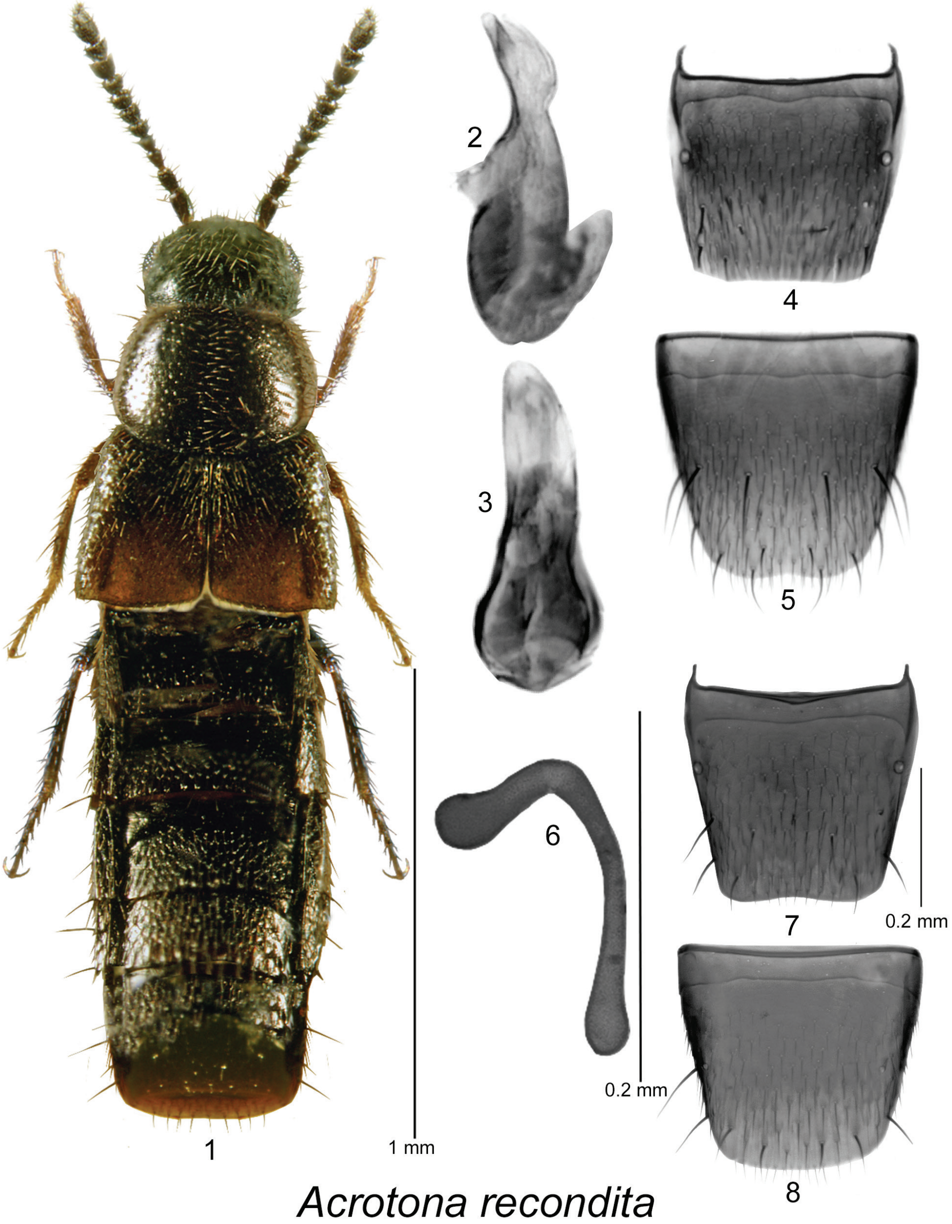
Acrotona recondita (Erichson)

Figs 1–8

LECTOTYPE (male): *Homalota recondita* Erichson; USA: Pennsylv[ania], Zimm[erman] [on green rectangular card]; # 5472; Typus; *recondita* Er.; Lectotypus, male, *Homalota recondita* Erichson, V.I. Gusarov des. (not published); our lectotype designation label as *H. recondita*; *Acrotona recondita* (Er.) V.I. Gusarov 2002 (ZMB) studied. PARALECTOTYPES: labelled as the lectotype, our paralectotype designation label (ZMB) 1 male, 2 females, 1 sex undetermined, specimen partially damaged, studied.

Arisota apacheella Casey 1910: 135. Synonymized by Moore and Legner 1975: 371.
Arisota insueta Casey 1910: 134. Synonymized by Moore and Legner 1975: 371.
Arisota pomonensis Casey 1910: 135. Synonymized by Moore and Legner 1975: 371.
Arisota speculifer Casey 1910: 135. Synonymized by Moore and Legner 1975: 371.
Arisota tetricula Casey 1910: 134. Synonymized by Moore and Legner 1975: 371.
Arisota umbrina Casey 1910: 136. Synonymized by Moore and Legner 1975: 371.

Diagnosis. Body narrowly subparallel (Fig. 1), length 1.7–1.8 mm, dark brown with two large reddish-brown spots on posterior sutural part of elytra and lighter colour tarsi (Fig. 1); head, pronotum and elytra coarsely and sparsely punctate, punctures large; pubescence sparse; integument strongly glossy; pronotum transverse, slightly narrower than elytra, pubescence directed laterad from median line; elytra at suture about as long as pronotum; abdomen subparallel. MALE. Median lobe of aedeagus with oval bulbus and narrowly elongate and rounded tubus in dorsal view (Fig. 3), in lateral view tubus slightly arcuate basally and straight apically (Fig. 2); internal sac structures not pronounced; tergite VIII truncate apically (Fig. 4); sternite VIII slightly emarginated at apex and with broad distance between base of disc and antecostal suture (Fig. 5). FEMALE. Tergite VIII truncate apically (Fig. 7); sternite VIII broadly arcuate apically (Fig. 8); spermatheca with narrowly elongate club-shaped capsule angularly connected to narrow and long stem, together forming L-shaped structure (Fig. 6).



Figures 1–8. *Acrotona recondita* (Casey): **1** habitus in dorsal view **2** median lobe of aedeagus in lateral view, and **3** in dorsal view **4** male tergite VIII **5** male sternite VIII **6** spermatheca in lateral view **7** female tergite VIII **8** female sternite VIII; **1, 6–8** based on female from Saskatchewan **2–5** based on male from Pennsylvania.

Distribution.

Origin	Nearctic
Distribution	Canada: first record for Canada and **SK**; USA: AR, CA, NH, NV, NY, PA
New records	New provincial record; **Saskatchewan:** Maple Creek, horse manure, 49.9037°, -109.5909°, 764 m, 2.IX.2012 (BGC) 1 female
References	Erichson 1839, Bland 1865, Casey 1910, Moore and Legner 1975

Natural history. The single female in Saskatchewan was captured in horse manure.

Remarks. This species was originally described by Erichson (1839) as *Homalota recondita*, from Pennsylvania. It clearly does not belong to *Homalota* and was subsequently listed by Moore and Legner (1975) as belonging to the subgenus *Dimetrota* of *Atheta*. Gusarov, V.I. identified types of *H. recondita* as *Acrotona*. The inclusion of this species in *Acrotona* needs confirmation because it has scarcly visible minute part of pronotal hypomeron visible in lateral view.

Aloconota sulcifrons (Stephens)

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

Distribution.

Origin	Palaearctic, adventive in North America
Distribution	Canada: **MB**, NB, NF, ON, QC,; USA: AL, IL, IN, KY, MO, NH, NY, TN, VA, WV
New records	New provincial record: **Manitoba**, Winnipeg, Whittier Park, Red River bank dry litter, 49.8968, -97.1155, 226 m, 21.X.2009 (BGC) 1 female
References	Klimaszewski and Peck 1986 [under *A. insecta*], Gusarov 2003a, Webster et al. 2009, Majka and Klimaszewski 2010, Bousquet et al. 2013

Natural history. In Saskatchewan, one female was captured in dry litter on the banks of the Red River. In Newfoundland, adults were collected in mixedwood forest litter, in litter in riparian zones along forested streams, a sandy lakeshore and a marsh. Elsewhere, adults were recorded from organic debris, fungi and carrion, and often found in caves in the USA (Klimaszewski and Peck 1986, Klimaszewski et al. 2011). The adults were collected from June to October.

Atheta (*Datomicra*) *celata* (Erichson)

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

Distribution.

Origin	Probably Holarctic
Distribution	Canada: BC, NB, NL, NS, QC, **SK**; USA: AK (as *D. wrangleri* Casey)
New records	New provincial records: **Saskatchewan:** Prince Albert, sandy beach, 53.9804°, -106.28°, 532 m, 4.VI.2013 (BGC, LFC) 2 males, 1 female: Meadow Lake, wet spruce litter, 54.4144°, -108.8897°, 486 m, 7.VI.2013 (BGC, LFC) 1 male, 1 female
References	Casey 1910, Benick and Lohse 1974, Majka et al. 2006, Gouix and Klimaszewski 2007, Majka and Klimaszewski 2008, 2010, Klimaszewski et al. 2011, Bousquet et al. 2013

Natural history. In Saskatchewan, adults were captured on a sandy beach and in wet spruce litter. In Newfoundland, one specimen was collected in a carrion-baited pitfall trap in a forest (Klimaszewski et al. 2011). In Nova Scotia, adults were collected in nests of boreal and saw-whet owls (Klimaszewski and Majka 2007). The adults were collected in July and August.

Atheta (*Datomicra*) *dadopora* Thomson

(for diagnosis and illustrations, see Klimaszewski et al. 2011; for synonyms, see Gusarov 2003a)

Distribution.

Origin	Probably Holarctic
Distribution	Canada: AB, **BC**, LB, NB, NF, NS, ON, PE, QC, **SK**, YT,; USA: AK, NY, PA, RI
New records	New provincial records: **Saskatchewan:** Meadow Lake, wet spruce litter, 54.4144°, -108.8897°, 486 m, 7.VI.2013 (BGC, LFC) 1 male, 1 female; Prince Albert, poplar/spruce litter, 53.9665°, -106.0652°, 538 m, 4.VI.2013 (BGC) 1 male; **British Columbia:** Liard River, bison scats, 59.4288°, -126.1157°, 468 m, 10.VI.2013 (BGC, LFC) 1 female, 1 male
References	Gusarov 2003a, Klimaszewski et al. 2005, 2011, Gouix and Klimaszewski 2007, Majka and Klimaszewski 2008, 2010, Bousquet et al. 2013

Natural history. This species is strongly associated with forests. The habitats of adults include bison faeces in British Columbia and wet spruce litter and poplar-spruce litter in Saskatchewan. In Newfoundland, adults were collected using carrion traps and flight intercept traps in various mixedwood and coniferous forest types (Klimaszewski et al. 2011). Some specimens were found in rotting mushrooms in forests and under the bark of decaying spruce logs (Klimaszewski et al. 2011). Elsewhere in North America it was collected from fungi and in pitfall traps in forests. The adults were collected from June to August.

Atheta (*Datomicra*) *nigra* (Kraatz)

Figs 9–15

Diagnosis. Body narrowly elongate (Fig. 9), length 1.8–2.3 mm, dark brown to black, legs with at least tarsi reddish-brown; head, pronotum and elytra finely and densely punctate, punctures small; pubescence dense; integument strongly glossy; pronotum transverse, slightly narrower than elytra, with median line of disc well defined, pubescence directed laterad from median line; elytra at suture slightly longer than pronotum; abdomen subparallel. MALE. Median lobe of aedeagus with oval bulbus and narrowly elongate and pointed tubus in ventral view (Fig. 11), in lateral view tubus slightly sinuate and slightly pointed ventrally at apex (Fig. 10); internal sac structures not pronounced; tergite VIII with four small dents apically (Fig. 12); sternite VIII broadly rounded apically. FEMALE. Tergite VIII truncate and slightly concave apically (Fig. 14); sternite VIII broadly arcuate apically with shallow apical emargination (Fig. 15); spermatheca with narrowly elongate and angularly bent capsule bearing large and long apical invagination, stem narrow, and with a single posterior coil bearing swollen apical part (Fig. 13).

Distribution.

Origin	Palaearctic, adventive in North America
Distribution	First record for **North America**, **Canada** and **SK**; USA unrecorded
New records	New country and provincial record: **Saskatchewan:** Maple Creek, horse manure, 49.9037°, -109.5909°, 764 m, 2.IX.2012 (LFC) 1 female
References	Kraatz 1856, Benick and Lohse 1974, Smetana 2004, Klimaszewski and Majka 2007

Natural history. The single female in Saskatchewan was captured in horse manure in September.

Remarks. This species is similar to our native *Atheta* (*D.*) *acadiensis* Klimaszewski & Majka (2007) described from Nova Scotia but it is readily distinguishable by the morphology of genital structures. For illustrations of *A. acadiensis*, see Klimaszewski and Majka (2007).

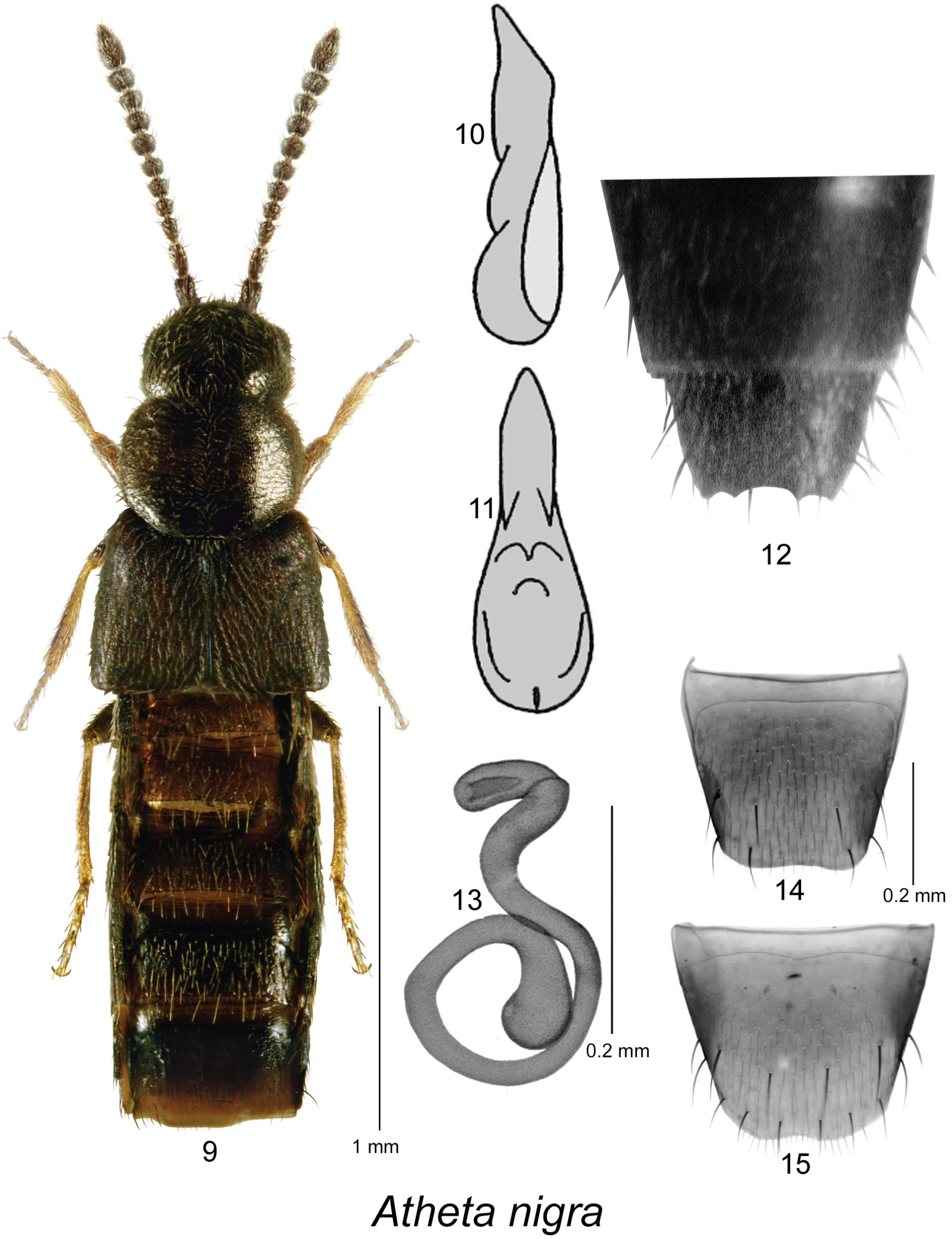
Atheta (*Bessobia*) *cryptica* (Lohse)

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

Distribution.

Origin	Nearctic
Distribution	Canada: **BC**, NF, QC, YT
New records	New provincial record: British Columbia, Summit Lake, willow/aspen litter, 58.6616°, -124.5215°, 1238 m, 10.VI.2013 (BGC, LFC) 2 males, 2 females
References	Lohse et al. 1990, Gouix and Klimaszewski 2007, Klimaszewski et al. 2008, 2011, Bousquet et al. 2013

Natural history. In British Columbia, adults were captured in willow-aspen litter. In Newfoundland, adults were collected using pitfall traps in fir forests (Klimaszewski et al. 2011). In Yukon Territory, adults were collected from sifted willow litter (*Salix* sp.) (Klimaszewski et al. 2008). The adults were collected from May to July.



Figures 9–15. *Atheta* (*Datomicra*) *nigra* (Kraatz): **9** habitus in dorsal view **10** median lobe of aedeagus in lateral view, and **11** in ventral view **12** apical part of male abdomen with visible 4 dents on apical margin of male tergite VIII **13** spermatheca **14** female tergite VIII **15** female sternite VIII; **9, 13–15** based on a female from Saskatchewan **10, 11** after Benick and Lohse (1974) **12** based on a male from Germany.

Atheta (*Dimetrota*) *fanatica* Casey

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

Distribution.

Origin	Nearctic
Distribution	Canada: **AB**, BC [as *A. fanatica*], LB, NB, NS, QC [as *A. irrita*], **SK**; USA: AK, NV [as *A. irrita*]; likely transcontinental in Canada
New records	New provincial records: **Saskatchewan:** La Ronge, wet spruce litter, 55.118°, -105.2457°, 366 m, 6.VI.2013 (BGC) 1 female; **Alberta:** c. 100 km NW of Peace River, 56.68°, -118.63°, EMEND compartment 908, white spruce log in early decay stage, 12.VI.2012 (NoFC) 1 male
References	Casey 1910, 1911, Moore and Legner 1975, Campbell and Davies 1991, Majka et al. 2006, Gouix and Klimaszewski 2007, Webster et al. 2009, Majka and Klimaszewski 2010, Klimaszewski et al. 2011, Bousquet et al. 2013

Natural history. In Saskatchewan, a female was captured in wet spruce litter, and one Newfoundland specimen was captured using a carrion-baited pitfall trap in a spruce/moss forest (Klimaszewski et al. 2011). In Alberta, one male was captured in an early decay stage of a white spruce log in spruce-aspen mixed forest. Elsewhere, adults were collected in the nests of several owl species, in maple forest, in oyster mushrooms (*Pleurotus* sp.), and in organic material on standing trees (Majka et al. 2006, Webster et al. 2009). The adults were collected from June to August.

Atheta (*Atheta*) *graminicola* (Gravenhorst)

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

Distribution.

Origin	Holarctic
Distribution	Canada: AB, BC, LB, MB, NB, NF, NT, ON, QC, **SK**, YT; USA: AL, OR; Palaearctic: Europe, Asia
New records	New provincial record: **Saskatchewan:** Prince Albert, sandy beach, 53.9804°, -106.28°, 532 m, 4.VI.2013 (BGC, LFC) 1 male, 1 female
References	Lohse and Smetana 1985, Lohse et al. 1990 [as *A. granulata* Mannerheim], Gusarov 2003a, Gouix and Klimaszewski 2007, Webster et al. 2009, Majka and Klimaszewski 2010, Klimaszewski et al. 2011, Bousquet et al. 2013

Natural history. In Saskatchewan, adults were captured on a sandy beach. In Newfoundland, some adults were collected using a flight intercept trap in a mixed forest (Klimaszewski et al. 2011). Elsewhere, adults occur in forest leaf litter, at edges of streams and pools, in moss and in drift material (Lohse et al. 1990, Webster et al. 2009). The adults were collected from April to June.

Atheta (*Pseudota*) *klagesi* Bernhauer

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

Distribution.

Origin	Nearctic
Distribution	Canada: AB, BC, NB, NF, NS, PE, QC, ON, **SK**, YT; USA: IA, ME, MN, NJ, NY, PA
New records	New provincial record: **Saskatchewan:** Cypress Hills, near pond, riparian, 49.6704°, -109.5005°, 1189 m, 2.IX.2012 (BGC) 1 male
References	Gusarov 2003a, Klimaszewski et al. 2007b, 2011, Gouix and Klimaszewski 2007, Majka and Klimaszewski 2008, 2010, Webster et al. 2009, Bousquet et al. 2013

Natural history. In Saskatchewan, one male was captured from the riparian zone of a pond. In Newfoundland, most adults were collected in forests of various types (deciduous, coniferous, mixedwood, riparian) using carrion-baited pitfall traps and flight intercept traps, as well as on coastal barrens using pitfall traps and on rotting mushrooms (Klimaszewski et al. 2011). Elsewhere, adults were collected on gilled, polypore and coral fungi, in compost and other organic debris, and in rotten logs, and the usual habitat is forest, e.g., hardwoods, eastern white cedar swamps, red spruce/yellow birch, hemlock, mixedwood (Klimaszewski and Peck 1986, Klimaszewski et al. 2005, 2007b, Majka and Klimaszewski 2008, Webster et al. 2009, Majka and Klimaszewski 2010). The adults were collected from April to August.

Atheta (*Chaetida*) *longicornis* (Gravenhorst)

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

Distribution.

Origin	Palaearctic; adventive in North America
Distribution	Canada: NB, NF, NS, QC, **SK**; USA: CA, MN; Palaearctic: Europe, North Africa, Asia, and Oriental region
New records	New provincial record: **Saskatchewan:** Maple Creek, horse manure, 49.9037°, -109.5909°, 764 m, 2.IX.2012 (BGC, LFC) 2 males, 1 female
References	Klimaszewski et al. 2007a, 2011, Gouix and Klimaszewski 2007, Webster et al. 2009, Majka and Klimaszewski 2010, Michaud et al. 2010, Bousquet et al. 2013

Natural history. In Saskatchewan, specimens were captured in horse manure. Elsewhere, adults are usually associated with cow dung, carrion, compost, rotting mushrooms, and other rotting organic substrates (Klimaszewski et al. 2007a, Webster et al. 2009, Michaud et al. 2010). The adults were collected from May to October.

***Atheta* (*Microdota*) *platonoffi* Brundin**

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

Distribution.

Origin	Holarctic
Distribution	Canada: AB, LB, NB, NF, NS, **SK**; USA: AK; Palaearctic: northern Europe.
New records	New provincial records: **Saskatchewan:** Prince Albert, ferns and scat, 53.987, -106.2802, 532 m (BGC) 1 female; Meadow Lake, wet spruce litter, 54.4144, -108.8897, 486 m, 7.VI.2013 (BGC, LFC) 2 males, 2 females
References	Klimaszewski et al. 2005, 2011, Gouix and Klimaszewski 2007, Majka and Klimaszewski 2008, 2010, Bousquet et al. 2013

Natural history. In Saskatchewan, adults were found on ferns and scat, and in wet spruce litter. In Newfoundland, adults were collected using carrion-baited pitfall traps and flight intercept traps in various mixedwood and coniferous forest types (Klimaszewski et al. 2011). In New Brunswick, adults were captured from litter in a red spruce forest (Klimaszewski et al. 2005). The adults were collected from June to August.

***Atheta* (*Dimetrota*) *prudhoensis* (Lohse)**

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

Distribution.

Origin	Nearctic
Distribution	Canada: LB, NB, NF, NS, QC, ON, **SK**, YT; USA: AK, VT
New records	New provincial record: **Saskatchewan:** Maple Creek, horse manure, 49.9037°, -109.5909°, 764 m, 2.IX.2012 (BGC) 1 female
References	Lohse et al. 1990, Gusarov 2003a, Klimaszewski et al. 2007a, 2011, Gouix and Klimaszewski 2007, Majka and Klimaszewski 2008, 2010, Webster et al. 2009, Bousquet et al. 2013

Natural history. In Saskatchewan, adults were found in horse manure. In Newfoundland, adults were collected using carrion-baited pitfall traps and flight intercept traps in conifer-dominated forests, including upland and riparian habitats (Klimaszewski et al. 2011). Elsewhere, adults were collected from gilled mushrooms, compost, and leaf litter in various forest types, e.g., birch, maple, oak, hemlock mixed forests and spruce forest (Lohse et al. 1990, Klimaszewski et al. 2007a, Webster et al. 2009). The adults were collected from June to September.

***Atheta* (*Microdota*) *pseudosubtilis* Klimaszewski & Langor**

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

Distribution.

Origin	Nearctic
Distribution	Canada: **AB**, LB, NB, NF, QC
New records	New provincial record: **Alberta:** c. 100 km NW of Peace River, Blk C31, 5.93 ha aggregated retention of white spruce, 56.68°, -118.64°, 21.VI.2011 (NoFC) 1 female
References	Klimaszewski et al. 2011, Bousquet et al. 2013

Natural history. In Alberta, one female was found in a white spruce dominated aggregated retention patch (5.93 ha) surrounded by 10-year-old regenerating coniferous trees using a window trap attached to the trunk of white spruce snag. Elsewhere, adults were collected from unbaited and baited pitfall traps and flight intercept traps in various coniferous and mixedwood forest types (Klimaszewski et al. 2011). The adults were collected from June to August.

***Atheta* (*Alaobia*) *ventricosa* Bernhauer**

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

Distribution.

Origin	Nearctic
Distribution	Canada: AB, BC, LB, NB, NF, NS, ON, **SK**, YT; USA: AK, DC, NC, NJ, NY, PA, VT
New records	New provincial record: **Saskatchewan:** Cypress Hills, near pond, riparian, 49.6704°, -109.5005°, 1189 m, 2.IX.2012 (BGC) 1 male
References	Gusarov 2003a, Klimaszewski et al. 2005, 2008, 2011, Gouix and Klimaszewski 2007, Majka and Klimaszewski 2008, 2010, Bousquet et al. 2013

Natural history. In Saskatchewan, one male was captured in the riparian zone of a pond. In Newfoundland, adults were collected in unbaited and carrion-baited pitfall traps and flight intercept traps in various coniferous and mixedwood forest types (Klimaszewski et al. 2011). Elsewhere, adults were found in coniferous forests and in organic litter in mixed forests (Klimaszewski et al. 2005, Majka and Klimaszewski 2008).The adults were collected from May to October.

Boreophilia davidgei Klimaszewski & Godin

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

Distribution.

Origin	Nearctic
Distribution	Canada: **AB**, YT
New records	New provincial records: **Alberta:** c. 100 km NW of Peace River, Blk C14, 2.93 ha aggregated retention, white spruce girdled in 2010, 56.712°, -118.779°, 13.IX.2011 (NoFC) 1 female; Block C14, 1.43 ha aggregated retention, white spruce snag, 56.7103°, -118.7786°, 21.VI.2010 (NoFC) 1 female; Block C31, 1.71 ha aggregated retention, white spruce snag, 56.688°, -118.645°, 20.VI.2010 (NoFC) 1 female; Block C31, white spruce intact forest, white spruce snag, 56.682°, -118.636°, 15.VIII.2010 (NoFC) 1 male; EMEND compartment 896, white spruce snag, 56.7571°, -118.3981°, 810.9 m, 10.VII.2010 (NoFC) 1 female; EMEND compartment 919, regenerating aspen (*Populus tremuloides* Michaux), 56.7964°, -118.3607°, 715 m, 18.VI.2010 (NoFC) 1 female
References	Klimaszewski et al. 2012, Bousquet et al. 2013

Natural history. In Alberta, adults were collected using window traps installed on the trunk of a recently girdled white spruce tree and on snags. The adults were found in white spruce dominated aggregated retention patches (> 1.43 ha) surrounded by 10-year-old coniferous regenerating matrix, small aggregated retention patch (0.20 ha) surrounded by 20% dispersed retention, 10-year-old regenerating aspen stand, and intact white spuce forest. In Yukon Territory, adults were collected using pitfall traps and sifting organic litters in various coniferous and mixedwood forest types (Klimaszewski et al. 2012). The adults were collected from May to September.

Boreophilia islandica (Kraatz)

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

Distribution.

Origin	Holarctic
Distribution	Canada: **AB**, NF, NT, NU, YT; USA: AK; Palaearctic: Europe, Asia
New records	New provincial records: **Alberta:** c. 90 km NW of Peace River, EMEND compartment 919, white spruce log in intermediate decay stage, 56.7968°, -118.3603°, 715 m, 18.VI.2010 (NoFC) 1 female; EMEND compartment 892, regenerating aspen (*Populus tremuloides* Michaux), 56.7506°, -118.3994°, 781.1 m, 18.VI.2010 (NoFC) 1 female
References	Lohse et al. 1990, Gouix and Klimaszewski 2007, Klimaszewski et al. 2011, Bousquet et al. 2013

Natural history. In Alberta, one female was collected in June in an aggregated retention patch (0.46 ha) surrounded by 20% dispersed retention of a white spruce dominated stand, using an emergence trap attached to the trunk of intermediate decay stage of white spruce log. The other female was captured in 10-year-old regenerating trembling aspen, using a window trap. This is the first habitat record of the species.

Boreostiba parvipennis (Bernhauer)

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

Distribution.

Origin	Nearctic
Distribution	Canada: AB, LB, NF, **NT**, QC, YT; USA: AK, NH
New records	New provincial records: **Northwest Territories:** 27 km west of Yellowknife, aspen, 62.522°, -114.8859°, 171 m, 1.V.2009 (BGC, LFC) 1 male 1 female; 32 km west of Yellowknife, birch/spruce, 62.531°, -114.9581°, 168 m, 3.VI.2009 (LFC) 1 female
References	Lohse et al. 1990 [as *B. hudsonica*], Gusarov 2003a, Gouix and Klimaszewski 2007, Klimaszewski et al. 2008, 2011, Bousquet et al. 2013

Natural history. In the Northwest Territories, adults were found in aspen and birch-spruce litter. In Newfoundland, adults were collected mostly using pitfall traps in fir and spruce forests (Klimaszewski et al. 2011). One specimen was found in a rotting mushroom and another under detritus on a sandy beach (Klimaszewski et al. 2011). The adults were collected from May to August.

Dinaraea pacei Klimaszewski & Langor

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

Distribution.

Origin	Nearctic
Distribution	Canada: AB, BC, LB, NB, NF, QC, **YT**; USA: AK
New records	New provincial record: **Yukon Territory,** EMAN, Fireweed Dr., Lindgren 2 weeks; white spruce, 60.6014°, -134.9387°, 772 m, 12.VI.2013 (BGC) 1 female
References	Klimaszewski et al. 2011, 2013, Bousquet et al. 2013

Natural history. One female was captured in the Yukon using a Lindgren funnel trap in a white spruce stand. Adults in Newfoundland and Labrador were collected 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 British Columbia, adults were caught 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) (Langor, unpublished). In New Brunswick, 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; 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. 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 (Klimaszewski et al. 2013). The adults were collected from March to September.

Dinaraea worki Klimaszewski & Jacobs

(for diagnosis and illustrations, see Klimaszewski et al. 2013)

Distribution.

Origin	Holarctic
Distribution	Canada: **AB**, QC
New records	New provincial records: **Alberta:** c. 90 km NW of Peace River, EMEND compartment 922, white spruce girdled in 2009, 56.7971°, -118.3750°, 17.IX.2009 (NoFC) female; EMEND compartment 918, white spruce log in intermediate decay stage, 56.792°, -118.364°, 757.8 m, 18.VI.2010 (NoFC) 1 female; EMEND compartment 932, white spruce snag, 56.8068°, -118.3290°, 17.VII.2009 (NoFC) 1 female; EMEND compartment 911, white spruce log in early decay stage, 4.VIII.2011 (NoFC) 1 female
Reference	Klimaszewski et al. 2013

Natural history. In Alberta, adults were collected using window traps attached to a girdled white spruce tree and a snag, and were reared from white spruce logs in early and intermediate decay stages. In Quebec, adults were found in dead and dying black spruce (*Picea mariana* Mill. (BSP)) in black spruce dominated stands. The adults were collected from June to September.

Liogluta aloconotoides Lohse

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

Distribution.

Origin	Nearctic
Distribution	Canada: **AB**, LB, NB, NF, NS, YT
New records	New provincial records: **Alberta:** c. 90 km NW of Peace River, EMEND compartment 918, white spruce log in advanced decay stage, 56.792°, -118.364°, 757.8 m, 27.VIII.2009 and 9.VII.2010 (NoFC) 2 males
References	Klimaszewski et al. 2011, Webster et al. 2012, Bousquet et al. 2013

Natural history. In Alberta, adults were reared from well-decayed white spruce logs. Elsewhere, adults were captured in various forest types including a recently burned forest. The adults were collected from July to October.

Lypoglossa franclemonti Hoebeke

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

Distribution.

Origin	Nearctic
Distribution	Canada: AB, MB, NB, NF, NS, NT, QC, ON, **SK**, YT; USA: NY, VT
New records	New provincial record: **Saskatchewan:** Prince Albert, sandy beach, 53.9804°, -106.28°, 532 m, 2013.VI.3 (BGC) 1 male
References	Hoebeke 1992, Gusarov 2004, Gouix and Klimaszewski 2007, Webster et al. 2009, Majka and Klimaszewski 2010, Klimaszewski et al. 2011, Bousquet et al. 2013

Natural history. In Saskatchewan, one male was captured on a sandy beach. In Newfoundland, a single specimen was collected in a pitfall trap in a balsam fir stand (Klimaszewski et al. 2011). Elsewhere, adults were captured in litter in spruce bogs, birch bogs, in moss and lichens, and in coniferous and deciduous forests (Gusarov 2004). The adults were collected from May to September.

Philhygra botanicarum (Muona)

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

Distribution.

Origin	Holarctic
Distribution	Canada: BC, LB, NB, NF, NS, ON, **SK**, YT; Palaearctic: northern Europe
New records	New provincial record: **Saskatchewan:** Cypress Hills, wet willow stand, 49.5978°, -109.9231°, 1134 m, 2.IX.2012 (BGC) 1 male
References	Muona 1983, 1984, Gouix and Klimaszewski 2007, Klimaszewski et al. 2008, 2011, Webster et al. 2009, Majka and Klimaszewski 2010, Bousquet et al. 2013

Natural history. In Saskatchewan, one male was captured in wet willow stand. In Newfoundland, adults were collected using flight intercept traps in mixedwood and coniferous forests, and along the margins of streams (Klimaszewski et al. 2011). In New Brunswick, adults were found on muddy soil, near margins of water in alder swamps, in mixed forests, in drift material on a lakeshore, and in moist leaves under a sap flow from a yellow birch (Webster et al. 2009). The adults were collected from May to August.

Philhygra clemens (Casey)

(for details and body image, see Klimaszewski et al. 2005, 2007b, Majka and Klimaszewski 2008)

Distribution.

Origin	Nearctic
Distribution	Canada: **MB**, NB, NS, QC, ON, YT; USA: WI
New records	New provincial record: **Manitoba:** Winnipeg, Whittier Park, Red River bank litter, 49.8996, -97.1250, 228 m, 18.X.2009 (BGC) 1 male
References	Casey 1910, Moore and Legner 1975, Klimaszewski et al. 2005, 2007b, Majka and Klimaszewski 2008, Bousquet et al. 2013

Natural history. The Manitoba male was captured in litter on the bank of the Red River. In New Brunswick, it was found in red spruce (*P. rubens*) forests (Klimaszewski et al. 2005), whereas in Quebec it was found in yellow birch (*B. alleghaniensis*) forests (Klimaszewski et al. 2007b). The adults were collected from June to October.

Philhygra jarmilae Klimaszewski & Langor

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

Distribution.

Origin	Nearctic
Distribution	Canada: NB, NF, ON, **SK**, YT
New records	New provincial records: **Saskatchewan:** Meadow Lake, birch/alder litter, 54.4188°, -108.944°, 482 m, 7.VI.2013, 1 male (BGC) 1 female; Prince Albert, sandy beach, 53.9804°, -106.28°, 532 m, 4.VI.2013 (BGC, LFC) 1 male, 3 females; Cypress Hills, near pond, riparian, 49.5978°, -109.9231°, 1189 m, 2.IX.2012 (LFC) 1 male
References	Klimaszewski et al. 2011, Bousquet et al. 2013

Natural history. The holotype was captured in a flight intercept trap in a mixed-wood forest in Newfoundland (Klimaszewski et al. 2011). In Saskatchewan, adults were found in birch-alder litter, on a sandy beach, and in the riparian zone of a pond. The adults were collected from June to September.

Philhygra ripicoloides Lohse

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

Distribution.

Origin	Nearctic
Distribution	Canada: NF, NT, **SK**, YT
New records	New provincial record: **Saskatchewan**: Prince Albert, sandy beach, 53.9804°, -106.28°, 532 m, 4.VI.2013 (BGC) 1 male
References	Lohse et al. 1990, Gouix and Klimaszewski 2007, Klimaszewski et al. 2011, Bousquet et al. 2013

Natural history. In Saskatchewan, one male was captured on a sandy beach. Adults were collected from May to August (Klimaszewski et al 2011).

Philhygra rostrifera Lohse

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

Distribution.

Origin	Nearctic
Distribution	Canada: NF, **NT**, **SK**, YT
New records	New provincial records: **Northwest Territories:** 32 km west of Yellowknife, birch/spruce, 62.531°, -114.9581°, 168 m, 3.VI.2009 (BGC) 1 male; **Saskatchewan:** Cypress Hills, wet willow stand, 49.5978°, -109.923°1, 1134 m, 2.IX.2012 (LFC) 1 male; Lug Creek, spruce/alder litter, 55.1776°, -106.6885°, 406 m, 6.VI.2013 (BGC) 1 female; Prince Albert, ferns and scat, 53.9804°, -106.28°, 532 m, 3.VI.2013 (BGC) 1 female; La Ronge, ditch litter in deciduous forest, 55.118°, -105.2457°, 366 m, 6.VI.2013 (LFC) 1 female
References	Lohse et al. 1990, Gouix and Klimaszewski 2007, Klimaszewski et al. 2011, Bousquet et al. 2013

Natural history. In Northwest Territories, one male was captured in birch/spruce forest. In Saskatchewan, adults were found in wet willow thicket, spruce-alder litter, ditch litter in a deciduous forest, and on ferns and in scat. In Newfoundland, a single adult was collected from treading vegetation and sphagnum moss in a boggy area (Klimaszewski et al. 2011). In Yukon Territory, the species was found in moss in a meadow (Klimaszewski et al. 2012). The adults were collected from June to September.

Philhygra sinuipennis Klimaszewski & Langor

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

Distribution.

Origin	Nearctic
Distribution	Canada: LB, NB, NF, **SK**, YT
New records	New provincial record: **Saskatchewan:** Prince Albert, sandy beach, 53.9804°, -106.28°, 532 m, 4.VI.2013 (LFC) 1 male
References	Klimaszewski et al. 2011, 2012, Bousquet et al. 2013

Natural history. In Saskatchewan, one male was captured on a sandy beach. In Newfoundland, one specimen was collected amongst litter and stones on the sandy shore of a lake (Klimaszewski et al. 2011). The adults were collected in June and July.

Philhygra terrestris Klimaszewski & Godin

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

Distribution.

Origin	Nearctic
Distribution	Canada: **SK**, YT
New records	New provincial records: **Saskatchewan:** Cypress Hills, wet willow stand, 49.5978°, -109.9231°, 1134 m, 2.IX.2012 (BGC, LFC) 2 males; Meadow Lake, birch/alder litter, 54.4188°, -108.944°, 482 m, 7-VI-2013, 2 females; La Ronge, alder/spruce litter, 55.118°, -105.2457°, 366 m, 6.VI.2013 (BGC) 1 female
References	Klimaszewski et al. 2012, Bousquet et al. 2013

Natural history. In Saskatchewan, adults were captured in a wet willow stand and in birch-alder and birch-spruce litter. The Yukon specimen was collected from ground litter (Klimaszewski et al. 2012). The adults were collected from June to September.

Schistoglossa campbelli Klimaszewski

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

Distribution.

Origin	Nearctic
Distribution	Canada: **AB**, BC
New records	New provincial record: **Alberta:** c. 90 km NW of Peace River, EMEND compartment 932, white spruce snag, 56.8071°, -118.3276°, 6.VIII.2009 (NoFC) 1 female; same except, EMEND compartment 933, white spruce girdled in 2009, 56.8056°, -118.3328°, 19.VI.2010 (NoFC) 1 female
References	Klimaszewski et al. 2009a, Bousquet et al. 2013

Natural history. In Alberta, adults were captured in window traps attached to a recent white spruce snag. In British Columbia, adults were captured by treading *Sphagnum* and *Carex* at the edge of a marsh (Klimaszewski et al. 2009a). The adults were collected in July and August.

Schistoglossa carexiana Klimaszewski

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

Distribution.

Origin	Nearctic
Distribution	Canada: BC, **SK**
New records	New provincial record: **Saskatchewan:** Prince Albert, sandy beach, 53.9804°, -106.28°, 532 m, 4.VI.2013 (LFC) 1 female
References	Klimaszewski et al. 2009a, Bousquet et al. 2013

Natural history. In Saskatchewan, one female was captured on a sandy beach. In British Columbia, adults were captured by treading *Sphagnum* and *Carex* at the edge of a marsh (Klimaszewski et al. 2009a). The adults were collected from June to August.

Schistoglossa hampshirensis Klimaszewski

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

Distribution.

Origin	Nearctic
Distribution	Canada: **AB**, NB, QC; USA: NH
New records	New provincial record: **Alberta:** c. 100 km NW of Peace River, Block C14, 1.43 ha aggregated retention, white spruce girdled in 2010, 56.7103°, -118.7786°, 22.VI.2011 (NoFC) 1 female
References	Klimaszewski et al. 2009a, Bousquet et al. 2013

Natural history. In Alberta, one female was captured in a window trap attached to a recently girdled white spruce tree. Elsewhere, adults were captured in *Salix*, *Vaccinium* and *Chamaedaphne* leaf litter (Klimaszewski et al. 2009a). The adults were collected from June to September.

Seeversiella globicollis (Bernhauer)

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

Distribution.

Origin	Nearctic
Distribution	Canada: AB, BC, NF, NS, ON, QC, **SK**; USA: AZ, CO, ID, MN, MT, NH, SD, WI; Mexico; Guatemala
New records	New provincial record: **Saskatchewan**: Prince Albert, aspen stand, 54.7217°, -105.689°6, 484 m, 5.VI.2013 (BGC) 1 male
References	Ashe 1986, Gusarov 2003a,b, Gouix and Klimaszewski 2007, Majka and Klimaszewski 2008, 2010, Klimaszewski et al. 2011, Bousquet et al. 2013

Natural history. In Saskatchewan, one male was captured in an aspen stand. In Newfoundland, adults were collected using pitfall traps in fir and riparian forests (Klimaszewski et al. 2011). Elsewhere, adults were found in leaf litter near a body of water, in litter near the sea and in mountain forests (Klimaszewski et al. 2011). The adults were collected from March to September.

***Trichiusa pilosa* Casey**

Figs 16–23

Trichiusa pilosa Casey 1894: 341, 343; Moore and Legner 1975: 504.
LECTOTYPE (female): USA: RI [Rhode Island; in orig. descrip. Boston Neck]; Casey determ. *pilosa*-3; Casey bequest 1925; *Trichiusa pilosa* Casey, Gusarov V.I. det. 2010; our lectotype designation label, present designation (USNM). PARALECTOTYPES: labelled as the lectotype except: Casey determ. *pilosa*-4 (USNM) 1 male; Casey determ. *pilosa*-5 (USNM) 1 female; Type USNM 39424 (USNM) 1 male.

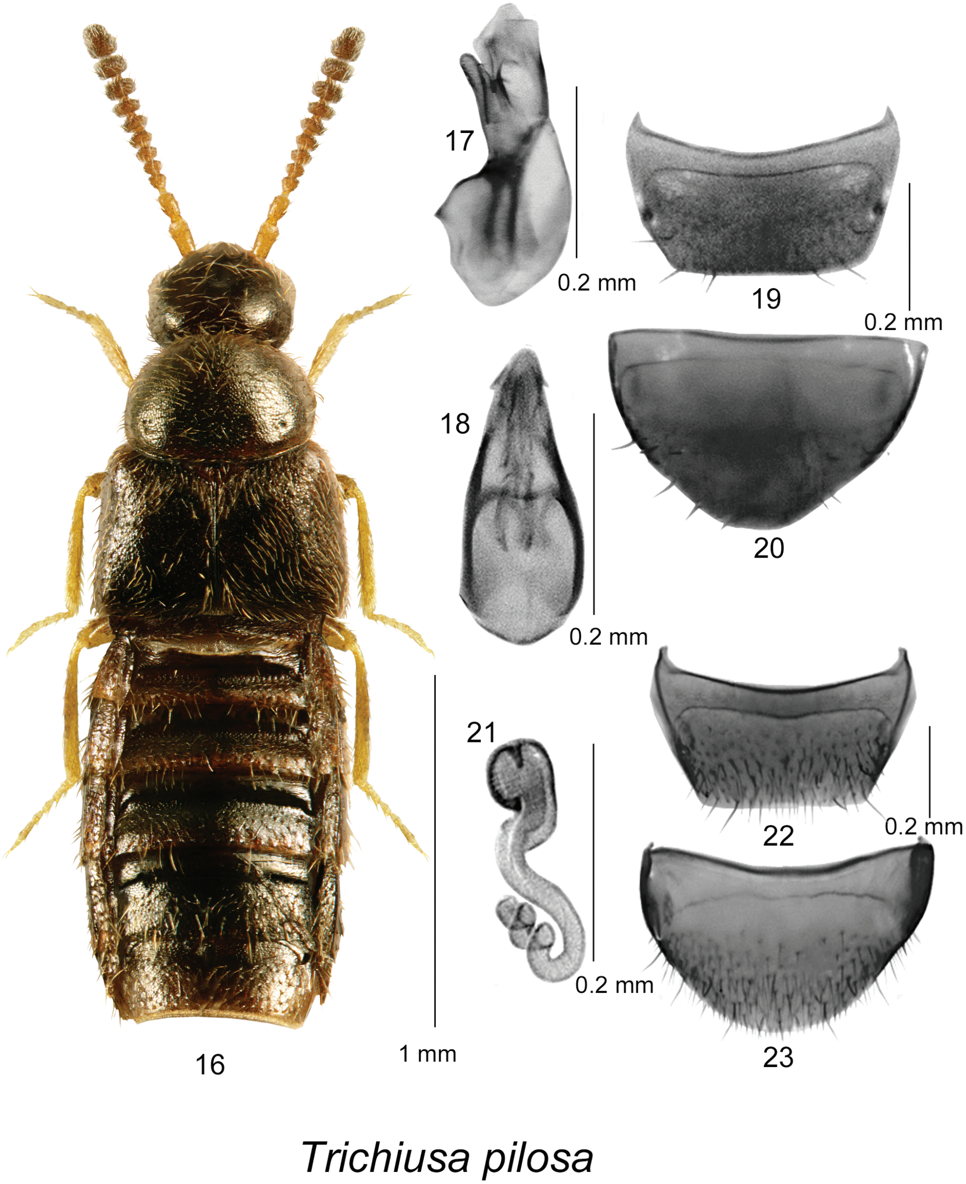
Trichiusa atra Casey 1906: 330; Moore and Legner 1975: 504. **New Synonymy**.
LECTOTYPE (male): USA: McPherson, W. Kansas; *atra* Casey; Type USNM 39426; Casey bequest 1925; Lectotypus *Trichiusa atra* Casey, Gusarov V.I. det. 2011 [unpublished designation]; our lectotype designation label, present designation (USNM).

Trichiusa monticola Casey 1906: 328; Moore and Legner 1975: 504. **New Synonymy**.
LECTOTYPE (male): USA: Coeur d'Alene, Idaho [in orig. descrip. H.F. Wickham]; *monticola* Casey; Type USNM 39421; Lectotypus *Trichiusa monticola* Casey, Gusarov, V.I. des. 2011[unpublished designation]; our lectotype designation label, present designation (USNM).

Trichiusa parviceps Casey 1906: 328; Moore and Legner 1975: 504. **New Synonymy**.
LECTOTYPE (female): USA: Cin. [in orig. descript.: Ohio, Cincinnati, Chas. Dury]; *parviceps* Casey; Casey bequest 1925; Lectotypus *Trichiusa parviceps*, Gusarov V.I. des. 2011 [unpublished designation]; our lectotype designation label, present designation (USNM).

Trichiusa postica Casey 1906: 330; Moore and Legner 1975: 504. **New synonymy**.
LECTOTYPE (male): W.H.H. [W.H. Harrington], Ottawa, Canada; Type USNM 39427; Casey bequest 1925; *Trichiusa pilosa* Casey, Gusarov, V.I. det. 2010; our lectotype designation label, present designation (USNM).

Diagnosis. Body broadly oval (Fig. 16), length 1.5–1.8 mm, dark brown with reddish tinge and slightly paler base of abdomen or uniformly black, appendages usually lighter than rest of body (Fig. 16); sparsely punctate and pubescent; setae straight and erect, particularly on pronotum; integument strongly glossy; head slightly narrower than pronotum; pronotum moderately transverse, rounded laterally and basally, distinctly narrower than elytra; elytra broad at suture about as long as pronotum; abdomen arcuate laterally and broadest at middle of its length. MALE. Median lobe of aedeagus with oval bulbus and triangularly shaped tubus in dorsal view (Fig. 18), in lateral view tubus



Figures 16–23. *Trichiusa pilosa* Casey: **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 **21** spermatheca in lateral view **22** female tergite VIII **23** female sternite VIII **17–23** based on type material from Rhode Island, USA.

slightly sinuate and narrow apically with apex narrowly rounded (Fig. 17); internal sac structures not pronounced; tergite VIII short and truncate apically (Fig. 19); sternite VIII slightly produced apically and rounded at apex and with narrow distance between base of disc and antecostal suture (Fig. 20). FEMALE. Tergite VIII short and truncate apically (Fig. 22); sternite VIII broadly arcuate apically (Fig. 23); spermatheca with broad and sac-shaped capsule with minute apical invagination, stem narrow, sinuate and narrowly twisted apically (Fig. 21).

Distribution.

Origin	Nearctic
Distribution	Canada: **AB**, **BC**, NS, ON (as *T. postica*); USA: ID, IN, KS, OH, RI
New records	New provincial records: **Alberta**: c. 100 km NW of Peace River, Block C14, white spruce regenerating stand, 56.7079°, -118.7775°, 14.IX.2011 (NoFC) 1 female; **British Columbia:** Liard River, bison scats, 59.4288°, -126.1157°, 468 m, 10.VI.2013 (BGC, LFC) 1 male, 1 female
References	Casey 1894, 1906, Moore and Legner 1975, Majka and Klimaszewski 2010 (as *T. postica*), Brunke et al. 2012, Bousquet et al. 2013 (as *T. postica*)

Natural history. In Alberta, one female was collected using a window trap deployed in a 10-year-old regenerating white spruce stand. The British Columbia specimens were found on bison scat. The adults were collected from June to September.

Comments. The two specimens from British Columbia agree with the type series in external morphology and shape of genitalia except for the entirely black body. It is well known that many aleocharine species exhibit darker colour at higher latitudes compared with more southern populations.

GYMNUSINI Heer

Gymnusa campbelli Klimaszewski

(for diagnosis and illustrations, see Klimaszewski 1979, Klimaszewski et al. 2011)

Distribution.

Origin	Nearctic
Distribution	Canada: NB, NF, NT, ON, QC, **SK**, YT; USA: AK
New records	New provincial record: **Saskatchewan:** Prince Albert, sandy beach, 53.9804°, -106.28°, 532 m, 4.VI.2013 (BGC) 1 female
References	Klimaszewski 1979, Gouix and Klimaszewski 2007, Majka and Klimaszewski 2010, Klimaszewski et al. 2011, Bousquet et al. 2013

Natural history. In Saskatchewan, one female was captured on a sandy beach. In Newfoundland, adults were collected in riparian areas (Klimaszewski et al. 2011). Elsewhere, adults were collected by treading wet moss on muddy shores of shallow lakes (Klimaszewski et al. 2011). The adults were collected from June to August.

HOMALOTINI Heer

Gyrophaena criddlei Casey

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

Distribution.

Origin	Nearctic
Distribution	Canada: LB, MB, NB, ON, **SK**, YT
New records	New provincial record: **Saskatchewan:** Cypress Hills, mushroom, pine forest, 49.669°, -109.4998°, 1196 m, 2.IX.2012 (BGC, LFC) 2 males
References	Seevers 1951, Klimaszewski et al. 2009b, 2011, 2012, Majka and Klimaszewski 2010, Brunke et al. 2012, Bousquet et al. 2013

Natural history. In Saskatchewan, adults were captured on a mushroom in pine forest. In Newfoundland, adults were collected using flight intercept traps in spruce-poplar forest (Klimaszewski et al. 2011). Elsewhere, adults were collected from gilled mushrooms in pine, hardwood and mixedwood forests (Seevers 1951, Klimaszewski et al. 2009b). The adults were collected in August and September.

Gyrophaena insolens Casey

(for diagnosis and illustrations, see Seevers 1951, Klimaszewski et al. 2011)

Distribution.

Origin	Nearctic
Distribution	Canada: BC, LB, MB, NB, NF, ON, **SK**; USA: MI
New records	New provincial record: **Saskatchewan:** Cypress Hills, mushroom, pine forest, 49.669°, -109.4998°, 1196 m, 2.IX.2012 (BGC, LFC) 2 males, 2 females
References	Seevers 1951, Klimaszewski et al. 2009b, 2011, Majka and Klimaszewski 2010, Brunke et al. 2012, Bousquet et al. 2013

Natural history. In Saskatchewan, adults were collected from mushrooms in a pine forest. In Labrador, adults were collected using flight intercept traps in spruce-birch and spruce-poplar forests (Klimaszewski et al. 2011). Elsewhere, adults were collected from gilled mushrooms (*Russula* sp.) in mixed forests, white and red spruce forests, white cedar swamps, yellow birch and spruce forests, and oak and maple forests (Seevers 1951, Klimaszewski et al. 2009b, 2011). The adults were collected in August and September.

Gyrophaena uteana Casey

(for diagnosis and illustrations, see Seevers 1951, Brunke et al. 2012, Webster et al. 2012)

Distribution.

Origin	Nearctic
Distribution	Canada: AB, BC, NB, ON, QC, **SK**; USA: CA, CO, UT
New records	New provincial records: **Saskatchewan:** Prince Albert, aspen stand, 54.7217°, -105.6896°, 484 m, 5.VI.2013 (LFC) 1 male; La Ronge, alder/spruce litter, 55.118°, -105.2457°, 366 m, 6.VI.2013 (BGC) 1 male
References	Casey 1906, Seevers 1951, genitalia in Klimaszewski et al. 2009b (as *G. gaudens*), Brunke et al. 2012, Webster et al. 2012, Bousquet et al. 2013

Natural history. The Saskatchewan specimens were found in June in an aspen stand and in alder/spruce litter in a forest.

Homalota plana (Gyllenhal)

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

Distribution.

Origin	Palaearctic; adventive in North America
Distribution	Canada: **AB**, NB, NF, NS; USA: AK; Palaearctic: Europe, North Africa, Asia
New records	New provincial records: **Alberta:** c. 100 km NW of Peace River, Blk C31, 10-year-old regenerating coniferous stands, 56.6833°, -118.6336°, 8.IX.2011 (NoFC) 1 female; Blk C31, intact white spruce forest, white spruce girdled in 2010, 56.7114°, -118.6470°, 20.VI.2010 (NoFC) 1 male and 1 female; EMEND compartment 892, white spruce snag, 56.7506°, -118.4001°, 781.1 m, 15.IX.2009 (NoFC) 1 female; EMEND compartment 896, white spruce girdled in 2009, 56.7572°, -118.3962°, 802.7 m, 6.IX.2010 (NoFC) 1 female; EMEND compartment 898, white spruce girdled in 2009, 56.7598°, -118.3990°, 826.3 m, 13.VIII.2010 (NoFC) 1 female
References	Gouix and Klimaszewski 2007, Klimaszewski et al. 2011, Bousquet et al. 2013

Natural history. In Alberta, most adults were collected using window traps attached to boles of recently girdled trees and snags of white spruce in white spruce dominated stands. Elsewhere, adults were found under bark of coniferous trees (Klimaszewski et al. 2007a, 2011). The adults were collected from June to September.

MYLLAENINI Ganglbauer

Myllaena arcana Casey

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

Distribution.

Origin	Nearctic
Distribution	Canada: AB, LB, NB, NF, NS, ON, QC, **SK**; USA: AL, FL, IA, IL, MA, NH, NJ; Mexico
New records	New provincial record: **Saskatchewan:** Meadow Lake, birch/alder litter, 54.4188°, -108.944°, 482 m, 7.VI.2013 (BGC) 1 female
References	Klimaszewski 1982, Campbell and Davies 1991, Gouix and Klimaszewski 2007, Bishop et al. 2009, Majka and Klimaszewski 2010, Klimaszewski et al. 2008, 2011, Bousquet et al. 2013

Natural history. In Saskatchewan, adults were captured in birch and alder litter in a forest. Elsewhere, the species appears to be riparian. Adults were collected from February to November from debris near streams and lakes, and from a beaver lodge (Klimaszewski et al. 2008, 2011).

OXYPODINI C.G. Thomson

Devia prospera (Erichson)

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

Distribution.

Origin	Holarctic
Distribution	Canada: AB, BC, LB, MB, NB, NT, ON, **SK**; USA: AK, CO, MI, MN, NM, OR, SD, UT, WA, WY; Palaearctic: Europe, Asia
New records	New provincial records: **Saskatchewan:** La Ronge, alder/spruce litter, 55.118°, -105.2457°, 366 m, 6.VI.2013 (BGC) 1 male; Meadow Lake, wet spruce litter, 54.4144°, -108.8897°, 486 m, 7.VI.2013 (BGC, LFC) 1 male, 2 females
References	Gusarov 2003a, Gouix and Klimaszewski 2007, Klimaszewski et al. 2007a, 2011, Webster et al. 2009, Majka and Klimaszewski 2010, Bousquet et al. 2013

Natural history. In Saskatchewan, adults were collected from alder/spruce and wet spruce litter in forests. In Newfoundland, adults were collected in abundance using pitfall traps in a patch of mixedwood forest in an urban area but were uncommon in a disturbed field with forbs and grasses (Klimaszewski et al. 2011). Elsewhere, adults were collected in human settlements from stables, barns, heaps of straw, haystacks, rotting organic debris, mushrooms, and forest litter (Klimaszewski et al. 2007a). The adults were collected from June to August.

Ocyusa canadensis Lohse

(for diagnosis and illustrations, see Lohse et al. 1990, Klimaszewski et al. 2014)

Distribution.

Origin	Nearctic
Distribution	Canada: NB, NF, ON, **SK**, YT; USA: AK
New records	New provincial record: **Saskatchewan:** Cypress Hills, wet willow stand, 49.5978°, -109.9231°, 1134 m, 2.IX.2012 (BGC, LFC) 3 males, 2 females
References	Lohse et al. 1990, Klimaszewski et al. 2014

Natural history. The Saskatchewan specimens were captured in a wet willow stand. Elsewhere, adults were collected at lake margins, on moist soil/gravel among sedges and by treading *Carex* and grasses (Klimaszewski et al. 2014). The adults were collected from June to September.

Oxypoda grandipennis (Casey)

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

Distribution.

Origin	Nearctic
Distribution	Canada: AB, BC, LB, NB, NF, NS, ON, QC, **SK**, YT; USA: AK, NH
New records	New provincial record: **Saskatchewan:** Cypress Hills, 49.669°, -109.4998°, 1196 m, 2.IX.2012 (BGC) 1 male
References	Klimaszewski et al. 2005, 2006, 2011, Gouix and Klimaszewski 2007, Majka and Klimaszewski 2010, Bousquet et al. 2013

Natural history. In Newfoundland, adults were collected using pitfall traps, carrion traps and flight intercept traps in various forest types (coniferous, deciduous, mixedwood and riparian) and on coastal limestone barrens of Labrador (Klimaszewski et al. 2011). Some specimens were collected from rotting mushrooms in forests (Klimaszewski et al. 2011). Elsewhere, adults were collected from leaf litter, moss, fungi, in natural and harvested deciduous and coniferous forests (Klimaszewski et al. 2006). It is a very adaptable and common *Oxypoda* species in Canada. The adults were collected from May to October.

Oxypoda hiemalis Casey

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

Distribution.

Origin	Nearctic
Distribution	Canada: **AB**, LB, NB, NF, NS, NT, ON QC; USA: AK
New records	New provincial record: **Alberta:** c. 90 km NW of Peace River, EMEND compartment 918, white spruce girdled in 2009, 56.7923°, -118.3634°, 7.VIII.2009 (NoFC) 1 female
References	Klimaszewski et al. 2011, Bousquet et al. 2013

Natural history. In Alberta, a single female was collected in a white spruce dominated stand using a window trap installed on the trunk of a recently girdled white spruce. Elsewhere, adults were captured in various forest types, agricultural fields, a disturbed meadow with *Salix* shrubs, and vegetation on coastal sand dunes (Klimaszewski et al. 2011). The adults were collected from March to October.

Oxypoda lacustris Casey

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

Distribution.

Origin	Nearctic
Distribution	Canada: AB, BC, LB, **MB**, NB, NF, NS, NT, QC, ON, **SK**, YT; USA: AK
New records	New provincial records: **Saskatchewan:** Lug Creek, spruce/alder litter, 55.1776°, -106.6885°, 406 m, 6.VI.2013 (BGC) 1 female; La Ronge, alder/spruce litter, 55.118°, -105.2457°, 366 m, 6.VI.2013 (BGC) 1 female; Prince Albert, sandy beach, 53.9804°, -106.28°, 532 m, (LFC) 1 male; **Manitoba:** Winnipeg, Whittier Park, river bank litter, 49.8996, -97.1250, 228 m, 18.X.2009 (BGC) 4 males, 6 females
References	Klimaszewski et al. 2005, 2006, Gouix and Klimaszewski 2007, Webster et al. 2009, Majka and Klimaszewski 2010

Natural history. In Saskatchewan and Manitoba, specimens were found in alder/spruce litter in a forest stand and in litter on river banks. In Newfoundland, adults were collected using pitfall traps in birch forests, burned forest, fir forest, coastal sand dunes and coastal barrens (Klimaszewski et al. 2011). Elsewhere, adults were collected in forest litter, moss, gopher burrows, and muskrat nests (Klimaszewski et al. 2006, Webster et al. 2009). The adults were collected from June to September.

Oxypoda orbicollis Casey

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

Distribution.

Origin	Nearctic
Distribution	Canada: AB, NF, NS, ON, QC, **SK**, YT; USA: WI
New records	New provincial record: **Saskatchewan**: Cypress Hills, mushroom, pine forest, 49.669°, -109.4998°, 1196 m, 2.IX.2012 (BGC, LFC) 2 males
References	Klimaszewski et al. 2005, 2006, 2011, Gouix and Klimaszewski 2007, Majka and Klimaszewski 2010, Bousquet et al. 2013

Natural history. In Saskatchewan, specimens were found on a mushroom in a pine forest. In Labrador, specimens were collected using pitfall traps in various coniferous, deciduous and mixedwood forest types (Klimaszewski et al. 2011). Elsewhere, adults were collected in forest litter in deciduous-dominated stands and in balsam fir forest, as well as in sphagnum moss (Klimaszewski et al. 2006). The adults were collected from June to September.

Oxypoda pseudolacustris Klimaszewski

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

Distribution.

Origin	Nearctic
Distribution	Canada: AB, NB, NF, NS, ON, QC, **SK**
New records	New provincial record: **Saskatchewan:** Prince Albert, aspen stand, 54.7217°, -105.6896°, 484 m, 5.VI.2013 (BGC) 1 female.
References	Klimaszewski et al. 2005, 2006, 2011, Gouix and Klimaszewski 2007, Majka and Klimaszewski 2010, Bousquet et al. 2013

Natural history. In Saskatchewan, adults were captured in an aspen stand. In Newfoundland, adults were reared from the boles of dead balsam fir, collected with pitfall traps in fir forests and collected from coastal sand dunes (Klimaszewski et al. 2011). Elsewhere, adults were collected mostly from sphagnum moss near small bodies of water, other moss, forest litter in coniferous and deciduous forests and organic litter in alpine and subalpine habitats. Most adults were collected from May through October, with some records from November and December (details in Klimaszewski et al. 2006).

PLACUSINI Mulsant & Rey

Placusa incompleta Sjöberg

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

Distribution.

Origin	Palaearctic, adventive in North America; possibly introduced separately in eastern Canada and western WA
Distribution	Canada: **AB**, BC, NB, NF, NS, QC; USA: WA; Palaearctic: Europe
New records	New provincial records: **Alberta:** c. 100 km NW of Peace River, Blk C14, white spruce gridled in 2010, 56.707°, -118.778°, 24.VIII.2011 (NoFC) 1 female; EMEND compartment 898, white spruce log in early decay stage, 56.759°, -118.399°, 826.3 m, 10.VII.2010 (NoFC) 2 females; EMEND compartment 889, white spruce snag, 56.7498°, -118.4188°, 27.VII.2010 (NoFC) 1 female; EMEND compartment 892, white spruce snag, 56.7506°, -118.4001°, 781.1 m, 10.VII.2010 (NoFC) 1 female; EMEND compartment 919, white spruce snag, 56.7954°, -118.3610°, 714.3 m, 18.VI.2010 (NoFC) 1 female; EMEND compartment 920, white spruce snag, 56.7906°, -118.3740°, 10.VII.2010 (NoFC) 1 female; EMEND compartment 920, white spruce gridled in 2009, 56.7921°, -118.3737°, 17.IX.2009 (NoFC) 1 female
References	Klimaszewski et al. 2001, 2011, Bousquet et al. 2013

Natural history. In Alberta, 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. 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.

Placusa pseudosuecica Klimaszewski

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

Distribution.

Origin	Nearctic
Distribution	Canada: **AB**, BC, QC, ON
New records	New provincial records: **Alberta:** c. 100 km NW of Peace River, Blk C31, white spruce snag, 56.697°, -118.652°, 13.VII.2010 (NoFC) 1 female; Blk C14, white spruce gridled in 2010, 56.686°, -118.643°, 5.VIII.2011 (NoFC) 1 female; Blk C14, white spruce girdled in 2010, 56.712°, -118.779°, 16.VIII.2010 (NoFC) 1 female; Blk 79A, white spruce girdled in 2010, 56.688°, -118.605°, 14.VII.2010 (NoFC) 1 female; EMEND compartment 920, white spruce girdled in 2009, 56.7908°, -118.3738°, 18.VII.2009 (NoFC) 1 female; EMEND compartment 929, white spruce girdled in 2009, 56.8024°, -118.3226°, 29.VII.2010 (NoFC) 1 female; EMEND compartment 933, white spruce girdled in 2009, 56.8058°, -118.3324°, 17.VII.2009 (NoFC) 1 female
References	Klimaszewski et al. 2001, Bousquet et al. 2013

Natural history. In Alberta, adults were collected from dead or dying white spruce in aggregated retention patches surrounded by different levels of dispersed retention, using window traps. Elsewhere, adults were found in mature coniferous forests, using pit-light traps and ethanol-baited Lindgren funnel traps (Klimaszewski et al. 2011). The adults were collected in July and August.

Placusa tachyporoides (Waltl)

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

Distribution.

Origin	Palaearctic, adventive in North America
Distribution	Canada: **AB**, BC, NB, NS, QC, ON; Palaearctic: Europe, the Mediterranean, Caucasus, Siberia, Japan
New records	New provincial record: **Alberta:** c. 90 km NW of Peace River, EMEND compartment 918, white spruce logs, 56.792°, -118.364°, 757.8 m, 14.VI.2010 (NoFC) 2 males and 1 female in early decay stage and 1 female in intermediate decay stage
References	Klimaszewski et al. 2001, Bousquet et al. 2013

Natural history. In Alberta, adults were reared from white spruce logs in early and intermediate decay stages in white spruce dominated stands. 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.

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References

Ashe JS (1986) *Seeversiella bispinosa*, a new genus and species of athetine Aleocharinae (Coleoptera: Staphylinidae) from North America. Journal of the New York Entomological Society 94: 500–511.

Benick G, Lohse GA (1974) Tribus 14 (Callicerini). In: Freude H, Harde KW, Lohse A (Eds) Die Käfer Mitteleuropas. Band 5: Staphylinidae II (Hypocyphtinae und Aleocharinae) Pselaphidae. Goecke & Evers, Krefeld, 381 pp.

Bishop DJ, Majka CG, Bondrup-Nielsen S, Peck SB (2009) Deadwood and saproxylic beetle diversity in naturally disturbed and managed spruce forests in Nova Scotia. In: Majka CG, Klimaszewski J (Eds) Biodiversity, Biosystematics, and Ecology of Canadian Coleoptera II. ZooKeys 22: 309–340. doi: 10.3897/zookeys.22.144

Bland JHB (1865) Compiled descriptions of North American Staphylinidae. Proceedings of the Entomological Society of Philadelphia 4: 391–425.

Bousquet Y, Bouchard P, Davies AE, Sikes D (2013) Checklist of beetles (Coleoptera) of Canada and Alaska. Pensoft Publishers, Sofia-Moscow, 402 pp.

Brunke AJ, Klimaszewski J, Dorval JA, Bourdon C, Paiero SM, Marshall SA (2012) New species and distributional records of Aleocharinae (Coleoptera, Staphylinidae) from Ontario, Canada, with a checklist of recorded species. ZooKeys 186: 119–206. doi: 10.3897/zookeys.186.2947

Campbell JM, Davies A (1991) Family Staphylinidae rove beetles. In: Bousquet Y (Ed.) Checklist of beetles of Canada and Alaska. Research Branch Agriculture Canada Publication 1861/E, 86–124.

Casey TL (1894) Coleopterological notices – V. Annals of the New York Academy of Sciences 7: 281–606. [often cited as 1893]

Casey TL (1906) Observations on the staphylinid groups Aleocharinae and Xantholinini, chiefly of America. Transactions of the Academy of Sciences of St Louis 16: 125–434.

Casey TL (1910) New species of the staphylinid tribe Myrmedoniini. Memoirs on the Coleoptera 1. New Era Printing Co, Lancaster, 184 pp.

Casey TL (1911) New American species of Aleocharinae and Myllaeninae. Memoirs on the Coleoptera 2. The New Era Printing Co., Lancaster, Pennsylvania, 245 pp.

Erichson WF (1839) Die Käfer der Mark Brandenburg (Vol. 2). Berlin, 385–740.

Gouix N, Klimaszewski J (2007) Catalogue of aleocharine rove beetles of Canada and Alaska (Coleoptera; Staphylinidae; Aleocharinae). Pensoft Publishers, Sofia-Moscow, 165 pp.

Gusarov VI (2003a) Revision of some types of North American aleocharines (Coleoptera: Staphylinidae: Aleocharinae), with synonymic notes. Zootaxa 353: 1–134.

Gusarov VI (2003b) A catalogue of the athetine species of America north of Mexico (Coleoptera: Staphylinidae: Aleocharinae: Athetini). (I.S.: Internet Site). http://nhm.ku.edu/ksem/peet/cata_web.htm [Last updated: December 15, 2003]

Gusarov VI (2004) A revision of the genus *Lypoglossa* Fenyes, 1918 (Coleoptera: Staphylinidae: Aleocharinae). Zootaxa 747: 1–36.

Hoebeke ER (1992) Taxonomy and distribution of the athetine genus *Lypoglossa* Fenyes (Coleoptera: Staphylinidae: Aleocharinae) in North America, with description of a new species. Journal of the New York Entomological Society 100: 381–398.

Klimaszewski J (1979) A revision of the Gymnusini and Deinopsini of the world (Coleoptera: Staphylinidae: Aleocharinae). Agriculture Canada Monograph 25: 1–169.

Klimaszewski J (1982) Studies of Myllaenini (Coleoptera: Staphylinidae, Aleocharinae). 1. Systematics, phylogeny, and zoogeography of Nearctic *Myllaena* Erichson. The Canadian Entomologist 114: 181–242. doi: 10.4039/Ent114181-3

Klimaszewski J (1984) A revision of the genus *Aleochara* Gravenhorst of America north of Mexico (Coleoptera: Staphylinidae). Memoirs of the Entomological Society of Canada 129, 211 pp.

Klimaszewski J, Peck SB (1986) A review of the cavernicolous Staphylinidae (Coleoptera) of eastern North America: Part I. Aleocharinae. Quaestiones Entomologicae 22: 51–113.

Klimaszewski J, Pelletier G, Germain C, Hébert C, Humble LM, Winchester NN (2001) Diversity of *Placusa* (Coleoptera: Staphylinidae, Aleocharinae) in Canada, with descriptions of two new species. The Canadian Entomologist 133: 1–47. doi: 10.4039/Ent1331-1

Klimaszewski J, Winchester NN (2002) Aleocharine rove beetles (Coleoptera Staphylinidae) of the ancient Sitka spruce forest on Vancouver Island, British Columbia, Canada. Mémoires de la Société Royale Belge d'Entomologie 40: 3–126.

Klimaszewski J, Majka CG (2007) Two new *Atheta* species (Coleoptera: Staphylinidae: Aleocharinae) from eastern Canada: taxonomy, bionomics, and distribution. The Canadian Entomologist 139: 45–53. doi: 10.4039/n05-089

Klimaszewski J, Godin B, Pelletier G, Savard K (2008) Six new species and records of aleocharine beetles from Yukon and Alaska (Coleoptera: Staphylinidae: Aleocharinae). The Canadian Entomologist 140: 265–291. doi: 10.4039/n07-054

Klimaszewski J, Pelletier G, Sweeney J (2002) Genus *Tinotus* (Coleoptera: Staphylinidae, Aleocharinae) from America north of Mexico: review of the types, distribution records, and key to species. The Canadian Entomologist 134: 281–298. doi: 10.4039/Ent134281-3

Klimaszewski J, Sweeney J, Price J, Pelletier G (2005) Rove beetles (Coleoptera: Staphylinidae) in red spruce stands, eastern Canada: diversity, abundance, and descriptions of new species. The Canadian Entomologist 137: 1–48. doi: 10.4039/n03-123

Klimaszewski J, Pelletier G, Germain C, Work T, Hébert C (2006) Review of *Oxypoda* species in Canada and Alaska (Coleoptera, Staphylinidae, Aleocharinae): systematics, bionomics, and distribution. The Canadian Entomologist 138: 737–852. doi: 10.4039/n05-064

Klimaszewski J, Assing V, Majka CG, Pelletier G, Webster RP, Langor D (2007a) Records of adventive aleocharine beetles (Coleoptera: Staphylinidae: Aleocharinae) found in Canada. The Canadian Entomologist 139: 54–79. doi: 10.4039/n05-105

Klimaszewski J, Langor D, Savard K, Pelletier G, Chandler DS, Sweeney J (2007b) Rove beetles (Coleoptera: Staphylinidae) in yellow birch-dominated stands of southeastern Quebec, Canada: diversity, abundance, and description of a new species. The Canadian Entomologist 139: 793–833. doi: 10.4039/n06-057

Klimaszewski J, Godin B, Pelletier G, Savard K (2008) Six new species and records of aleocharine beetles from the Yukon and Alaska (Coleoptera: Staphylinidae: Aleocharinae). The Canadian Entomologist 140: 265–291. doi: 10.4039/n07-054

Klimaszewski J, Webster RP, Savard K (2009a) First record of the genus *Schistoglossa* Kraatz from Canada with descriptions of seven new species (Coleoptera, Staphylinidae, Aleocharinae). In: Majka CG, Klimaszewski J (Eds) Biodiversity, Biosystematics, and Ecology of Canadian Coleoptera II. ZooKeys 22: 45–79. doi: 10.3897/zookeys.22.153

Klimaszewski J, Webster RP, Savard K (2009b) Review of the rove beetle species of the subtribe Gyrophaenina Kraatz (Coleoptera, Staphylinidae) from New Brunswick, Canada: new species, provincial records and bionomic information. In: Majka CG, Klimaszewski J (Eds) Biodiversity, Biosystematics, and Ecology of Canadian Coleoptera II. ZooKeys 22: 81–170. doi: 10.3897/zookeys.22.219

Klimaszewski J, Langor D, Majka CG, Bouchard P, Bousquet Y, LeSage L, Smetana A, Sylvestre P, Pelletier G, Davies A, DesRochers P, Goulet H, Webster R, Sweeney J (2010) Review of adventive species of Coleoptera (Insecta) recorded from eastern Canada. Pensoft, Sofia-Moscow, 272 pp.

Klimaszewski J, Langor D, Pelletier G, Boudron C, Perdereau L (2011) Aleocharine beetles (Coleoptera, Staphylinidae) of the province of Newfoundland and Labrador, Canada. Pensoft Publishers, Sofia-Moscow, 313 pp.

Klimaszewski J, Godin B, Bourdon C (2012) Further contributions to the aleocharine fauna of the Yukon Territory, Canada (Coleoptera, Staphylinidae). ZooKeys 186: 207–237. doi: 10.3897/zookeys.186.2674

Klimaszewski J, Webster RP, Langor DW, Bourdon C, Jacobs J (2013) Review of Canadian species of the genus *Dinaraea* Thomson, with descriptions of six new species (Coleoptera, Staphylinidae, Aleocharinae, Athetini). ZooKeys 327: 65–101. doi: 10.3897/zookeys.327.5908

Klimaszewski J, Webster RP, Langor DW, Bourdon C, Hammond JHE, Pohl GR, Godin B (2014) Review of Canadian species of the genera *Gnathusa* Fenyes, *Mniusa* Mulsant and Rey and *Ocyusa* Kraatz (Coleoptera, Staphylinidae, Aleocharinae). ZooKeys 412: 9–40. doi: 10.3897/zookeys.412.7282

Kraatz G (1856) Naturgeschichte der Insecten Deutschlands. Erste Abtheilung Coleoptera. Zweiter Band. Lieferung 1 und 2, Bogen 1–24 [pp. 1–376] Staphylinii. Nicolai, Berlin, viii + 1080 pp.

Lohse GA, Smetana A (1985) Revision of the types of species of Oxypodini and Athetini (*sensu* Seevers) described by Mannerheim and Mäklin from North America (Coleoptera: Staphylinidae). The Coleopterists Bulletin 39: 281–300.

Lohse GA, Klimaszewski J, Smetana A (1990) Revision of arctic Aleocharinae of North America (Coleoptera: Staphylinidae). The Coleopterists Bulletin 44: 121–202.

Majka CG, Klimaszewski J (2008) New records of Canadian Aleocharinae (Coleoptera: Staphylinidae). In: Majka CG, Klimaszewski J (Eds) Biodiversity, Biosystematics, and Ecology of Canadian Coleoptera. ZooKeys 2: 85–114. doi: 10.3897/zookeys.2.7

Majka CG, Klimaszewski J (2010) Contributions to the knowledge of the Aleocharinae (Coleoptera, Staphylinidae) in the Maritime Provinces of Canada. ZooKeys 46: 15–39. doi: 10.3897/zookeys.46.413

Majka CG, Klimaszewski J, Lauff RF (2006) New Coleoptera records from owl nests in Nova Scotia, Canada. Zootaxa 1194: 33–47.

McLean JA, Klimaszewski J, Li A, Savard K (2009a) Survey of rove beetles (Coleoptera, Staphylinidae) from Stanley Park, Vancouver, British Columbia, Canada, with new records and description of a new species. Part 1. In: Majka CG, Klimaszewski J (Eds) Biodiversity, Biosystematics, and Ecology of Canadian Coleoptera II. ZooKeys 22: 5–17. doi: 10.3897/zookeys.22.86

McLean JA, Klimaszewski J, Chandler DS, Savard K, Li A (2009b) Survey of rove beetles (Coleoptera, Staphylinidae) from Stanley Park, Vancouver, British Columbia, Canada, with new records and description of a new species. Part 2. In: Majka CG, Klimaszewski J (Eds) Biodiversity, Biosystematics, and Ecology of Canadian Coleoptera II. ZooKeys 22: 19–33. doi: 10.3897/zookeys.22.177

Michaud J-P, Majka CG, Privé J-P, Moreau G (2010) Natural and anthropogenic changes in the insect fauna associated with carcasses in the North American Maritime lowlands. Forensic Science International 2010: 1–7. doi: 10.1016/j.forsciint.2010.04.028

Moore I, Legner EF (1975) A catalogue of the Staphylinidae of America north of Mexico (Coleoptera). University of California, Division of Agricultural Science, Special Publication 3015, 514 pp.

Muona J (1983) Two new Palaearctic *Atheta* species (Coleoptera, Staphylinidae). Annales Entomologici Fennici 49: 57–58.

Muona J (1984) Review of Palaearctic Aleocharinae also occurring in North America (Coleoptera: Staphylinidae). Entomologica Scandinavica 15: 227–231. doi: 10.1163/187631284X00190

Pohl GR, Langor D, Spence JR (2007) Rove beetles and ground beetles (Coleoptera: Staphylinidae, Carabidae) as indicators of harvest and regeneration practices in western Canadian foothills forests. Biological Conservation 137: 294–307. doi: 10.1016/j.biocon.2007.02.011

Pohl GR, Langor DW, Klimaszewski J, Work TT, Paquin P (2008) Rove beetles (Coleoptera: Staphylinidae) in northern Nearctic forests. The Canadian Entomologist 140: 415–436. doi: 10.4039/n07-LS03

Seevers CH (1951) A revision of the North American and European staphylinid beetles of the subtribe Gyrophaenae (Aleocharinae, Bolitocharini). Fieldiana Zoology 32: 655–762. doi: 10.5962/bhl.title.2816

Seevers CH (1978) A generic and tribal revision of the North American Aleocharinae (Coleoptera: Staphylinidae). Fieldiana Zoology 71: 1–289.

Smetana A (2004) Family Staphylinidae Latreille, 1802 [subfamilies Piestinae-Staphylininae]. In: Löbl I, Smetana A (Eds) Catalogue of Palaearctic Coleoptera. Apollo Books, Stenstrup, 29–35, 237–272, 329–495, 504–698.

Webster RP, Klimaszewski J, Pelletier G, Savard K (2009) New Staphylinidae (Coleoptera) records with new collection data from New Brunswick, Canada. I. Aleocharinae. In: Majka CG, Klimaszewski J (Eds) Biodiversity, Biosystematics, and Ecology of Canadian Coleoptera II. ZooKeys 22: 171–248 doi: 10.3897/zookeys.22.152

Webster RP, Klimaszewski J, Sweeney JD, DeMerchant I (2012) New Staphylinidae (Coleoptera) records with new collection data from New Brunswick, and an addition to the fauna of Quebec, Canada: Aleocharinae. ZooKeys 186: 83–118. doi: 10.3897/zookeys.186.2655

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Rediscovery of *Rhabdomastix* (*Rhabdomastix*) *incapax* Starý, 2005 (Diptera, Limoniidae), a crane fly species flightless in both sexes and probably endemic to Sardinia

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Abstract

Rediscovery of *Rhabdomastix* (*Rhabdomastix*) *incapax* Starý, 2005 in Sardinia made it possible to update the description of the male and to provide the first description of the female of this species. Notes on the wing reduction, ecology, and behaviour of this species are appended.

Keywords

Diptera, Limoniidae, *Rhabdomastix* (*Rhabdomastix*) *incapax*, new female, crane fly, wing reduction, ecology, behaviour

Introduction

Rhabdomastix (*Rhabdomastix*) *incapax* Starý, 2005 was described from a single teneral male collected in Sardinia. This holotype is preserved in ethanol and deposited in the Zoologisches Forschungsmuseum Alexander Koenig, Bonn, Germany. The male holotype is peculiar in having very long antennae, nearly two thirds the length of the entire body, and reduced wings, seemingly incapable of flight, reaching to the posterior margin of abdominal segment 4 (Starý 2005, Figs 1–2). The type locality was verbatim given as "… Rio de s'Éleme / S.S.389 …" (Starý 2005: 490). Whereas the record for the Éleme river was clear, it turned out only later that „SS389" is the number of the road from Monti to Alà dei Sardi (and further to Núoro). Thus, the type locality of *R.* (*R.*) *incapax* could be inferred as being near the bridge over the Éleme river on road SS389 (Province Olbia-Tempio).

Sardinia was visited in May 2014, and since the locality in question was within reach by car from our residence, we included it in our collecting plan. A fairly numerous population of *R.* (*R.*) *incapax* was found at the type locality and also recorded this species on another site in north-east Sardinia. This made it possible to provide additional information on this peculiar species. We here give some additions to the description of the male, describe the previously unknown female, and append notes on wing reduction, ecology and behaviour of the species.

Material and methods

The morphological terminology adopted here essentially follows McAlpine (1981). Designation of the wing veins is given in Fig. 1, and some special parts of the female terminalia of *Rhabdomastix* are referred to in Fig. 3 (cf. also figures in Starý 2003, 2004). Female terminalia were prepared by boiling in a solution of 10% KOH and preserved in glycerine in a small plastic tube pinned below the associated specimen. Line drawings were made using a drawing tube (*camera lucida*) attached to a compound microscope. Measurements were made using an ocular grid. Live specimens were photographed in special boxes by a digital camera (Canon EOS 60D) with a macro lens (Canon MP-E 65 mm 1–5×) and a ring macro flash (Canon MR-14EX).

Results and discussion

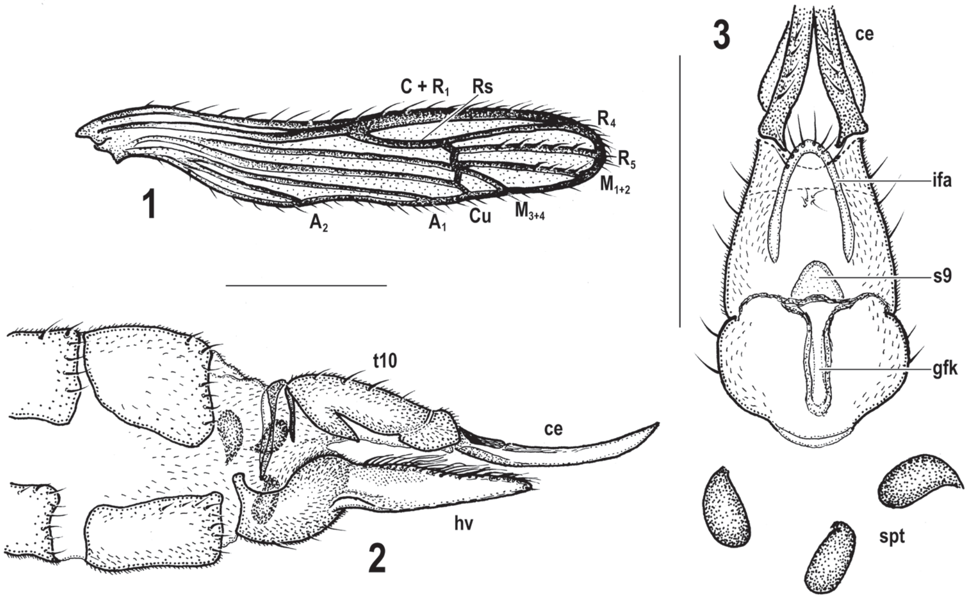
Redescription

Rhabdomastix (*Rhabdomastix*) *incapax* Starý, 2005

Figs 1–5, 8–9

Rhabdomastix (*Rhabdomastix*) *incapax* Starý 2005: 490 (original description), Figs 1 (general view), 2 (male antenna), 3 (male palpus), 4 (male terminalia).

Description of male. In general, the male was adequately described structurally in the original description. In contrast to the holotype, which was described as dirty yellow due to the teneral state and preservation in ethanol, the body of the fully-emerged specimen is shiny black throughout, with only bases of the wing rudiments and bases of the halteres light orange-yellow (Figs 4–5, 8–9). In dry-mounted material, the bases of the wings and halteres are darker and less conspicuous. Whereas the body, especially the abdomen,

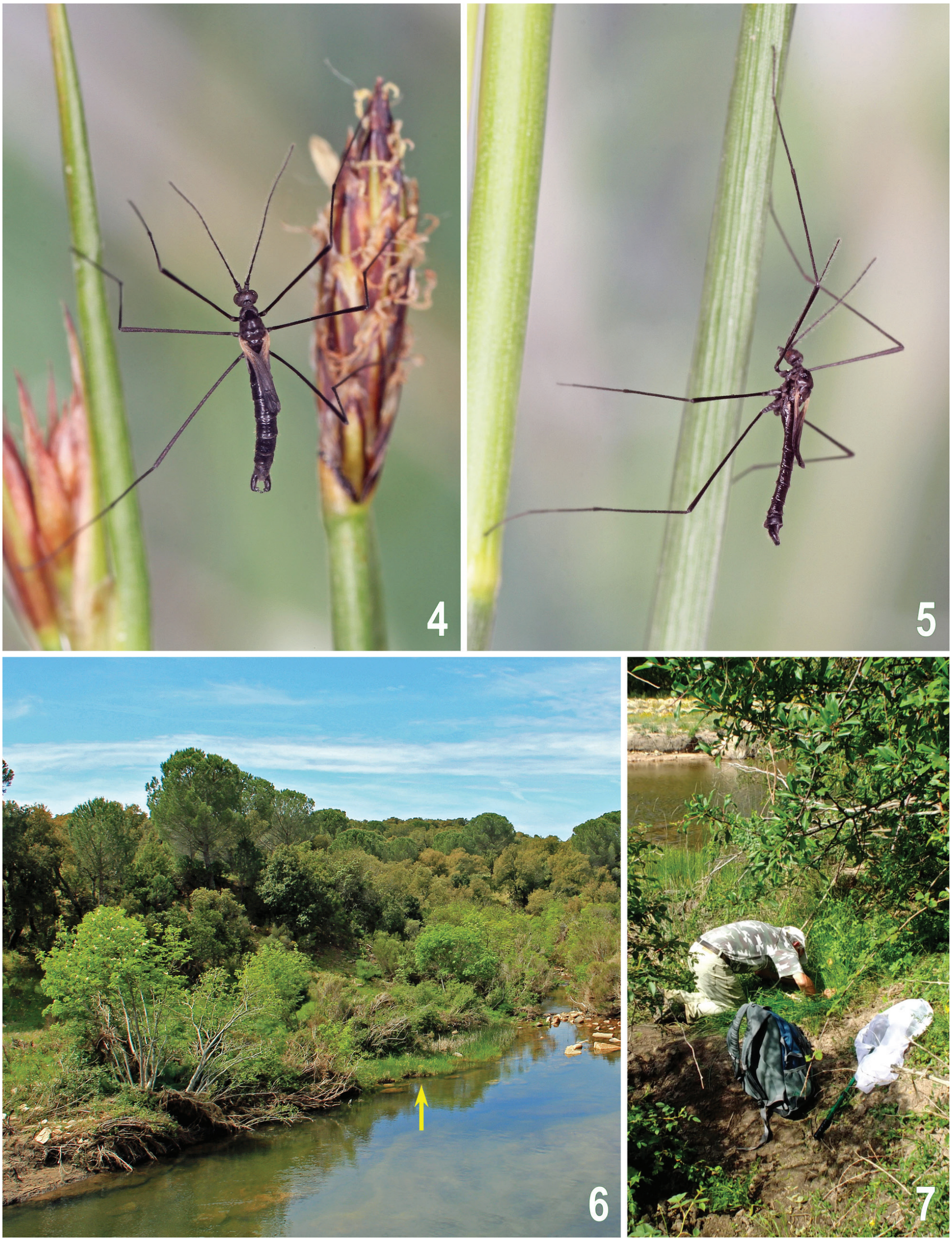


Figures 1–3. *Rhabdomastix* (*Rhabdomastix*) *incapax*. **1** Male wing **2–3** Female terminalia, general view, lateral (**2**) and internal structures, ventral (**3**). Scale bars 0.5 mm. ce – cercus; gfk – genital fork (vaginal apodeme); hv – hypogynial valve; ifa – infra-anal plate; spt – spermathecae; s9 – sternite 9; t10 – tergite 10.

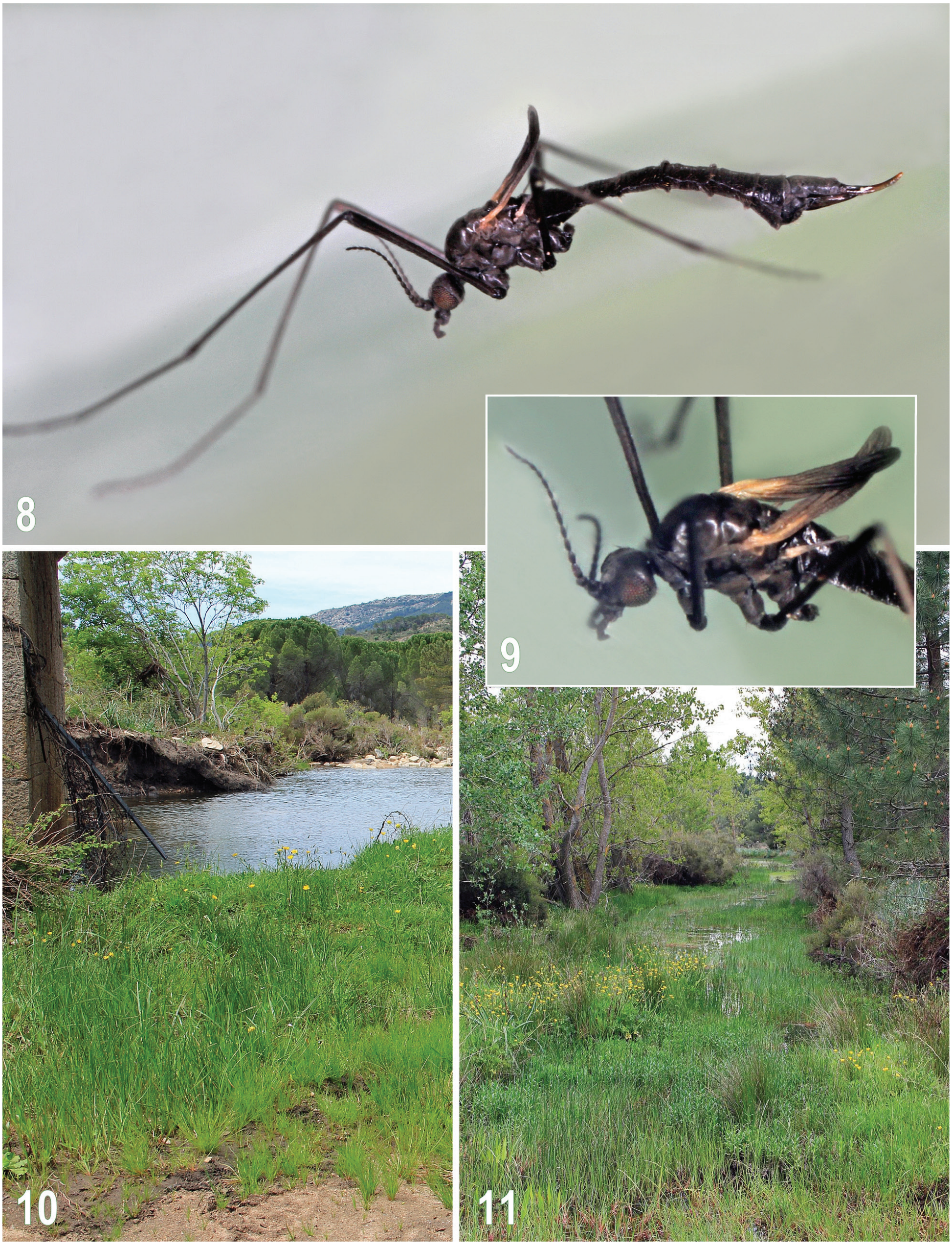
becomes somewhat wrinkled in dry-mounted specimens, in material preserved in ethanol an opposite process often occurs. This may change proportions and measurements from what was stated in the original description. The measurements of the holotype were given as follows: body length 4.0 mm, wing length 1.5 mm, antenna 2.5 mm (Starý 2005: 490). We here give the measurements based on dry-mounted males (see Material examined): body length 2.7–3.6 mm, wing length 1.4–1.8 mm, antenna 2.3–3.0 mm. For a better idea of live specimens, Figs 4–5, 8–9 should be consulted. Wing and wing venation of the male were partly described in the original description. The male wing is here illustrated (Fig. 1), with emphasis on the fact that veins R_5 and M_{1+2} have a few macrotrichia dorsally and vein A_2 is apparent. As described for the female below, the whole abdomen of the male is likewise densely covered with well-developed, spinoid microtrichia, not only segment 9 and the gonocoxite, as follows from the original description.

Description of female. In general appearance resembling male. Body length 3.1–3.5 mm, wing length 0.9–1.3 mm, antenna 1.0–1.1 mm (dry-mounted specimens).

Head. Antenna 15-segmented, considerably shorter than that of male, reaching to base of halter (Figs 8–9), distinctly longer than antenna of most other European *Rhabdomastix* (*Rhabdomastix*) females [except for female *R.* (*R.*) *hirticornis* (Lackschewitz, 1940), subequal in length of antenna to female *R.* (*R.*) *incapax*]. Flagellomeres from ovoid to long-ovoid, gradually narrowed towards apex of antenna. Verticils on flagellomeres sparse, more or less decumbent, shorter than respective segments. Palpus short, as in male (cf. Starý 2005, Fig. 3).



Figures 4–7. *Rhabdomastix* (*Rhabdomastix*) *incapax*, photographs of a live specimen, habitats, and collecting. **4–5** *R.* (*R.*) *incapax*, male on *Eleocharis* and *Juncus* stems and inflorescences **6** Éleme river taken from the bridge on road 389 (type locality, habitat of *R.* (*R.*) *incapax* is arrowed) **7** Collecting *R.* (*R.*) *incapax* in growth of *Eleocharis palustris* on the site arrowed in Fig. 6. Photographs by J. Roháček (4–6) and M. Vála (7).



Figures 8–11. *Rhabdomastix* (*Rhabdomastix*) *incapax*, photographs of a live specimen and habitats. **8–9** *R.* (*R.*) *incapax*, female **10** Another habitat of *R.* (*R.*) *incapax* at the type locality (under the bridge, with *Juncus* sp. predominating) **11** Locality of *R.* (*R.*) *incapax* at Mazzinaiu nr. Alà dei Sardi, 6.6 km NE. Photographs by J. Roháček.

Thorax slender as in male, with only a few short setae dorsally. Wing as in male (cf. Fig. 1) including venation, only slightly shorter and narrower (Figs 8–9), in general very dark to blackish, obscure yellow at base in dry-mounted specimens. Halter as in male, reaching to about half length of abdominal segment 2, obscure yellow at base, otherwise dark. Legs shorter than those of male, femora somewhat thickened distally, length ratio of male and female femur about 1.2 : 1.

Abdomen slightly stouter than in male, with only rows of short setae along posterior, and partly lateral, margins of segments as in male, and densely covered with well-developed, spinoid microtrichia, both on sclerites and membranes, except for cercus and hypogynial valve. **Female terminalia** (Figs 2–3). Cercus slender, gently upturned, slightly longer than tergite 10. Hypogynial valve extending to about one third length of cercus. Internal structures much as in other European *Rhabdomastix* (*Rhabdomastix*) species (cf. Starý 2004), differing only in details. Infra-anal plate slender, strongly arched, more or less horseshoe-shaped, with several setae at posterior margin; sternite 9 membranous, little-distinct, generally triangular; genital fork (vaginal apodeme) comparatively slender and long, with darkened edges; spermathecae three, darkly pigmented, medium-sized, long-ovoid to reniform, somewhat narrowed in portion closer to duct, practically without sclerotized parts of ducts (Figs 2–3).

Material examined. Italy: Sardinia (north-east): Monti, 8.1 km S, Rio de s'Éleme, road bridge (riverside vegetation), 465 m, 40°44'N, 9°22'E (Figs 6, 7, 10), 7.v.2014, 3 ♂, 1 ♀, 12.v.2014, 24 ♂, 2 ♀ (J. Roháček & J. Starý leg.); Mazzinaiu nr. Alà dei Sardi, 6.6 km NE, marshy vegetation along brook, 508 m, 40°45'N, 9°25'E (Fig. 11), 7.v.2014, 1 ♂ (M. Vála leg.) (all in coll. J. Starý, Olomouc, Czech Republic).

Discussion. Noticeably, *Rhabdomastix* (*R.*) *incapax* is the only species among European *Rhabdomastix* with reduced wings. The shiny black body colouration is another distinguishing character evident at first sight. The female antennae of *R.* (*R.*) *incapax* are longer than those of females of the majority of other species. *Rhabdomastix* (*R.*) *hirticornis* is the single other European species that has conspicuously sexually dimorphic antennae, corresponding in length, relative to the size of the species, to those of *R.* (*R.*) *incapax*. Female terminalia of the latter species are of general structure usual for *Rhabdomastix* (*Rhabdomastix*), the most indicative character being the shape of the spermathecae, which are considerably elongate (Figs 2–3, for various details in other species, see figures in Starý 2004, 2005).

Distribution. Italy: Sardinia. Considering the flightlessness of *R.* (*R.*) *incapax* and, consequently, its very limited dispersal abilities, the species is most probably endemic to the island.

Wing reduction in *R.* (*R.*) *incapax*

Wing-reduced Diptera are often characterized by having other body extremities shortened as well, namely the antennae and legs. The antennae in the male of *R.* (*R.*) *incapax*, however, are very long, and the legs are considerably slender (Figs 4–5), corresponding to those of some fully-winged species of this genus. It is worthy of mention that, in *R.* (*R.*) *incapax*, reduction of the wings has not yet achieved a strongly brachypterous appearance, but rather seems to have advanced towards what could be termed a stenopterous condition. As to the wing length, the species in question shows a certain resemblance to some unrelated species of Limoniidae with shortened wings, probably flightless, such as females of *Phylidorea* (*Phylidorea*) *heterogyna* (Bergroth, 1913), or both sexes in *Molophilus* (*Molophilus*) *ater* (Meigen, 1804). In the latter two species, in contrast to *R.* (*R.*) *incapax*, the legs are correspondingly shorter and stouter. On the other hand, in *Dicranomyia* (*Dicranomyia*) *reductissima* (Alexander, 1952) [= *lindrothi* (Tjeder, 1963)] (Limoniidae), described from Tibet (as *lindrothi* from Alaska), a species micropterous in the male (female unknown), the legs are very slender and the antennae normally developed (Tjeder 1963). [Note: A form characterized as stenopterous in both sexes, interpreted as belonging to this species, was recorded from Mongolia and Tuva Region in Russia (Savchenko 1972).] Another example of long-legged brachypterous species may be *Symplecta* (*Symplecta*) *holdgatei* (Freeman, 1962) from the Gough Island in the Atlantic Ocean (Jones et al. 2003). This indicates that reduction of the wings and shortening of the antennae and legs may not necessarily be correlated and may be subject to different selective pressures.

Hackman (1964) proposed several categories of wing-reduced Diptera according to the climatic conditions of their habitats and modes of their lives. In addition to a few comparatively curious cases related to parasitism, unknown in tipulomorphans, wing reduction is mostly explained as adaptation to severe environmental conditions. These include, above all, low temperature inhibiting flying activity (see also Byers 1961, Mani 1962, Martinovský and Starý 1969) under arctic, alpine or nival conditions. For some insular species or those living on the seashore, strong winds may favour selection towards wing reduction as a factor generally hindering the flight, not explicitly preventing the insects from being blown out to sea, as sometimes suggested (cf. Huxley 1945 ex Hackman 1964). In Tipulidae, brachyptery of some females (*Tipula*, mostly subgenus *Vestiplex*) may be correlated with their deep-boring mode of oviposition, in relation to low temperature, or wind exposure, or both (Hemmingsen 1956).

Rhabdomastix (*R.*) *incapax*, however, occurs in the warm Mediterranean subregion, at moderate altitudes (465–508 m), and on inland sites sheltered from wind. Hence, wing reduction resulting from adaptation to the life in terricolous habitats, particularly among dense low vegetation, may be the case for this species (cf. Hackman 1964; as known in *Molophilus ater*). This could indicate that although the size of wings has limited dispersal ability, but the habitat closer to water might have helped the species to disperse by water carrying. Wing reduction in *R.* (*R.*) *incapax* may have been also supported by combination of high humidity and secretive life on sandy to muddy ground at bases of low graminoid plants, similar to what is observed for *Crumomyia pedestris* (Meigen, 1830) (Sphaeroceridae), inhabiting marshland habitats (Roháček 1975, 2012).

Ecology and behaviour

All European *Rhabdomastix* species, in fact their larvae, require flowing water, and the adults live under riparian conditions, being closely associated with sandy or gravely banks of streams and larger rivers, overgrown with scattered, low vegetation. Even some fully-winged species may be observed sitting or crawling about on plants or on the ground, but are rarely seen flying (Starý 2003). A few specimens of *R.* (*R.*) *incapax* were at first discovered by us by sweeping a low riverbank vegetation, but the best technique to collect this species is by crawling on all fours, pulling apart tufts of plants and then aspirating specimens directly into the pooter (Fig. 7). The adults of *R.* (*R.*) *incapax* were found in the growths of the spikerush (*Eleocharis palustris*) and a small rush (*Juncus* sp.). Patches of these plant species occurred on sandy to muddy banks of the Éleme river (Figs 6, 10). Among this low vegetation, the adults, mostly males, significantly outnumbering females, were moving rather quickly, and when stimulated by our disturbance, they climbed up onto plant stems, making sometimes short jumps from these down on the wet ground.

Rhabdomastix (*R.*) *incapax* was collected not only at the Éleme river, but one specimen (see Material examined) was also swept from the vegetation on another site, approximately 6.8 km south-east of the type locality, with a somewhat different habitat. This included a slowly flowing brook (Fig. 11) with marshy littoral vegetation, containing, among other plants, low growths of a small *Juncus* sp. This indicates that the species may be more widely distributed in Sardinia, and not restricted only to banks of larger rivers.

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References

Byers GW (1961) Biology and classification of Chionea. Verhandlungen des XI. Internationalen Kongresses für Entomologie, Wien 1960, Vol. 1. Wien, 188–191.

Hackman W (1964) On reduction and loss of wings in Diptera. Notulae Entomologicae 44: 73–93.

Hemmingsen AM (1956) Deep-boring ovipository instincts of some cranefly species (Tipulidae) of the subgenera *Vestiplex* Bezzi and *Oreomyza* Pok. and some associated phenomena. Videnskabelige Meddelelser fra Dansk Naturhistorisk Forening, Kobenhavn 118: 243–315.

Jones AG, Chown SL, Webb JL, Gaston KJ (2003) The free-living pterygote insects of Gough Island, South Atlantic Ocean. Systematics and Biodiversity 1: 213–273. doi: 10.1017/S1477200003001142

Mani MS (1962) Introduction to high altitude entomology. Insect life above timber-line in the NorthWest Himalaya. Methuen, London, 302 pp.

Martinovský J, Starý J (1969) The discovery of brachypterous females of Limnophila platyptera (Macquart), with notes on the classification of this species (Diptera, Tipulidae). Acta Entomologica Bohemoslovaca 66: 381–386.

McAlpine JF (1981) Morphology and terminology – adults. In: McAlpine JF, Peterson BV, Shewell GE, Teskey HJ, Vockeroth JR, Wood DM (Eds) Manual of Nearctic Diptera, Volume 1. Research Branch, Agriculture Canada, Ottawa, Monograph No. 27, Canada, 9–63.

Roháček J (1975) Die Flügelpolymorphie bei den europäischen Sphaeroceridenarten und Taxonomie der Limosina heteroneura-Gruppe (Diptera). Acta Entomologica Bohemoslovaca 72: 196–207.

Roháček J (2012) Wing polymorphism in European species of Sphaeroceridae (Diptera). Acta Entomologica Musei Nationalis Pragae 52(2): 535–558.

Savchenko EN (1972) The Limoniid-flies (Diptera, Limoniidae) collected by the Soviet-Mongolian expedition 1967-1969. Isects of Mongolia, 1. Nauka, Leningrad, 721–738. [in Russian]

Starý J (2003) Revision of European species of the genus *Rhabdomastix* (Diptera: Limoniidae). Part 1: Introduction and subgenus *Lurdia* subgen. n. European Journal of Entomology 100: 587–608. doi: 10.14411/eje.2003.089

Starý J (2004) Revision of European species of the genus *Rhabdomastix* (Diptera: Limoniidae). Part 2: Subgenus *Rhabdomastix* s. str. European Journal of Entomology 101: 657–687. doi: 10.14411/eje.2004.089

Starý J (2005) A remarkable new *Rhabdomastix* s. str. from Sardinia. Studia dipterologica 11: 489–492.

Tjeder B (1963) Three subapterous crane-flies from Alaska (Dipt. Tipulidae). Opuscula Entomologica 28: 229–241.

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RESEARCH ARTICLE

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Reptiles of Chubut province, Argentina: richness, diversity, conservation status and geographic distribution maps

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Abstract

An accurate estimation of species and population geographic ranges is essential for species-focused studies and conservation and management plans. Knowledge of the geographic distributions of reptiles from Patagonian Argentina is in general limited and dispersed over manuscripts from a wide variety of topics. We completed an extensive review of reptile species of central Patagonia (Argentina) based on information from a wide variety of sources. We compiled and checked geographic distribution records from published literature and museum records, including extensive new data from the LJAMM-CNP (CENPAT-CONICET) herpetological collection. Our results show that there are 52 taxa recorded for this region and the highest species richness was seen in the families Liolaemidae and Dipsadidae with 31 and 10 species, respectively. The Patagónica was the phytogeographic province most diverse in species and *Phymaturus* was the genus of conservation concern most strongly associated with it. We present a detailed species list with geographical information, richness species, diversity analyses with comparisons across phytogeographical provinces, conservation status, taxonomic comments and distribution maps for all of these taxa.

Keywords

Biogeography, diversity, herpetofauna, conservation, central Patagonia, Argentina

Introduction

Precise estimation of species' geographic ranges based on accurate taxonomic identification is central for species-focused studies and conservation and management plans (Feeley and Silman 2011, Katzner et al. 2011). Knowledge of reptile diversity in southern areas of Argentina has increased considerably in recent decades through numerous published monographs and books (Gallardo 1971, Cei 1973b, 1986, Scolaro 2005, 2006, Avila et al. 2006b, Abdala 2007). However, information on reptile geographic distributions, as well as systematic and ecological aspects is still limited, especially for large areas with difficult access, which remain unsurveyed. The current distribution knowledge of reptiles of Chubut province is fragmented, with data deriving from original species descriptions, geographic citations in the form of short notes, partial reviews or phylogenetic and phylogeographic studies (Abdala 2002, 2003, 2005, Cei et al. 2003, Scolaro 2003, Scolaro and Ibargüengoytía 2007, Avila et al. 2008, Pincheira-Donoso et al. 2008, Lobo et al. 2010). Several studies have made contributions to the herpetological knowledge of this province Cei (1973a, 1975a, 1975b, 1978); Cruz et al. (1999); Daciuk and Miranda (1980); Etheridge and Christie (2003); Pincheira-Donoso and Núñez (2005); Scolaro (1976a, 1976b); Scolaro et al. (1985); Scolaro and Cei (1987) and Cei and Scolaro (1977, 1980, 1983, 1999, 2003), but only a few considered the conservation status, richness, diversity and accurate distribution of species (Breitman et al. 2014); which is essential information for conservation plans.

The northern and central areas of Patagonia have changed since the 1890s and have undergone steady change as a result of human activity, but there has been no clear understanding of the resulting effects on biodiversity. Over the twentieth century, business activities such as oil extraction, mining and ranching have caused changes in different ecosystems of this area. In particular, sheep overgrazing (Bisigato and Bertiller 1997, Cesa and Paruelo 2011) has led to a desertification process in the Monte and Patagonian Steppe ecoregions (Ares et al. 1995, Aguiar et al. 1996). Another factor that may affect the diversity and ecological dynamics of large xerophytic areas like this one (e.g., Schulze et al. 1996), is the creation of hydroelectric dams which implies anthropic management of regional water availability and seasonal changes in rainfall (Paruelo et al. 1998) or rivers flow rates (Masiokas et al. 2008). An overall analysis of reptile diversity and accurate species distributional data is essential information for understanding the impact and consequences of these types of human activity (Böhm et al. 2013, Cook et al. 2013).

Vertebrate surveys and the elaboration of regional lists provide basic information, not only for systematic and biogeographic studies, but also for wildlife conservation plans, natural management and bio-ecological studies. This study is the first reptile inventory with detailed and updated geographic distributional data for Central Patagonia, Chubut Province. We compiled and checked geographic distribution records from published literature and museum records, including extensive new data from the LJAMM-CNP (CENPAT-CONICET) herpetological collection. We performed a spatial analysis considering all sampled localities, and two species richness analyses:

1) related to sampled areas within a grid, and 2) related to phytogeographic provinces. Furthermore, we analyzed species diversity within phytogeographic provinces along with a dissimilarity index among them, and also detailed geographic information for reptile occurrence based on administrative (political) units called Departments. Additionally, we discuss all the geographic records considered erroneous or outdated on a separate taxonomic section.

Materials and methods

Study area

The study area of this work is comprised in the Chubut Province (Argentina), with a central-latitudinal location between 42°00'–46°00'S and 72°08'–63°35'W, covering approximately 224,686 km^2 divided into 15 administrative departments (INDEC and IGM 2014). It has two clearly defined geographic regions: the Andean region confined to a narrow band on the west with granitic and metamorphic mountains; and an Extra-Andean region, characterized by volcanic terraces and plateaus product of volcanic events of the Tertiary and Quaternary (Scoppa 1998, Teruggi 1998). The climate is dry and cold in most of the territory, with an extremely variable temperature ranging, from -22.8 °C in winters to 41.3 °C degrees in summer (Teruggi 1998). The study area is characterized by four phytogeographic provinces: Patagónica, del Monte, Subantártica and Altoandina (Roig 1998). The majority of the field surveys were conducted in Patagónica and del Monte provinces and which have larger areas and higher numbers of presence records than the Subantártica province. The Altoandina province is the smallest in area and there are no reptile records from it, hence it was not represented on the map or included in the analyses.

Methods

Extensive biological surveys began in early 1998 and continued until 2011, with field trips made at different representative areas of Chubut province. Most specimens were collected in the vicinity of roads and the majority of snake records are from individuals found killed by vehicles. Each record has a voucher number with a species identity assigned, date and place of origin. Collection sites were geographically referenced using a Garmin GPS 12™ Global Position Device. The systematic classification for families was according to Oppel (1811), Gray (1827, 1865), Frost et al. (2001), Gamble et al. (2008) and Zaher et al. (2009). The specimens were deposited in several herpetological collections: LJAMM-CNP (CONICET-CENPAT), BYU (Monte L. Bean Museum, Brigham Young University), MLP (La Plata Museum) and FML (Miguel Lillo Foundation). Additional museum collections and literature vouchered records were obtained from AMNH (American Museum of Natural History), CNHM (Chicago Natural History Museum; in the present The Field Museum of Natural History, FMNH), IADIZACH (Instituto Argentino de Investigaciones de las Zonas Áridas), JMCDC (Colección Herpetológica José Miguel Cei), CRILaR PT (Centro Regional de Investigaciones Científicas y Transferencia Tecnológica), MACN (Museo Argentino de Ciencias Naturales "Bernardino Rivadavia"), MCZ (Museum of Comparative Zoology, Harvard University), MHNG (Muséum d'histoire naturelle de la Ville de Genève), MZUC (Museo de Zoología de la Universidad de Concepción Chile), NMBA (Zoologische Expedition de Naturhistorischen Museums Basel), PT (Proyecto *Tupinambis*, Félix Benjamín Cruz), FBC (Félix Benjamín Cruz Field Collection), SDSU (San Diego State University), IBAUNC (Universidad Nacional de Cuyo), CH (Colección Centro Regional Universitario Bariloche, Universidad Nacional del Comahue, Río Negro, Argentina), MCN (Museo de Ciencias Naturales, Universidad Nacional de Salta) and UNMDP (Colección Herpetológica de la Universidad Nacional de Mar del Plata). Geographic information from the LJAMM-CNP collection and additional data from other collections and literature sources (see Institutions above, Supplementary file 1: Specimens examined) were considered for species presence analysis, according to Departmental units in Chubut province. Literature and museum records with acronyms or specific localities were quoted literally. We include these records from revisionary literature: Abdala (2005), Abdala (2007), Avila et al. (2001, 2003, 2006a, 2007a, 2007b, 2012), Abdala et al. (2012b), Breitman et al. (2011b), Carrasco et al. (2010), Carrera and Avila (2008a, 2008b), Cei (1973a, 1974, 1986, 1993, 2003), Cei and Castro (1973), Cei et al. (2001, 2003), Cei and Scolaro (1980), Cei and Scolaro (1999), Cruz et al. (1999), Daciuk and Miranda (1980), Etheridge and Christie (2003), Gallardo (1960), Giambelluca (1999), Giraudo et al. (2012), Giraudo and Scrocchi (2002), Ibargüengoytía and Schulte II (2001), Kluge (1964), Koslowsky (1898), Lobo (2005), Lobo and Quinteros (2005a, 2005b), Lobo et al. (2010), Montero (1996), Nenda et al. (2007), Schulte II et al. (2004), Scolaro (1976a, 1976b, 1990, 1993, 2005, 2006), Scolaro and Cei (1979, 1997, 2006), Scolaro et al. (2005, 2013), Scolaro and Ibargüengoytía (2007), Scolaro and Pincheira-Donoso (2010), Scott Jr. et al. (2006), Victoriano et al. (2010), Williams (1997), Yoke et al. (2006) and Wallach et al. (2014).

We constructed a hexagonal cell grid (White et al. 1992, White 2000) with each entire perimeter cell having an area of 2,787 km^2, covering the entire territory of Chubut province. The resulting grid contained 106 hexagons. Hexagons are used rather than squares because they possess greater statistical efficiency (Olea 1984) and are more dynamically adaptable (Yfantis et al. 1987), allowing them to adjust to the boundaries of an irregular perimeter (e.g., Chubut province's coastline). In this approach with continuous tessellations, hexagons have the advantage over squares in that all six adjacent plots of a plot are equally distant, while squares have four closer and four more distant neighbors (Dengler 2009). This facilitates comparison of different data sets by discretizing a large and continuous area (White 2000). The grid was intersected to fit the shape of Chubut province and to restrict the cells to match the limits of the study area. For this grid, we recorded the number of different localities and species richness for each cell.

We analyzed species richness, Shannon-Weaver index, Simpson's index and Jaccard similarity index for Subantártica, Patagónica and del Monte phytogeographic provinces (Roig 1998) using a shapefile created and provided by the National Environment Secretary (SAyDS 1997). To remove the potential bias of uneven catch rates, rarefaction was used to compare species richness (Gotelli and Colwell 2001, Buddle et al. 2005). We used QUANTUM GIS 2.6® (Open Source Geospatial Foundation Project Development Team 2014) for spatial and species richness analyses and to elaborate species geographic distribution maps. All statistical analyses were performed with R 3.0.2 (R Core Team 2014) and VEGAN PACKAGE 2.0–9 (Oksanen et al. 2013). Additional data taken from the literature were cited literally and only mapped when the data was from vouchered specimens with accurate coordinates or location. The conservation status of each species was taken from Abdala et al. (2012a). Geographic records considered erroneous or outdated were discussed in the taxonomic comments section.

Results

Richness and diversity

We compiled a total of 2,842 reptile presence records (Fig. 1) distributed over 16 departments, 2,720 correspond to lizards (162 Leiosauridae, 2,302 Liolaemidae, 253 Phyllodactylidae and 3 Teiidae), 107 to snakes (89 Dipsadidae and 18 Viperidae), 14 to amphisbaenians (Amphisbaenidae) and one was a turtle (Cheloniidae) (Tables 1–3). These records represent eight families, 18 genera and 52 reptile species present in Chubut province.

The families that showed the highest species number were Liolaemidae and Dipsadidae with 31 and 10 species respectively (Table 3). Dipsadidae also has the greatest number of genera represented (eight, Table 3). Liolaemidae and Phyllodactylidae were the groups that had the highest number of records with 2,302 and 253 respectively (Table 3). Species number recorded within political Departments varies between six and 27 for Futaleufú and Telsen, respectively (Tables 1–2). The highest number of records were recorded for Telsen (664) and Paso de Indios (410) Departments (Table 4). There are 2,222 LJAMM-CNP collection records for this province; whereas there are 620 literature and museums records, of which 127 do not clearly specify the Department and were not mapped (Table 4).

The cells from central-east of Telsen (e.g. 35 and 34 localities) and west of Gastre (14 localities) Departments and the area around Puerto Madryn city (22 localities), represent the most over-sampled regions of Central Patagonia (Fig. 1A), for which we found higher richness. Although the number of sampled localities in the cells around Puerto Madryn ($S = 9$), Paso de Indios ($S = 9$), Sarmiento ($S = 8$), Río Senguer ($S = 8$) and Escalante ($S = 8$) was only moderate, they also supported a relatively high number of species (Fig. 1B). The Patagónica was the phytogeographic province with the highest species richness ($S = 42$), followed by del Monte ($S = 30$) and Subantártica ($S = 4$; Fig. 1C).

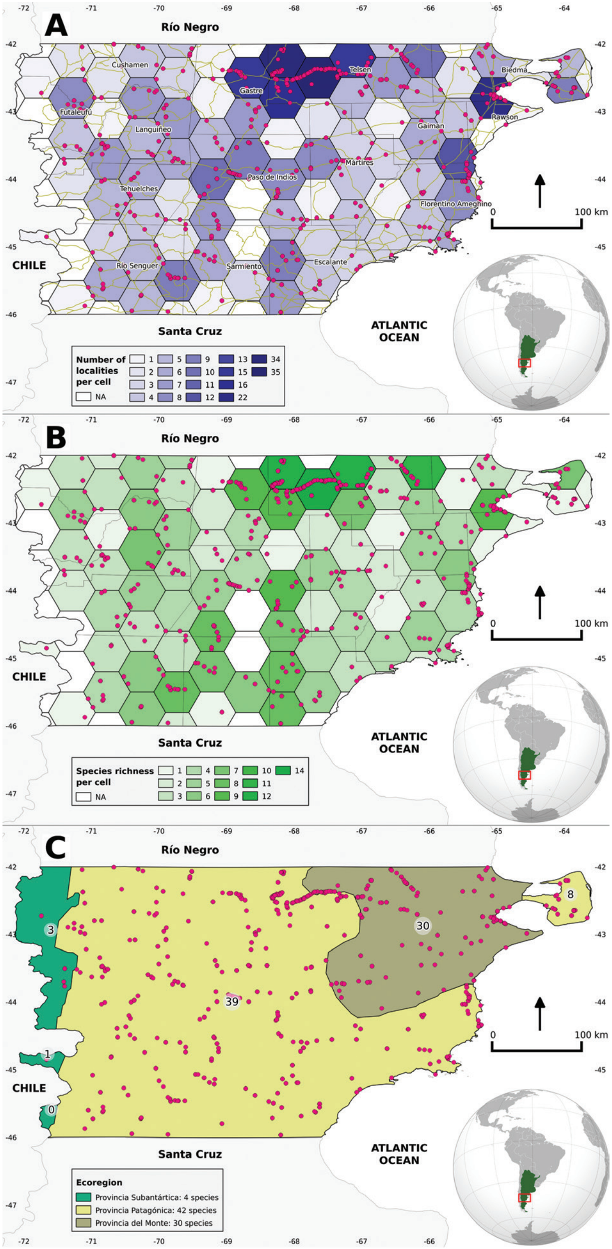

Figure 1. A Presence of reptiles recorded for central Patagonia, based on a spatial grid. Blue gradient grid: representing the number of localities sampled within each cell; brown lines: roads from a vector line shapefile; department's names and main geographic references are presented **B** Species richness of reptiles recorded for central Patagonia, analyzed based on a spatial grid. Green gradient grid: representing the richness within each cell **C** Species richness of reptile recorded for central Patagonia, analyzed based on phytogeographic provinces. White circles: representing the richness within each phytogeographic province polygon; map legend: total species per phytogeographic province. References: magenta dots: localities with accurate location information.

Table 1. Presence of reptiles for Chubut province. References: A = LJAMM-CNP, B = museum or literature, C = both. Departments: 1 = Biedma, 2 = Cushamen, 3 = Escalante, 4 = Florentino Ameghino, 5 = Futaleufú, 6 = Gaiman, 7 = Gastre, 8 = Languiñeo, 9 = Mártires, 10 = Paso de Indios, 11 = Rawson, 12 = Río Senguer, 13 = Sarmiento, 14 = Tehuelches, 15 = Telsen, 16 = Without department information, 17 = phytogeographic provinces (PS – Subantártica, PP – Patagónica, PDM – del Monte).

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
AMPHISBAENIDAE																	
Amphisbaena plumbea (Fig. 3B)	C			C											A	B	PP, PDM
Amphisbaena kingii (Fig. 3B)	B										B						PDM
CHELONIIDAE																	
Chelonia mydas (Fig. 3A)	B																PP
DIPSADIDAE																	
Paraphimophis rustica	B															B	PP, PDM
Erythrolamprus sagittifer sagittifer (Fig. 3A)	B								A						B	B	PDM
Xenodon semicinctus																B	
Oxyrhopus rhombifer (Fig. 3)	B														B		PDM
Phalotris bilineatus (Fig. 3A)	B																PDM
Philodryas patagoniensis (Fig. 3)	C			A						A	A				A	B	PP, PDM
Philodryas psammophidea	B										B						PDM
Philodryas trilineata (Fig. 3A)	C					A			A						A	B	PDM
Pseudotomodon trigonatus (Fig. 3A)	C			C						A					A	B	PP, PDM
Tachymenis chilensis (Fig. 3A)		B			C											B	PP
LEIOSAURIDAE																	
Diplolaemus bibronii (Fig. 3B)	B		C							C		C	C	A	A	B	PP
Diplolaemus darwinii (Fig. 3B)			C	C								A				B	PP
Diplolaemus sexcinctus (Fig. 3B)		A					A	A							A	B	PP
Leiosaurus bellii (Fig. 3B)	C		B	B		A				A	A				A	B	PP, PDM
Pristidactylus nigroiugulus (Fig. 3B)			A				A	A		C					C		PP, PDM
PHYLLODACTYLIDAE																	
Homonota darwinii (Fig. 3C)	C	A	C	A			A	A	A	A		C	C		A	B	PP, PDM
TEIIDAE																	
Aurivela longicauda (Fig. 3B)	C														A		PDM
VIPERIDAE																	
Bothrops ammodytoides (Fig. 3A)	B		B												A	B	PP, PDM

The highest reptile diversity was recorded for the Patagónica province (H = 2.98898; D = 0.9330269), while the lowest diversity was found for the Subantártica province (H = 1.232643; D = 0.6632653, Table 5). The most similar phytogeographic provinces in terms of their species' composition were Patagonian and del Monte Provinces (d_{jk} = 0.8839369), while the Subantártica province shares all its species with the Patagónica province (d_{jk} = 0.9943445), but does not share any species with del Monte province (Table 5). Regarding the exclusive occurrence of species in relation to the boundaries of each phytogeographic province, the Patagónica supports 17 unique species, while del Monte has eight and the Subantártica has only *Liolaemus pictus argentinus* with no records in the

Table 2. Presence of Liolaemidae taxa for Chubut province. References: A = LJAMM-CNP, B = museum or literature, C = both. Departments: 1 = Biedma, 2 = Cushamen, 3 = Escalante, 4 = Florentino Ameghino, 5 = Futaleufú, 6 = Gaiman, 7 = Gastre, 8 = Languiñeo, 9 = Mártires, 10 = Paso de Indios, 11 = Rawson, 12 = Río Senguer, 13 = Sarmiento, 14 = Tehuelches, 15 = Telsen, 16 = Without department information, 17 = phytogeographic provinces (PS – Subantártica, PP – Patagónica, PDM – del Monte).

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
LIOLAEMIDAE																	
Liolaemus bibronii (Fig. 3D)		A	A	C	A		A	A	A	A		A	A	A	A	B	PP, PDM
Liolaemus boulengeri (Fig. 3D)	B	C	A	C	B	B	A	C	A	A		C	A	C	A	B	PP, PDM
Liolaemus camarones (Fig. 3E)				C													PP
Liolaemus canqueli (Fig. 3E)							A	A	A	C						B	PP, PDM
Liolaemus chehuachekenk (Fig. 3E)		A					A	A		A					A		PP, PDM
Liolaemus darwinii (Fig. 3E)	C					A			A		C				C	B	PP, PDM
Liolaemus elongatus (Fig. 3E)		A			A			C		A		A	C	C	A	B	PP, PS
Liolaemus fitzingerii (Fig. 3E)	B		C	C						A		A	A	A		B	PP, PDM
Liolaemus gracilis (Fig. 3E)	C					A									A	B	PP, PDM
Liolaemus kingii (Fig. 3F)		A	C		A			C		C		C	C	A		B	PP, PS
Liolaemus kriegi (Fig. 3F)		B														B	PP
Liolaemus lineomaculatus (Fig. 3F)			C					C				C		A		B	PP, PS
Liolaemus morandae (Fig. 3F)			C									A					PP
Liolaemus melanops (Fig. 3F)	C					A			C	A	C				C	B	PP, PDM
Liolaemus petrophilus (Fig. 3F)		A					A	A	C	C			A		A		PP, PDM
Liolaemus pictus argentinus (Fig. 3G)					A			A								B	PS
Liolaemus rothi (Fig. 3G)		A					A								C	B	PP, PDM
Liolaemus senguer (Fig. 3G)										A		C		C			PP
Liolaemus shehuen (Fig. 3E)															C		PP, PDM
Liolaemus somuncurae (Fig. 3G)															A		PP
Liolaemus telsen (Fig. 3G)															C		PP, PDM
Liolaemus uptoni (Fig. 3G)							C										PP
Liolaemus xanthoviridis (Fig. 3G)			A	C		B			A	A	C					B	PP, PDM
Phymaturus calcogaster (Fig. 3H)															C		PP, PDM
Phymaturus camilae (Fig. 3H)								B									PP
Phymaturus castillensis (Fig. 3H)													B				PP
Phymaturus felixi (Fig. 3H)										C							PP
Phymaturus indistinctus (Fig. 3H)												C	B				PP
Phymaturus patagonicus (Fig. 3H)						B				C					C	B	PP, PDM
Phymaturus somuncurensis (Fig. 3H)															C	B	PP
Phymaturus videlai (Fig. 3H)													B				PP

Table 3. Reptile list records based on the information source: A) number of family records from the LJAMM-CNP collection, B) number of family records from literature and museum information, C) number of total records per family, D) number of genera per family, E) number of species per genus.

Families	**A (n = 2222)**	**B (n = 620)**	**C (n = 2832)**	**D (n = 18)**	**E (n = 52)**
Amphisbaenidae	4	10	14	1	2
Cheloniidae	0	1	1	1	1
Dipsadidae	35	54	89	8	10
Leiosauridae	96	66	162	3	5
Liolaemidae	1840	462	2302	2	31
Phyllodactylidae	244	9	253	1	1
Teiidae	1	2	3	1	1
Viperidae	2	16	18	1	1

Table 4. Reptile records for political department based on the information source: A) number of family records from the LJAMM-CNP collection, B) number of family records from literature and museum information, C) total records per political department.

Political departments	**A (n = 2222)**	**B (n = 620)**	**C (n = 2842)**	**Area km²**
Biedma	169	63	232	12920.36
Cushamen	76	28	104	16312.96
Escalante	174	13	187	14286.51
Florentino Ameghino	139	48	187	15866.99
Futaleufú	31	12	43	9162.13
Gaiman	28	32	60	11633.59
Gastre	104	11	115	15996.02
Languiñeo	150	36	186	14798.94
Mártires	96	5	101	15645.31
Paso de Indios	326	84	410	22232.58
Rawson	32	17	49	4151.81
Río Senguer	134	29	163	22868.47
Sarmiento	86	26	112	14543.86
Tehuelches	81	21	102	14594.87
Telsen	596	68	664	19459.08
Without department information	0	127	127	----

Table 5. Species diversity in central Patagonia, Argentina: PS) Subantártica province, PP) Patagónica province, PDM) del Monte province.

Diversity	**Species richness (*S*)**	**Shannon-Weaver's index (*H*)**	**Simpson's index (*D*)**
PS	4	1.232643	0.6632653
PP	42	2.98898	0.9330269
PDM	30	2.513668	0.8555218
Jaccard index (d_{jk})	PS	PP	PDM
PS	0	0.9943445	1
PP	0.9943445	0	0.8839369
PDM	1	0.8839369	0

other phytogeographic provinces (Table 2). The genus *Diplolaemus* was only present in Patagónica province and del Monte province was represented mostly by snakes (Table 1). Rarefaction estimates of species richness indicated that Patagónica accumulated species faster than did the other phytogeographic provinces (Supplementary file 1: Fig. 1).

We recorded five zoogeographical novelties: (1) First record of *Pseudotomodon trigonatus* for Telsen Department; (2) southernmost record of *Liolaemus gracilis* in Argentina and first vouchered presence for Gaiman Department; (3) first records of *L. kingii* for Cushamen, Escalante, Futaleufú, Languiñeo, Paso de Indios, Río Senguer and Tehuelches Departments; (4) first records of *L. rothi* for Cushamen and Gastre Departments; (5) first records of *Phymaturus indistinctus* for Río Senguer Department. The reptile species list for Chubut province is detailed in Tables 1 and 2.

Taxonomic comments

Based on the reptile species list for Chubut province and updated species distribution detailed above; we provide specific comments for published records for which we detected problems:

1 Montero (1996) cited two records of *Amphisbaena kingii* (Bell, 1833) vouchered as CHINM 1759–60, but we did not include them in a map because the author´s coordinates correspond to a location in the sea.

2 We did not consider Dixon and Thomas's (1982) presence record of *Erythrolamprus sagittifer sagittifer* for Chubut, because these authors did not include either a literature record or vouchered specimens.

3 Giraudo and Scrocchi (2002) cited *Micrurus pyrrhocryptus* (Cope, 1862) for Chubut province. At the present time we cannot confirm the presence of this species in Chubut because no voucher specimens are deposited in a herpetological collection reviewed by us and no bibliographic citation was made based on a particular specimen.

4 We did not take into account the records of *Liolaemus ceii* (Donoso-Barros, 1971) for Nahuel Pan, Futaleufú Department, cited as the southernmost limit of this species by Cei (1986) and Scolaro (2005) for the northwestern area of Chubut, because we could not verify any vouchered specimen from this area.

5 We did not consider the records for *Liolaemus kingii* for Península Valdés (CENAI 1761), *L. lineomaculatus* (CENAI 1768 = JD-Z 1589) for Puerto Madryn and *L. melanops* (CENAI 854 = JD-Z 1734) for Sierra Cuadrada from Daciuk and Miranda (1980). Current distribution of *L. kingii* and *L. lineomaculatus* is well studied and their range of distribution is much further south than the city of Puerto Madryn (Breitman pers. comm.). This was well analyzed, mapped and verified in Breitman et al. (2011a, 2011b, 2011c, 2012, 2013). The locality in which Daciuk and Miranda (1980) cited a specimen identified as *L. melanops* was subsequently recognized to harbor populations of *L. canqueli* (Cei and Scolaro 1980, 1983). We considered these

records of *L. kingii*, *L. lineomaculatus* and *L. melanops* as potentially erroneous, based on the taxonomic and distributional updates reviewed and considered in this work.

6 *Liolaemus wiegmannii* (Daciuk and Miranda 1980, Etheridge 2000) is a species cited for Chubut based on specimens purportedly collected in the province but we think this information represents an error at either the taxonomic or geographic level. This record of *L. wiegmannii* in Bahía del fondo (Chubut province, Etheridge 2000) is separated by approximately 560 km in a straight line from the southernmost locality known in Río Negro province (see review of this species group, Avila et al. 2009). This is the only provincial record for this species and is in complete isolation of populations mentioned above. In addition, we were unable to review this specimen ourselves. We considered that future surveys are needed to conclusively determine its presence in Chubut province.

7 We did not consider the records IBA-UNC N°1142, 1076, 1075 CNP N°28, 33–4, 79 for *Liolaemus goetschi* (Müller and Hellmich 1938) cited by Scolaro (1976b) in Península Valdés. This taxon has been recently redescribed (Nori et al. 2010a) and the current known populations are restricted to the north of Río Negro province (Nori et al. 2010b, Pérez et al. 2011) approximately 430 km in a straight line from Península Valdés. The populations cited as *L. goetschi* in Scolaro (1976b) are considered as *L. melanops* since subsequent works showed molecular (Avila et al. 2006b) and morphological (Abdala 2007, Abdala et al. 2012b) differences between these two taxa.

8 We did not include on a map the reference for *Liolaemus lineomaculatus* Boulenger, 1885 MLP.S. 2106 (Ibargüengoytía et al. 2001), located in Escalante Department, because the author´s coordinates correspond to a locality 224 km N (straight line distance) in Mártires Department. This record should be re-examined and compared with new and recently described species (Breitman et al. 2011b) from this group of lizards.

9 We consider that, the taxonomic identity for the records of *Liolaemus xanthoviridis* (Cei and Scolaro 1980) made by Cruz et al. (1999) for Península Valdés should be checked based on updated taxonomic proposals. The populations of Península Valdés considered as *Liolaemus xanthoviridis* by Cruz et al. (1999), have subsequently been considered to be *L. melanops* based on molecular (Avila et al. 2006b) and morphological (Abdala 2007, Abdala et al. 2012b) differences.

Discussion

Knowledge about world biodiversity remains inadequate because most species living on Earth are still not formally described (the Linnean shortfall) and because geographical distributions of most species are poorly understood and usually contain many gaps (the Wallacean shortfall; Bini et al. 2006). Regional lists are small steps towards solving some of these problems, and checklists with geographic and voucher information, despite their limitations, are a good start for further detailed studies. As Rivas et al. (2012) state, checklists are dynamic and should be considered as a still frame in time that has no lasting value, only showing the state of knowledge at a particular moment.

Reports of new species, synonymizations and elevation of old synonyms to specific status, clarification of prior mistakes and new data about species distributions rapidly change our knowledge of biological diversity. Here we present a comprehensive background useful to other biologists for future, more detailed works. Based on this review, the reptile fauna of central Patagonia is dominated by lizards, both in species diversity and number of records. On the contrary, the regional distribution of snakes are rather marginal and for most of them, this area represents the southernmost limit of their geographic range, since the majority of the species to be related with the del Monte or ecotonal areas with Patagónica province (except *Tachymenis chilensis*).

Some biases are evident in our study; north-central and northeastern areas of the Chubut province have a high number of data because they were more intensively sampled due to their proximity to our research center, or because they were used in several ecological studies and have easy access by road or trails (Fig. 1A). Some areas located far away from our research center need greater sampling effort, such as the central-south and the Subantártica province, where no information is available for some grid cells (Figs 1B, C). Information about reptile distribution from central Patagonia is scarce and access to specimens deposited in public herpetological collections or bibliographic references with accurate locality information is relatively rare. The majority of the species were relatively recently reviewed (see bibliography) and some old taxonomic problems were partially solved (e.g., Abdala 2003, Lobo and Quinteros 2005b, Lobo et al. 2010); but for some species complexes, the taxonomic status of some populations and species limits are still unclear (e.g., Morando et al. 2013). The only turtle cited for central Patagonia is the marine species *Chelonia mydas*, but the cited specimen probably corresponds to a lost individual, since coastal Chubut areas are not in the feeding or nesting activity range of this species (Falabella et al. 2009).

The spatial occurrence of *Homonota darwinii* is fragmented across the studied area with two distributional gaps: a western strip and central and eastern areas of the Chubut province (Fig. 3C). On the other hand, *Liolaemus bibronii* and *L. boulengeri* were the taxa most evenly distributed along the studied region, although they were presented by few records for the del Monte province (Fig. 3D). Some recently described species (e.g. *Liolaemus camarones*, *L. shehuen*, Fig. 3E; *L. morandae*, Fig. 3F; *L. senguer*, Fig. 3G; *Phymaturus camilae*, *P. castillensis*, *P. felixi* and *P. videlai*, Fig. 3H) need further studies on their geographic distribution, whereas other species previously cited for the province were not found in any of the collections studied or collected / observed in the field, despite being easily detected or sampled in other areas of their distribution (e.g. *L. somuncurae*, *L. kriegi*). Some citations for the region were considered here as taxonomic misidentifications, such as *L. goetschi*, which is restricted to northern Río Negro and southern La Pampa provinces (Nori et al. 2010a, 2010b), whereas other records require new investigation and/or reexamination (e.g. *L. wiegmannii*, Etheridge 2000).

The most remarkable results from a conservation status standpoint are that only one taxon (*Chelonia mydas*) is considered endangered, seven of the eight *Phymaturus* species are vulnerable and *Psuedotomodon trigonatus* is data deficient (Fig. 2). The analyses of

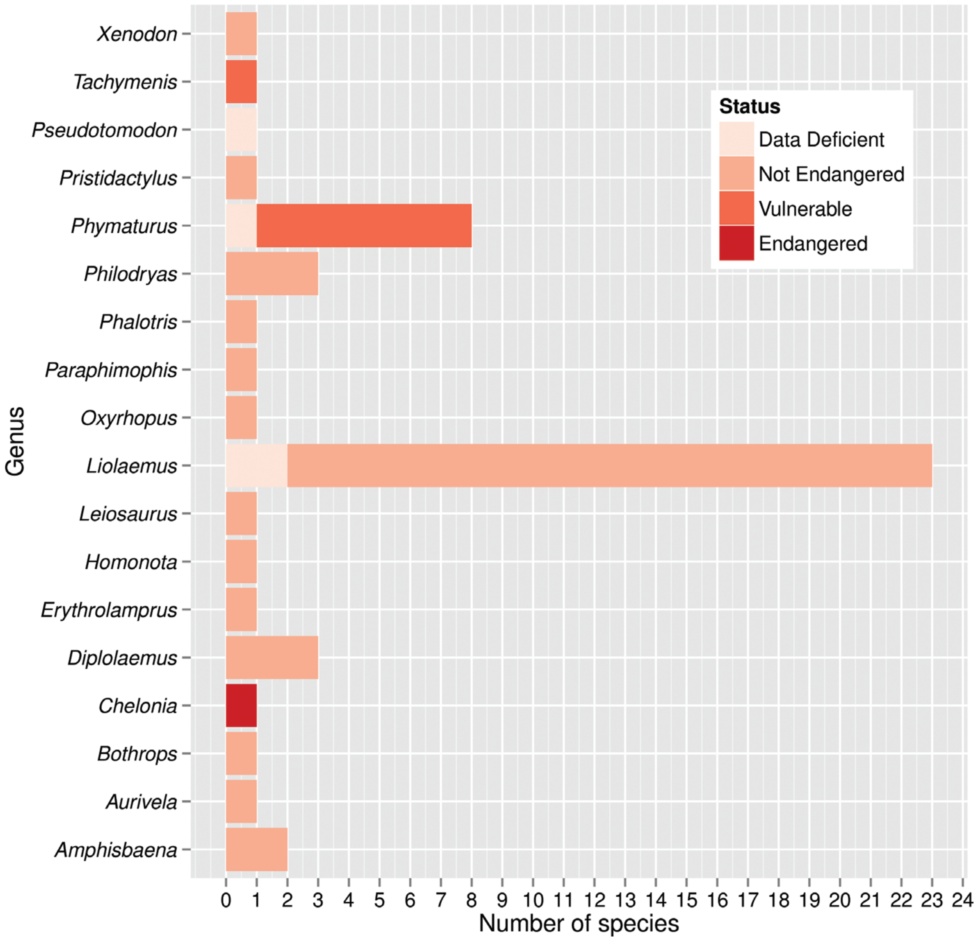

Figure 2. Reptile species conservation status per genus for central Patagonia, Argentina.

conservation status by phytogeographic provinces showed that, Patagónica province had the largest number of vulnerable (8) and endangered (1) taxa. Additionally, Subantártica province was the province with the lowest number of taxa (0) with data deficient status, followed by del Monte (1). Our study reveals the small geographic distribution of each of the *Phymaturus* species, of which almost all were recently considered as "vulnerable" (Abdala et al. 2012a). This genus is characterized by living in rocky habitats, exhibiting a high degree of endemism and being viviparous and herbivorous (Abdala et al. 2012a). Thus, we consider that most future management decisions should address the conservation of threatened populations of different *Phymaturus* species.

In summary, the systematic knowledge of several groups are essential to conservation decisions (see Cook et al. 2013), especially for the genera *Liolaemus*, *Phymaturus*, *Pristidactylus* and *Diplolaemus*, which require further taxonomic studies. Studies that update and review species' geographic distribution coupled with their taxonomic status are necessary (Feeley and Silman 2011) as they provide basic information for

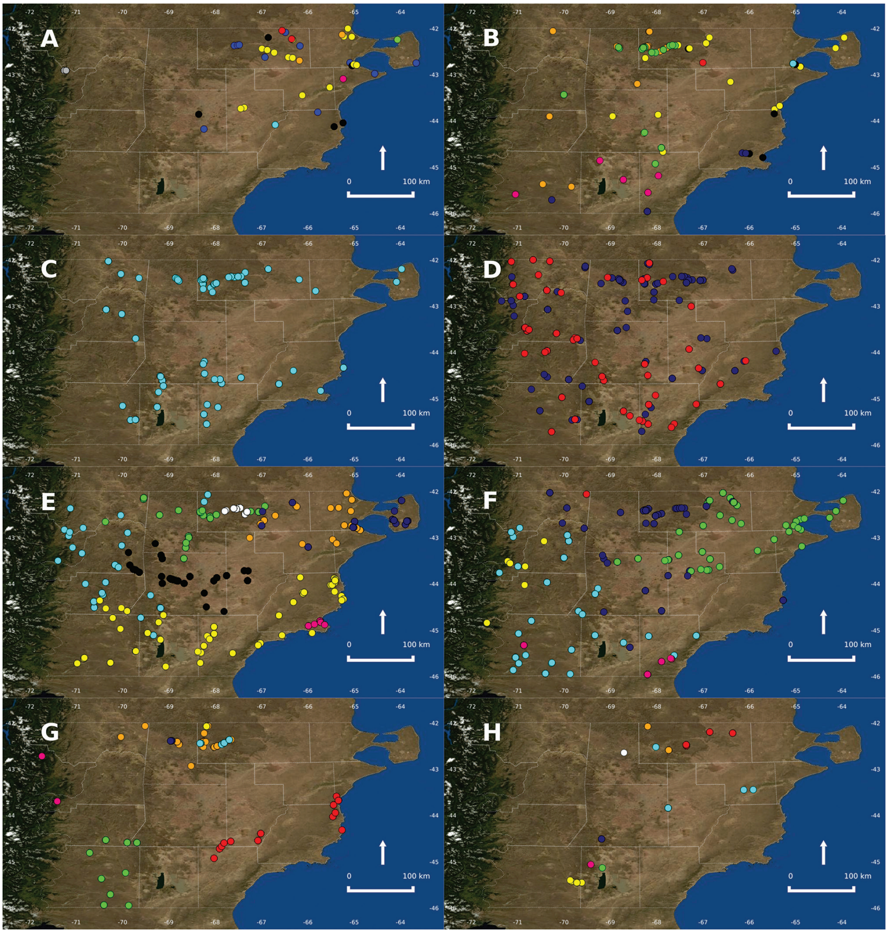

Figure 3. Imagery source: Blue Marble Next Generation (true-color), Web Map Service (WMS) layer from CREAF MAP SERVER (open-gis), EPSG: 4326. **A** Records of Cheloniidae, Dipsadidae and Viperidae. Green dot: *Chelonia mydas*; light blue dot: *Erythrolamprus sagittifer sagittifer*; magenta dot: *Phalotris bilineatus*; red dots: *Bothrops ammodytoides*; orange dots: *Oxyrhopus rhombifer*; black dots: *Pseudotomodon trigonatus*; blue dots: *Philodryas patagoniensis*; yellow dots: *P. trilineata*; grey dots: *Tachymenis chilensis* **B** Records of lizards. Black dots: *Amphisbaena plumbea*; light blue dot: *A. kingii*; red dot: *Aurivela longicauda*; magenta dots: *Diplolaemus bibronii*; blue dots: *D. darwinii*; orange dots: *D. sexcinctus*; yellow dots: *Leiosaurus bellii*; green dots: *Pristidactylus nigroiugulus* **C** Records of *Homonota darwinii* **D** Records of some *Liolaemus* species. Blue dots: *Liolaemus bibronii*; red dots: *L. boulengeri* **E** Records of some *Liolaemus* species. Magenta dots: *Liolaemus camarones*; black dots: *L. canqueli*; green dots: *L. chehuachekenk*; orange dots: *L. darwinii*; light blue dots: *L. elongatus*; yellow dots: *L. fitzingerii*; blue dots: *L. gracilis*; white dots: *L. shehuen* **F** Records of some *Liolaemus* species. Light blue dots: *Liolaemus kingii*; red dot: *L. kriegi*; yellow dots: *L. lineomaculatus*; green dots: *L. melanops*; magenta dots: *L. morandae*; blue dots: *L. petrophilus* **G** Records of some *Liolaemus* species. Magenta dots: *Liolaemus pictus argentinus*; orange dots: *L. rothi*; green dots: *L. senguer*; yellow dot: *L. somuncurae*; light blue dots: *L. telsen*; blue dots: *L. uptoni*; red dots: *L. xanthoviridis* **H** Records of *Phymaturus* species. Red dots: *Phymaturus calcogaster*; white dot: *P. camilae*; green dot: *P. castillensis*; blue dot: *P. felixi*; yellow dots: *P. indistinctus*; light blue dots: *P. patagonicus*; orange dots: *P. somuncurensis*; magenta dot: *P. videlai*.

biogeographic (Corbalán and Debandi 2008), systematic (Debandi et al. 2012), and conservation (Corbalán et al. 2011, Katzner et al. 2011, Böhm et al. 2013) approaches. Numerous records of lizard population extinctions have been reported worldwide (Sinervo et al. 2010), and there is no doubt that the information presented here will be a useful contribution for future analyses of climate driven population extinction, as well as for the development of conservation plans.

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References

Abdala CS (2002) Nuevo *Liolaemus* (Iguania: Liolaemidae) perteneciente al grupo *boulengeri* de la provincia de Neuquén, Argentina. Cuadernos de Herpetología 16: 3–13.

Abdala CS (2003) Cuatro nuevas especies del género *Liolaemus* (Iguania: Liolaemidae), pertenecientes al grupo *boulengeri*, de la Patagonia Argentina. Cuadernos de Herpetología 17: 3–32.

Abdala CS (2005) Dos nuevas especies del género *Liolaemus* (Iguania: Liolaemidae) y redescripción de *Liolaemus boulengeri* (Koslowsky, 1898). Cuadernos de Herpetología 19: 3–33.

Abdala CS (2007) Phylogeny of the *boulengeri* group (Iguania: Liolaemidae, *Liolaemus*) based on morphological and molecular characters. Zootaxa 1538: 1–84.

Abdala CS, Acosta JL, Acosta JC, Álvarez BB, Arias F, Avila LJ, Blanco GM, Bonino MF, Boretto JM, Brancatelli G, Breitman MF, Cabrera MR, Cairo S, Corbalán V, Hernando A, Ibargüengoytía NR, Kacoliris F, Laspiur A, Montero R, Morando M, Pelegrin N, Pérez CHF, Quinteros AS, Semhan RV, Tedesco ME, Vega L, Zalba SM (2012a) Categorización del estado de conservación de las lagartijas y anfisbenas de la República Argentina. Cuadernos de Herpetología 26: 215–248.

Abdala CS, Díaz Gómez JM, Juarez Heredia VI (2012b) From the far reaches of Patagonia: new phylogenetic analyses and description of two new species of the *Liolaemus fitzingerii* clade (Iguania: Liolaemidae). Zootaxa 3301: 34–60.

Aguiar MR, Paruelo JM, Sala OE, Lauenroth WK (1996) Ecosystem responses to changes in plant functional type composition: an example from the Patagonian steppe. Journal of Vegetation Science 7: 381–390. doi: 10.2307/3236281

Ares J, Beeskow A, Bertiller M, Rostagno M, Irisarri M, Anchorena J, Defossé G, Merino C (1995) Structural and dynamic characteristics of overgrazed lands of northern Patagonia, Argentina. In: Breymeyer A (Ed.) Managed Grasslands. Elsevier Science Publishers B.V., Amsterdam, 149–175.

Avila LJ, Frutos N, Perez CHF, Morando M (2006a) Reptilia, Iguania, Liolaemini, *Liolaemus petrophilus* and *Liolaemus pictus*: distribution extension, filling gaps, new records. Check List 2: 65–69.

Avila LJ, Frutos N, Perez CH, Morando M (2007a) Reptilia, Iguania, Liolaemidae, *Liolaemus somuncurae*: Distribution extension. Check List 89: 11–13.

Avila LJ, Kozykariski M, Feltrin N, Morando M (2007b) Notes on geographic distribution: *Amphisbaena plumbea*. Herpetological Review 38: 217.

Avila LJ, Morando M, Belver LC (2012) *Tachymenis chilensis* Schegel, 1837 (Reptilia: Squamata: Dipsadidae). New record and geographic distribution map. Cuadernos de Herpetología 26: 1–2.

Avila LJ, Morando M, Pérez CHF (2003) New records and natural history notes for *Pristidactykus nigroiugulus* Cei, Scolaro & Videla 2001 from Río Negro and Chubut provinces, Argentina. Herpetozoa 16: 83–86.

Avila LJ, Morando M, Pérez DR (2001) New records and natural history notes for lizards and snakes from Patagonia, Argentina. Herpetological Review 32: 64–65.

Avila LJ, Morando M, Pérez DR, Sites Jr JW (2009) A new species of *Liolaemus* from Añelo sand dunes, northern Patagonia, Neuquén, Argentina, and molecular phylogenetic relationships of the *Liolaemus wiegmannii* species group (Squamata, Iguania, Liolaemini). Zootaxa 2234: 39–55. doi: 10.15560/2.2.65

Avila LJ, Morando M, Sites Jr. JW (2006b) Congeneric phylogeography: hypothesizing species limits and evolutionary processes in Patagonian lizards of the *Liolaemus boulengeri* group (Squamata: Liolaemini). Biological Journal of the Linnean Society 89: 241–275. doi: 10.1111/j.1095-8312.2006.00666.x

Avila LJ, Morando M, Sites Jr JW (2008) New species of the iguanian lizard genus *Liolaemus* (Squamata, Iguania, Liolaemini) from central Patagonia, Argentina. Journal of Herpetology 42: 186–196. doi: 10.1670/06-244r2.1

Bini LM, Diniz-Filho JAF, Rangel TFLVB, Bastos RP, Pinto MP (2006) Challenging Wallacean and Linnean shortfalls: knowledge gradients and conservation planning in a biodiversity hotspot. Diversity and Distributions 12: 475–482. doi: 10.1111/j.1366-9516.2006.00286.x

Bisigato AJ, Bertiller MB (1997) Grazing effects on patchy dryland vegetation in northern Patagonia. Journal of Arid Environments 36: 639–653. doi: 10.1006/jare.1996.0247

Böhm M, Collen B, Baillie JEM, Bowles P, Chanson J, Cox N, Hammerson G, Hoffmann M, Livingstone SR, Ram M, Rhodin AGJ, Stuart SN, van Dijk PP, Young BE, Afuang LE, Aghasyan A, García A, Aguilar C, Ajtic R, Akarsu F, Alencar LRV, Allison A, Ananjeva N, Anderson S, Andrén C, Ariano-Sánchez D, Arredondo JC, Auliya M, Austin CC, Avci A, Baker PJ, Barreto-Lima AF, Barrio-Amorós CL, Basu D, Bates MF, Batistella A, Bauer A, Bennett D, Böhme W, Broadley D, Brown R, Burgess J, Captain A, Carreira S, Castañeda M del R, Castro F, Catenazzi A, Cedeño-Vázquez JR, Chapple DG, Cheylan M, Cisneros-Heredia DF, Cogalniceanu D, Cogger H, Corti C, Costa GC, Couper PJ, Courtney T, Crnobrnja-Isailovic J, Crochet P-A, Crother B, Cruz F, Daltry JC, Daniels RJR, Das I, de Silva A, Diesmos AC, Dirksen L, Doan TM, Dodd CK, Doody JS, Dorcas ME, Duarte de Barros Filho J, Egan VT, El Mouden EH, Embert D, Espinoza RE, Fallabrino A, Feng X, Feng Z-J, Fitzgerald L, Flores-Villela O, França FGR, Frost D, Gadsden H, Gamble T, Ganesh SR, Garcia MA, García-Pérez JE, Gatus J, Gaulke M, Geniez P, Georges A, Gerlach J, Goldberg S, Gonzalez J-CT, Gower DJ, Grant T, Greenbaum E, Grieco C, Guo P, Hamilton AM, Hare K, Hedges SB, Heideman N, Hilton-Taylor C, Hitchmough R, Hollingsworth B, Hutchinson M, Ineich I, Iverson J, Jaksic FM, Jenkins R, Joger U, Jose R, Kaska Y, Kaya U, Keogh JS, Köhler G, Kuchling G, Kumlutaş Y, Kwet A, La Marca E, Lamar W, Lane A, Lardner B, Latta C, Latta G, Lau M, Lavin P, Lawson D, LeBreton M, Lehr E, Limpus D, Lipczynski N, Lobo AS, López-Luna MA, Luiselli L, Lukoschek V, Lundberg M, Lymberakis P, Macey R, Magnusson WE, Mahler DL, Malhotra A, Mariaux J, Maritz B, Marques OAV, Márquez R, Martins M, Masterson G, Mateo JA, Mathew R, Mathews N, Mayer G, McCranie JR, Measey GJ, Mendoza-Quijano F, Menegon M, Métrailler S, Milton DA, Montgomery C, Morato SAA, Mott T, Muñoz-Alonso A, Murphy J, Nguyen TQ, Nilson G, Nogueira C, Núñez H, Orlov N, Ota H, Ottenwalder J, Papenfuss T, Pasachnik S, Passos P, Pauwels OSG, Pérez-Buitrago N, Pérez-Mellado V, Pianka ER, Pleguezuelos J, Pollock C, Ponce-Campos P, Powell R, Pupin F, Quintero Díaz GE, Radder R, Ramer J, Rasmussen AR, Raxworthy C, Reynolds R, Richman N, Rico EL, Riservato E, Rivas G, da Rocha PLB, Rödel M-O, Rodríguez Schettino L, Roosenburg WM, Ross JP, Sadek R, Sanders K, Santos-Barrera G, Schleich HH, Schmidt BR, Schmitz A, Sharifi M, Shea G, Shi H-T, Shine R, Sindaco R, Slimani T, Somaweera R, Spawls S, Stafford P, Stuebing R, Sweet S, Sy E, Temple HJ, Tognelli MF, Tolley K, Tolson PJ, Tuniyev B, Tuniyev S, Üzüm N, van Buurt G, Van Sluys M, Velasco A, Vences M, Veselý M, Vinke S, Vinke T, Vogel G, Vogrin M, Vogt RC, Wearn OR, Werner YL, Whiting MJ, Wiewandt T, Wilkinson J, Wilson B, Wren S, Zamin T, Zhou K, Zug G (2013) The conservation status of the world's reptiles. Biological Conservation 157: 372–385. doi: 10.1016/j.biocon.2012.07.015

Breitman MF, Avila LJ, Sites JW, Morando M (2011a) Lizards from the end of the world: Phylogenetic relationships of the *Liolaemus lineomaculatus* section (Squamata: Iguania: Liolaemini). Molecular Phylogenetics and Evolution 59: 364–376. doi: 10.1016/j.ympev.2011.02.008

Breitman MF, Avila LJ, Sites JW, Morando M (2012) How lizards survived blizzards: phylogeography of the *Liolaemus lineomaculatus* group (Liolaemidae) reveals multiple breaks and refugia in southern Patagonia and their concordance with other codistributed taxa. Molecular Ecology 21: 6068–6085. doi: 10.1111/mec.12075

Breitman MF, Minoli I, Avila LJ, Medina CD, Jack WSJ, Morando M (2014) Lagartijas de la provincia de Santa Cruz, Argentina: distribución geográfica, diversidad genética y estado de conservación. Cuadernos de herpetología 28: 83–110.

Breitman MF, Morando M, Avila LJ (2013) Past and present taxonomy of the *Liolaemus lineomaculatus* section (Liolaemidae): is the morphological arrangement hypothesis valid? Zoological Journal of the Linnean Society 168: 612–668. doi: 10.1111/zoj.12037

Breitman MF, Parra M, Pérez CHF (2011b) Two new species of lizards from the *Liolaemus lineomaculatus* section (Squamata: Iguania: Liolaemidae) from southern Patagonia. Zootaxa 3120: 1–28.

Breitman MF, Pérez CHF, Parra M, Morando M, Sites Jr JW, Avila LJ (2011c) New species of lizard from the *magellanicus* clade of the *Liolaemus lineomaculatus* section (Squamata: Iguania: Liolaemidae) from southern Patagonia. Zootaxa 3123: 32–48.

Buddle CM, Beguin J, Bolduc E, Mercado A, Sackett TE, Selby RD, Varady-Szabo H, Zeran RM (2005) The importance and use of taxon sampling curves for comparative biodiversity research with forest arthropod assemblages. The Canadian Entomologist 137: 120–127. doi: 10.4039/n04-040

Carrasco PA, Leynaud GC, Scrocchi GJ (2010) Redescription of the southernmost snake species, *Bothrops ammodytoides* (Serpentes: Viperidae: Crotalinae). Amphibia-Reptilia 31: 323–338. doi: 10.1163/156853810791769491

Carrera HM, Avila LJ (2008a) *Oxyrhopus rhombifer bachmanni* (False Coral Snake). Distribution. Herpetological Review 39: 242.

Carrera HM, Avila LJ (2008b) *Oxyrhopus rhombifer bachmanni* (False Coral Snake). Predation/Scavenging. Herpetological Review 39: 356.

Cei JM (1973a) Herpetología patagónica. VI. Los *Liolaemus* del grupo *fitzingeri* en Santa Cruz y Chubut (Sauria, Iguanidae). Physis 32: 447–458.

Cei JM (1973b) Lista de los ejemplares tipos de la colección herpetológica del Instituto de Biología Animal, Facultad de Ciencias Agrarias de la Universidad Nacional de Cuyo. Revista de la Facultad de Ciencias Agrarias 19: 1–9.

Cei JM (1974) Revision of Patagonian Iguanids of the *Liolaemus elongatus* complex. Journal of Herpetology 8: 219–229. doi: 10.2307/1563167

Cei JM (1975a) Herpetología patagónica. IX. *Liolaemus goetschi* y el conjunto *Liolaemus darwini-boulengeri*. Physis 34: 199–202.

Cei JM (1975b) *Liolaemus melanops* (Burmeister) and the subspecific status of the *Liolaemus Fitzingeri* group (Sauria, Iguanidae). Journal of Herpetology 9: 217–222. doi: 10.2307/1563040

Cei JM (1978) Estado taxonómico y distribución geográfica de las especies del género *Homonota* (Sauria, Gekkonidae). Publicación Ocasional Instituto Biología Animal, Universidad Nacional de Cuyo 9: 1–4.

Cei JM (1986) Reptiles del centro, centro-oeste y sur de la Argentina. Herpetofauna de las zonas áridas y semiáridas. Museo Regionale di Scienze Naturali Torino, 527 pp.

Cei JM (1993) Reptiles del nordeste y este de la Argentina. Herpetofauna de las selvas subtropicales, Puna y Pampas. Museo Regionale di Scienze Naturali Torino, 951 pp.

Cei JM (2003) Specific supraocular scutellation patterns as significant diagnostic characters: taxonomic inter and intrageneric "finger-print" in Lacertilia. Facena 19: 129–135.

Cei JM, Castro LP (1973) Taxonomic and serological researches on the *Phymaturus patagonicus* complex. Journal of Herpetology 7: 237–247. doi: 10.2307/1563009

Cei JM, Scolaro JA (1977) Herpetología Patagónica. XIII. La identidad de *Liolaemus goetschi* y de la forma *melanops* del grupo *Liolaemus fitzingerii*, en Rio Negro y Chubut. Physis 36: 225–226.

Cei JM, Scolaro JA (1980) Two new subspecies of the *Liolaemus fitzingeri* complex from Argentina. Journal of Herpetology 14: 37–43. doi: 10.2307/1563873

Cei JM, Scolaro JA (1983) Un nuevo arreglo taxonómico para los *Liolaemus* del grupo *Fitzingeri*. Boletín de la Asociación Herpetológica Argentina 1: 15–16.

Cei JM, Scolaro JA (1999) Speciation of the "*darwini* Complex" (genus *Liolaemus*, "patch group") in the southermost area of its distribution (Reptilia: Tropiduridae). Revue Français de Aquariologie 26: 79–82.

Cei JM, Scolaro JA (2003) Rectificación taxonómica y nomenclatural del presente status del taxon *Liolaemus melanops* Burmeister 1888. Facena 19: 163–164.

Cei JM, Scolaro JA (2006) The neotype of the type species of the neotropical iguanian genus *Phymaturus*: a critical commentary on a recent opinion of the International Commission on Zoological Nomenclature. Zootaxa 1297: 17–22.

Cei JM, Scolaro JA, Videla F (2001) The present status of Argentinean Polychrotidae species of the genus *Pristidactylus* and description of its southernmost taxon as a new species. Journal of Herpetology 35: 597–605. doi: 10.2307/1565897

Cei JM, Scolaro JA, Videla F (2003) A taxonomic revision of recognized argentine species of the Leiosaurid genus *Diplolaemus*. Facena 19: 137–155.

Cesa A, Paruelo JM (2011) Changes in vegetation structure induced by domestic grazing in Patagonia (Southern Argentina). Journal of Arid Environments 75: 1129–1135. doi: 10.1016/j.jaridenv.2011.04.003

Cook CN, Possingham HP, Fuller RA (2013) Contribution of systematic reviews to management decisions: systematic reviews. Conservation Biology 27: 902–915. doi: 10.1111/cobi.12114

Corbalán V, Debandi G (2008) La lacertofauna de Mendoza: lista actualizada, distribución y riqueza. Cuadernos de Herpetología 22: 5–24.

Corbalán V, Tognelli MF, Scolaro JA, Roig-Juñent SA (2011) Lizards as conservation targets in Argentinean Patagonia. Journal for Nature Conservation 19: 60–67. doi: 10.1016/j.jnc.2010.05.004

Cruz FB, Schulte II JA, Bellagamba P (1999) New distributional records and natural history notes for reptiles from southern Argentina. Herpetological Review 30: 182–183.

Daciuk J, Miranda ME (1980) Notas faunísticas y bioecologicas de Península Valdés y Patagonia XXV. Batraco-herpetofauna de la Península Valdés y costas patagónicas (Río Negro, Chubut, Santa Cruz y Tierra del Fuego, Republica Argentina). Neotropica 26: 99–115.

Debandi G, Corbalán V, Scolaro JA, Roig-Juñent SA (2012) Predicting the environmental niche of the genus *Phymaturus*: Are *palluma* and *patagonicus* groups ecologically differentiated? Austral Ecology 37: 392–400. doi: 10.1111/j.1442-9993.2011.02295.x

Dengler J (2009) A flexible multi-scale approach for standardised recording of plant species richness patterns. Ecological Indicators 9: 1169–1178. doi: 10.1016/j.ecolind.2009.02.002

Dixon JR, Thomas RA (1982) The status of the Argentine colubrid snakes *Liophis sagittifer* and *L. trifasciatus*. Herpetologica 38: 389–395.

Etheridge R (2000) A review of lizards of the *Liolaemus wiegmannii* group (Squamata, Iguania, Tropiduridae), and a history of morphological change in the sand-dwelling species. Herpetological Monographs 14: 293–352. doi: 10.2307/1467049

Etheridge R, Christie MI (2003) Two new species of the lizard genus *Liolaemus* (Squamata: Liolaemidae) from northern Patagonia, with comments on *Liolaemus rothi*. Journal of Herpetology 37: 325–341. doi: 10.1670/0022-1511(2003)037[0325:tnsotl]2.0.co;2

Falabella V, Campagna C, Croxall J (2009) Atlas of the Patagonian Sea. Species and Spaces. http://atlas-marpatagonico.org/species/39/green-turtle.htm [accessed 12/01/2014]

Feeley KJ, Silman MR (2011) Keep collecting: accurate species distribution modelling requires more collections than previously thought. Diversity and Distributions 17: 1132–1140. doi: 10.1111/j.1472-4642.2011.00813.x

Frost DR, Etheridge R, Janies D, Titus TA (2001) Total evidence, sequence alignment, evolution of polychrotid lizards, and a reclassification of the Iguania (Squamata: Iguania). American Museum Novitates: 1–39. doi: 10.1206/0003-0082(2001)343<0001:tesaeo>2.0.co;2

Gallardo JM (1960) Estudio zoogeográfico del género *Leiosaurus* (Reptilia, Sauria). Physis 22: 113–118.

Gallardo JM (1971) Algunas ideas sobre la zoogeografía de saurios patagónicos. Revista del Museo Argentino de Ciencias Naturales Bernardino Rivadavia I: 135–147.

Gamble T, Bauer AM, Greenbaum E, Jackman TR (2008) Out of the blue: a novel, trans-Atlantic clade of geckos (Gekkota, Squamata). Zoologica Scripta 37: 355–366. doi: 10.1111/j.1463-6409.2008.00330.x

Giambelluca LA (1999) *Lystrophis semicinctus* (Ophidia: Colubridae) nueva cita para la provincia de Chubut (Argentina). Boletín de la Asociación Herpetológica Española 10: 19.

Giraudo AR, Scrocchi GJ (2002) Argentinian snakes: an annotated checklist. Smithsonian Herpetological Information Service. doi: 10.5479/si.23317515.132.1

Giraudo AR, Vidoz F, Arzamendia V, Nenda SJ (2012) Distribution and natural history notes on *Tachymenis chilensis chilensis* (Schlegel, 1837) (Reptilia: Serpentes: Dipsadidae) in Argentina. Check List 8: 919–923.

Gotelli NJ, Colwell RK (2001) Quantifying biodiversity: procedures and pitfalls in the measurement and comparison of species richness. Ecology letters 4: 379–391. doi: 10.1046/j.1461-0248.2001.00230.x

Gray JE (1827) A synopsis of the genera of the saurian reptiles, in which some new genera are indicated, and the others reviewed by actual examination. Philisophical Magazine 2: 54–58. doi: 10.1080/14786442708675620

Gray JE (1865) A revision of the genera and species of amphisbaenians, with the descriptions of some new species now in the collections of the British Museum. Proceedings of the Zoological Society of London 1865: 442–455.

Ibargüengoytía N, Casalins L, II J, Amico G, Sympson L (2001) Geographic distribution: *Liolaemus lineomaculatus* 32: 120.

INDEC, IGM (2014) Instituto Nacional de Estadísticas y Censos (INDEC) & Instituto Geográfico Militar (IGM). División política, superficie y población. http://www.ign.gob.ar/NuestrasActividades/Geografia/DatosArgentina/DivisionPolitica [accessed 09/30/2014]

Katzner TE, Ivy JAR, Bragin EA, Milner-Gulland EJ, DeWoody JA (2011) Conservation implications of inaccurate estimation of cryptic population size. Animal Conservation 14: 328–332. doi: 10.1111/j.1469-1795.2011.00444.x

Kluge AG (1964) A revision of the south american gekkonid lizard genus *Homonota* Gray. American Museum Novitates 2193: 1–42.

Koslowsky J (1898) Enumeración sistemática y distribución geográfica de los reptiles argentinos. Revista del Museo de La Plata 8: 161–200.

Lobo F (2005) Las relaciones filogenéticas dentro del grupo *chiliensis* (Iguania: Liolaemidae: *Liolaemus*): sumando nuevos caracteres y taxones. Acta Zoológica Lilloana 49: 65–87.

Lobo F, Abdala CS, Valdecantos S (2010) Taxonomic studies of the genus *Phymaturus* (Iguania: Liolaemidae): description of four new species. South American Journal of Herpetology 5: 102–126. doi: 10.2994/057.005.0205

Lobo F, Quinteros S (2005a) A morphology-based phylogeny of *Phymaturus* (Iguania: Liolaemidae) with the description of four new species from Argentina. Papéis Avulsos de Zoologia (São Paulo) 45: 143–177. doi: 10.1590/s0031-10492005001300001

Lobo F, Quinteros S (2005b) Taxonomic studies of the genus *Phymaturus* (Iguania: Liolaemidae): redescription of *Phymaturus patagonicus* Koslowsky 1898, and revalidation and redescription of *Phymaturus spurcus* Barbour 1921. Journal of Herpetology 39: 533–540. doi: 10.1670/170-04a.1

Masiokas MH, Villalba R, Luckman BH, Lascano ME, Delgado S, Stepanek P (2008) 20th-century glacier recession and regional hydroclimatic changes in northwestern Patagonia. Global and Planetary Change 60: 85–100. doi: 10.1016/j.gloplacha.2006.07.031

Montero R (1996) Lista de las localidades de los Amphisbaenidae de la República Argentina. Cuadernos de Herpetología 10: 25–45.

Morando M, Avila LJ, Pérez CHF, Hawkins MA, Sites JW (2013) A molecular phylogeny of the lizard genus *Phymaturus* (Squamata, Liolaemini): Implications for species diversity and historical biogeography of southern South America. Molecular Phylogenetics and Evolution 66: 694–714. doi: 10.1016/j.ympev.2012.10.019

Müller L, Hellmich W (1938) *Liolaemus* -Arten aus dem westlichen Argentinien (ergebnisse der argentinienreise von Prof. Dr. W. Goetsch, Breslau). I. *Liolaemus darwini* (Bell) und *Liolaemus goetschi* n. sp. Zoologischer Anzeiger 123: 129–142.

Nenda SJ, Cacivio PM, Naturales C, Rivadavia B (2007) Notes on geographic distribution. Check List 3: 126–130. doi: 10.15560/3.2.126

Nori J, Abdala CS, Scrocchi GJ (2010a) *Liolaemus goetschi* (Iguania: Liolaemidae): redescription and phylogenetic relationships within the *L. boulengeri* group. Zootaxa 2440: 49–59.

Nori J, Abdala CS, Scrocchi GJ (2010b) Reptilia, Iguania, Liolaemidae, *Liolaemus goetschi* Müller and Hellmich, 1938: Distribution extension. Check List 6: 3–4.

Oksanen J, Blanchet FG, Kindt R, Legendre P, Minchin PR, O'Hara RB, Simpson GL, Solymos P, Stevens MHH, Wagner H (2013) vegan: Community Ecology Package R package version 2.0-9. http://CRAN.R-project.org/package=vegan [accessed 10/10/2013]

Olea RA (1984) Sampling design optimization for spatial functions. Journal of the International Association for Mathematical Geology 16: 369–392. doi: 10.1007/BF01029887

Open Source Geospatial Foundation Project Development Team (2014) Quantum GIS Geographic Information System. Available at: http://qgis.osgeo.org [accessed 11/15/2014]

Oppel M (1811) Die Ordnungen, Familien und Gattungen der reptilien als prodom einer naturgeschichte derselben. Joseph Lindauer Verlag, München. doi: 10.5962/bhl.title.4911

Paruelo JM, Beltran A, Jobbagy E, Sala OE, Golluscio RA (1998) The climate of Patagonia: general patterns and controls on biotic processes. Ecología Austral 8: 85–101.

Pérez CHF, Frutos N, Kozykariski M, Morando M, Perez DR, Avila LJ (2011) Lizards of Rio Negro Province, northern Patagonia, Argentina. Check List 7: 202–219.

Pincheira-Donoso D, Núñez HC (2005) 59/2005 Las especies chilenas del género *Liolaemus* Wiegmann, 1834 (Iguania: Tropiduridae: Liolaeminae) Taxonomía, Sistemática y Evolución. Museo Nacional de Historia Natural, Santiago de Chile, 486 pp.

Pincheira-Donoso D, Scolaro JA, Sura P (2008) A monographic catalogue on the systematics and phylogeny of the South American iguanian lizard family Liolaemidae (Squamata, Iguania). Zootaxa 1800: 1–85.

R Core Team (2014) R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. http://www.R-project.org/ [accessed 10/31/2014]

Rivas GA, Molina CR, Ugueto GN, Barros TR, Barrio-Amorós CL, Kok PJR (2012) Reptiles of Venezuela: an updated and commented checklist. Zootaxa 3211: 1–64.

Roig AF (1998) La vegetación de la Patagonia. In: Correa MN (Ed.) Flora Patagónica. Colección científica del INTA, Buenos Aires, Argentina, 48–174.

SAyDS - Secretaría de ambiente y desarrollo sustentable de la Nación (1997) Ecorregiones. Observatorio Nacional de Biodiversidad. http://obio.ambiente.gob.ar/ecorregiones [accessed 10/01/2013]

Schulte JA, Losos JB, Cruz FB, Núñez H (2004) The relationship between morphology, escape behaviour and microhabitat occupation in the lizard clade *Liolaemus* (Iguanidae: Tropidurinae: Liolaemini). Journal of Evolutionary Biology 17: 408–420. doi: 10.1046/j.1420-9101.2003.00659.x

Schulze E-D, Mooney HA, Sala OE, Jobbagy E, Buchmann N, Bauer G, Canadell J, Jackson RB, Loreti J, Oesterheld M (1996) Rooting depth, water availability, and vegetation cover along an aridity gradient in Patagonia. Oecologia 108: 503–511. doi: 10.1007/bf00333727

Scolaro JA (1976a) Fauna herpetológica de algunas islas del litoral de Chubut. Physis 35: 273–277.

Scolaro JA (1976b) Lista sistemática de reptiles de la Península de Valdés (Chubut). Physis 35: 267–271.

Scolaro JA (1990) Geographic distribution: *Chelonia mydas*. Herpetological Review 21: 24.

Scolaro JA (1993) *Liolaemus elongatus petrophilus* (Stone-loving Lizard). Herpetological Review 24: 109.

Scolaro JA (2003) Una excepcional nueva especie de *Phymaturus* de la precordillera de Chubut, Argentina (Liolaemidae, Iguania, Lacertilia, Reptilia). Facena 19: 107–112.

Scolaro JA (2005) Reptiles Patagónicos Sur: una guía de Campo. Universidad Nacional de la Patagonia, Trelew, 80 pp.

Scolaro JA (2006) Reptiles Patagónicos Norte: una guía de campo. Universidad Nacional de la Patagonia San Juan Bosco, Comodoro Rivadavia, 112 pp.

Scolaro JA, Cei JM (1979) The southernmost population of *Elapomorphus bilineatus* in Argentine Patagonia. Copeia 4: 745–747. doi: 10.2307/1443887

Scolaro JA, Cei JM (1987) A multivariate analysis of morphometric and exosomatic characters of iguanid lizards of the Patagonian *Liolaemus kingi* complex. Journal of Herpetology 21: 343–348. doi: 10.2307/1563981

Scolaro JA, Cei JM (1997) Systematic status and relationships of *Liolaemus* species of the *archeforus* and *kingii* groups: a morphological and taxonumerical approach (Reptilia: Tropiduridae). Bollettino del Museo Regionale di Scienze Naturali di Torino 15: 369–406.

Scolaro JA, Cei JM, Arias de Reyna L (1985) La identidad de las especies del grupo *Liolaemus fitzingeri - melanops* por medio del análisis discriminante de caracteres morfológicos (Sauria: Iguanidae). Historia Natural 5: 13–22.

Scolaro JA, Ibargüengoytía NR (2007) A new species of *Phymaturus* from rocky outcrops in the central steppe of Rio Negro province, Patagonia Argentina (Reptilia: Iguania: Liolaemidae). Zootaxa 1524: 47–55.

Scolaro JA, Jara M, Pincheira-Donoso D (2013) The sexual signals of speciation? A new sexually dimorphic *Phymaturus* species of the *patagonicus* clade from Patagonia Argentina. Zootaxa 3722: 317–332. doi: 10.11646/zootaxa.3722.3.2

Scolaro JA, Pincheira-Donoso D (2010) Lizards at the end of the world: Two new species of *Phymaturus* of the *patagonicus* clade (Squamata, Liolaemidae) revealed in southern Patagonia of Argentina. Zootaxa 2393: 17–32.

Scolaro JA, Tapari FO, González C (2005) *Phymaturus calcogaster*: rectificación de la localidad tipo y descripción de la hembra (Reptilia, Iguania, Liolaemidae). Facena 21: 29–36.

Scoppa CA (1998) Los suelos. In: Correa MN (Ed.) Flora Patagónica. Colección científica del INTA, Buenos Aires, Argentina, 15–30.

Scott Jr NJ, Giraudo AR, Scrocchi G, Aquino AL, Cacciali P, Motte M (2006) The genera *Boiruna* and *Clelia* (Serpentes: Pseudoboini) in Paraguay and Argentina. Papéis Avulsos de Zoologia (São Paulo) 46: 77–105. doi: 10.1590/s0031-10492006000900001

Sinervo B, Méndez de la Cruz F, Miles DB, Heulin B, Bastiaans E, Villagrán Santa Cruz M, Lara Resendiz R, Martinez Méndez N, Calderón Espinosa ML, Meza Lazaro RN, Gadsden H, Avila LJ, Morando M, De la Riva IJ, Sepúlveda PV, Rocha CFD, Ibarguengoytía N, Puntriano CA, Massot M, Lepetz V, Oksanen TA, Chapple DG, Bauer AM, Branch

WR, Clobert J, Sites JW (2010) Erosion of lizard diversity by climate change and altered thermal niches. Science 328: 894–899. doi: 10.1126/science.1184695

Teruggi ME (1998) Los materiales originarios de los suelos. In: Correa MN (Ed.) Flora Patagónica. Colección científica del INTA, Buenos Aires, Argentina, 3–14.

Victoriano PF, Coronado TM, Ortiz JC (2010) A multivariate analysis of taxonomic limits in *Diplolaemus* Bell 1843. Gayana 74: 23–26. doi: 10.4067/s0717-65382010000100006

Wallach V, Williams KL, Boundy J (2014) Snakes of the World: A Catalogue of Living and Extinct Species. CRC Press, 1260 pp. doi: 10.1201/b16901

White D (2000) Global grids from recursive diamond subdivisions of the surface of an octahedron or icosahedron. Environmental Monitoring and Assessment 64: 93–103. doi: 10.1023/A:1006407023786

White D, Kimerling JA, Overton SW (1992) Cartographic and geometric components of a global sampling design for environmental monitoring. Cartography and Geographic Information Systems 19: 5–22. doi: 10.1559/152304092783786636

Williams JD (1997) *Liolaemus lineomaculatus* (Sauria: Tropiduridae). Primera cita para la provincia de Chubut, Argentina. Cuadernos de Herpetología 11: 88–89.

Yfantis EA, Flatman GT, Behar JV (1987) Efficiency of kriging estimation for square, triangular, and hexagonal grids. Mathematical Geology 19: 183–205. doi: 10.1007/BF00897746

Yoke MM, Morando M, Avila LJ, Sites Jr JW (2006) Phylogeography and genetic structure in the *Cnemidophorus longicauda* complex (Squamata, Teiidae). Herpetologica 62: 420–434. doi: 10.1655/0018-0831(2006)62[424:pagsit]2.0.co;2

Zaher H, Grazziotin FG, Cadle JE, Murphy RW, Moura-Leite JC, Bonatto SL (2009) Molecular phylogeny of advanced snakes (Serpentes, Caenophidia) with an emphasis on South American Xenodontines: a revised classification and descriptions of new taxa. Papéis Avulsos de Zoologia (São Paulo) 49: 115–153. doi: 10.1590/s0031-10492009001100001

Supplementary material 1

Specimens examined from LJAMM-CNP herpetological collection

Authors: Ignacio Minoli, Mariana Morando, Luciano Javier Avila

Data type: Portable Document Format (pdf).

Explanation note: Specimens examined from LJAMM-CNP herpetological collection, museum voucher and bibliography data for the reptile's distribution in Chubut province, Patagonia, Argentina. Additional figures of the results section.

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RESEARCH ARTICLE

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A new species of *Hisonotus* (Siluriformes, Loricariidae) from rio São Francisco basin, Brazil

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Abstract

A new species of *Hisonotus* is described from the rio São Francisco basin. The new species can be distinguished from congeners by having (1) a unique coloration pattern of caudal fin with one black spot extending from its origin to the ventral lobe and two dark spots at the end of the lobe's rays; (2) odontodes forming longitudinally aligned rows on head and trunk; (3) a functional *V*-shaped spinelet; (4) a single rostral plate at the tip of the snout; (5) by lacking contrasting dark geometric spots on the anterodorsal region of the body; (6) a lower caudal-peduncle depth; and (7) lower counts of the lateral median plates and (8) higher premaxillary and dentary teeth. The new species is the second described species of the genus *Hisonotus* in the rio São Francisco basin. It was found inhabiting the marginal vegetation of the rio São Francisco and three of its tributary, rio das Velhas, rio Paraopeba and rio Formoso.

Keywords

Cascudinhos, Fresh-Water, Minas Gerais State, Neotropical Fish, Otothyrinae

Introduction

Loricariidae is one of the largest and most diverse families of Neotropical freshwater fish with about 900 valid species (Eschmeyer and Fong 2014). The loricariids are subdivided into seven subfamilies: Delturinae, Hypoptopomatinae, Hypostominae, Lithogeninae, Loricariinae, Neoplecostominae, and Otothyrinae (Armbruster 2004; Reis et al. 2006; Chiachio et al. 2008; Roxo et al. 2014a). Currently, Otothyrinae (sensu Chiachio et al. 2008 and Roxo et al. 2014a) is composed of about 100 valid species classified in twelve genera (Eschmeyer 2014).

Within the Otothyrinae, the genus *Hisonotus* Eigenmann & Eigenmann, 1889 (type species *H. notatus* Eigenmann & Eigenmann, 1889) was resurrected by Schaefer (1998) with the following combination of characters: snout plates in the anterior portion of the nostril reduced or absent, the rostrum having enlarged odontodes, and the lateral rostral margin composed of thickened plates. However, Britski and Garavello (2007) considered the rostrum with enlarged odontodes as a character very polymorphic and present in several other genera and species of Otothyrinae, as in species of *Parotocinclus* Eigenmann & Eigenmann, 1889. Furthermore, Britski and Garavello (2007) suggested that the other two characters are not satisfactory to define the genus *Hisonotus*.

Currently, *Hisonotus* contains 34 valid species, 19 of which were described in the past decade (Eschmeyer 2014), representing an increase of 127% of the diversity of this genus. Herein, we add a new species to the genus *Hisonotus* found during recent collection expeditions to the rio São Francisco basin. This is the second species of the genus described from this hydrographic system.

Material and methods

Measurements and counts were taken from the left side of the fish, and were made from point to point to the nearest 0.1 mm with a digital caliper. Abbreviations used in the text and the measurements followed Carvalho and Reis (2009). Specimens were cleared and double stained (c&s) according to the method of Taylor and Van Dyke (1985). Vertebral counts also include the five vertebrae that comprise the Weberian apparatus and the compound caudal centrum (PU1 + U1) as one element. Dorsal-fin ray counts include the spinelet as the first unbranched ray. Institutional acronyms follow Fricke and Eschmeyer (2014). Specimens are deposited at the LBP, Laboratório de Biologia e Genética de Peixes, Universidade Estadual Paulista, Botucatu; MZUSP, Museu de Zoologia, Universidade de São Paulo, São Paulo. Zoological nomenclature follows the International Code of Zoological Nomenclature (International Commission on Zoological Nomenclature 1999).

Results

Hisonotus vespuccii **sp. n.**
http://zoobank.org/CD9657F5-3F02-4B32-BF89-24AF86020201
Figure 1, 3; Table 1

Holotype. MZUSP 115274 (female 32.6 mm SL) Brazil, Minas Gerais State, municipality of Pirapora, rio São Francisco, 17°21'00"S, 44°57'08"W, 11 November 2014, LE Ochoa, FF Roxo, LH Roxo, GSC Silva.

Figure 1. Holotype of *H. vespuccii*, MZUSP 115274, female, 32.6 mm SL, from Minas Gerais State, municipality of Pirapora, rio São Francisco, 17°21'00"S, 44°57'08"W.

Paratypes. All from Brazil, Minas Gerais State, rio São Francisco basin (249 specimens in total). LBP 8960 (4 females 32.3–35.8 mm SL, 3 males 27.0–28.2 mm SL), municipality of Presidente Juscelino, rio das Velhas, 18°40'21"S, 44°11'33"W, 01 October 2009, C Oliveira, FF Roxo, GJC Silva, BF Melo. LBP 10421 (9 females 27.7–30.3 mm SL, 9 males 23.6–26.5 mm SL, 5 c&s sex not determined 20.2–29.6 mm SL), municipality of Pirapora, rio São Francisco, 17°21'00"S, 44°57'08"W, 15 July 2010, JA Senhorini, M Mehanna. LBP 19491 (9 females 19.9–32.4 mm SL, 12 males 21.1–27.9 mm SL, 1 female c&s 32.6 mm SL, 1 male c&s 27.7 mm SL), collected with holotype. LBP 19495 (1 female 32.6 mm SL, 1 male 28.7 mm SL), municipality of Presidente Juscelino, rio das Velhas, 18°40'21"S, 44°11'33"W, 11 November 2014, LE Ochoa, FF Roxo, LH Roxo, GSC Silva. MZUSP 39208 (5 sex not determined 23.8–30.0 mm SL), rio São Francisco, 29 November 1987, Y Sato (UHE Formoso project). MZUSP 39280, (3 sex not determined 28.4–30.2 mm SL), rio São Francisco, 20 January 1988, Y Sato (UHE Formoso project). MZUSP 39351 (33 sex not determined 16.5–34.4

mm SL), rio São Francisco, 23 January 1988, Y Sato (UHE Formoso project). MZUSP 39446 (9 sex not determined 22.9–30.5 mm SL), rio Formoso, 08 February 1988, Y Sato (UHE Formoso project). MZUSP 39482 (1 sex not determined 24.5 mm SL), rio Formoso, 08 to 10 February 1988, Y Sato (UHE Formoso project). MZUSP 39511 (1 sex not determined 30.4 mm SL), córrego Marambaia, rio São Francisco, 09 February 1988, Y Sato (UHE Formoso project). MZUSP 51507 (2 sex not determined 25.6–31.3 mm SL), municipality of Fortuna de Minas, rio Paraopeba, 13 July 1995, CBM Alves. MZUSP 57587 (110 sex not determined 20.8–33.6 mm SL), street between municipalities of Itacarambí and Manga, córrego das Missões, 15 July 1993, RE Reis. MZUSP 57588 (7 sex not determined 20.2–24.9 mm SL), street between municipalities of Manga and Montalvânia, rio Japuré, rio São Francisco, 15 July 1993, RE Reis. MZUSP 57590 (20 sex not determined 22.8–31.4 mm SL), municipality of Januária, rio São Francisco, 15°29'25"S, 44°21'50"W, 14 July 1993, JC Garavello. MZUSP 57591 (3 sex not determined 23.1–26.5 mm SL), street between municipalities of Manga and Montalvânia, rio Calindó, rio São Francisco, 15 July 1993, RE Reis.

Diagnosis. *Hisonotus vespuccii* differs from the congeners by having a unique coloration pattern of caudal fin with one black spot extending from its origin to the ventral lobe and two dark spots at the end of the lobe`s rays and the following combination of character states (none is unique): odontodes forming longitudinally aligned rows (one odontode after the other, but not necessarily forming parallel series) on head and trunk; a functional *V*-shaped spinelet; the presence of a single rostral plate at tip of the snout; the lack of contrasting dark geometric spots on the anterodorsal region of the body; a low caudal peduncle (depth 6–8% SL); few lateral median plates (21–23); and numerous premaxillary and dentary teeth (13–21 and 11–21, respectively).

Description. Counts and measurements are presented in Table 1. Maximum body size 35.7 mm SL. Dorsal profile of head, in lateral view, slightly convex from snout tip to margin of posterior naris; strongly convex to posterior margin of parieto-supraoccipital; and almost straight to dorsal-fin origin. Dorsal profile of trunk, in lateral view, straight and descending from dorsal-fin origin to insertion of caudal-fin. Ventral profile, in lateral view, straight from snout tip to anal-fin origin; concave and ascending to caudal-fin insertion. Greatest body depth at dorsal-fin origin (14–18% SL). Greatest body width at cleithral region (21–25% SL), progressively narrowing towards to both snout and caudal fin. Cross-section of body between pectoral and pelvic fins dorsally rounded and ventrally flat; cross-section of caudal peduncle ellipsoid, rounded laterally and almost flat dorsally and ventrally.

Head rounded in dorsal view; snout round and slightly pointed. Dorsal and ventral series of odontodes along anterior margin of snout completely covering its tip; odontodes larger than remaining ones on head. Odontodes on head and trunk hypertrophied and arranged in longitudinal rows. Head without conspicuous crests. Some specimens with a poor developed tuft of odontodes in posterior portion of parieto-supraoccipital. Eyes small (13–17% HL), dorsolaterally positioned. Iris operculum present and developed. Premaxillary teeth 13–21; dentary teeth 11–21. Teeth bifid, major

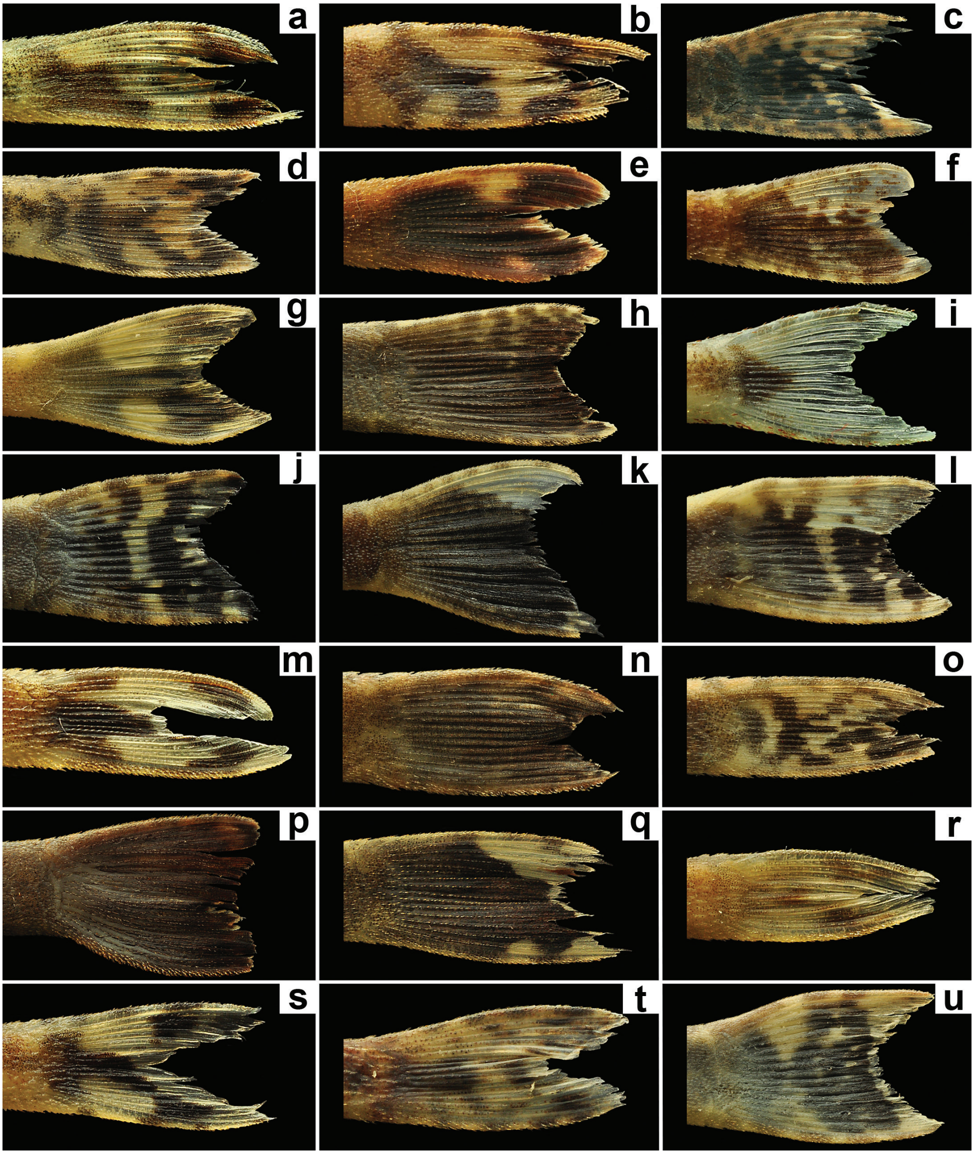

Figure 2. Coloration pattern of caudal fin of *Hisonotus* species. **a** *H. vespuccii*, LBP 19491, 26.2 mm SL **b** *H. acuen*, LBP 16279, 26.1 mm SL **c** *H. armatus*, LBP 14461, 38.2 mm SL **d** *H. bocaiuva*, LBP 17402, 24.8 mm SL **e** *H. chromodontus*, LBP 7964, 27.6 mm SL **f** *H. depressicauda*, LBP 1293, 26.1 mm SL **g***H. francirochai*, LBP 8356, 31.6 mm SL **h** *H. heterogaster*, LBP 14580, 38.7 mm SL **i** *H. insperatus*, LBP 17432, 26.9 mm SL **j** *H. iota*, LBP 13072, 41.5 mm SL **k** *H. leucofrenatus*, LBP 2039, 40.7 mm SL **l** *H. leucophrys*, LBP 13071, 41.1 mm SL **m** *H. luteofrenatus*, LBP 19534, 30.5 mm SL **n** *H. megaloplax*, LBP 13108, 35.8 mm SL **o** *H. montanus*, LBP 13055, 31.8 mm SL **p** *H. nigricauda*, LBP 14652, 38.5 mm SL **q** *H. notatus*, LBP 18472, 32.0 mm SL **r** *H. oliveirai*, LBP 13333, 24.0 mm SL **s** *H. paresi*, LBP 13351, 24.6 mm SL **t** *H. piracanjuba*, LBP 17256, 22.1 mm SL **u** *H. vireo*, LBP 14452, 35.5 mm SL.

Table 1. Morphometrics and meristic data for *Hisonotus vespuccii*, holotype and paratypes measured are from LBP fish collection.

Character	**Holotype**	**Males, n = 21**			**Females, n = 24**			**All paratypes, n = 45**	
		Range	**Mean**	**SD**	**Range**	**Mean**	**SD**	**Mean**	**SD**
SL	**32.6**	**24.1–28.7**	**26.2**	**1.4**	**24.4–35.7**	**30.2**	**2.8**	**28.3**	**3.0**
Percents of SL									
Head length	33.1	34.1–37.6	36.1	0.8	32.7–38.1	35.6	1.3	35.8	1.1
Predorsal length	44.5	44.2–47.3	45.8	0.8	44.1–48.6	46.1	1.2	46.0	1.0
Dorsal-fin spine length	22.6	22.6–27.2	24.6	1.3	19.5–25.4	23.2	1.1	23.8	1.4
Anal-fin unbranched ray length	15.5	16.0–19.2	17.4	0.8	14.9–18.1	16.1	0.7	16.7	1.0
Pectoral-fin spine length	23.9	23.9–29.1	26.0	1.3	23.1–27.7	25.2	1.1	25.6	1.3
Pelvic-fin unbranched ray length	16.9	17.3–21.5	19.3	1.0	15.1–18.5	16.8	0.8	18.0	1.5
Cleithral width	21.5	22.3–24.3	23.2	0.5	21.2–24.9	23.0	0.8	23.1	0.6
Thoracic length	18.0	15.2–18.3	16.5	0.7	14.9–18.4	16.7	0.9	16.6	0.8
Abdominal length	22.6	20.7–23.1	21.6	0.5	20.1–24.6	22.5	1.1	22.1	1.0
Body depth at dorsal-fin origin	14.7	14.0–17.7	15.7	0.9	14.3–17.5	15.9	0.8	15.8	0.9
Caudal-peduncle length	39.0	36.7–40.3	38.6	0.8	34.0–39.4	37.3	1.2	37.9	1.2
Caudal-peduncle depth	6.2	6.9–8.0	7.4	0.3	6.2–7.9	7.0	0.4	7.2	0.4
Nares opening	12.5	12.9–18.0	15.3	1.3	9.6–12.5	11.1	0.7	13.0	2.3
Percents of HL									
Snout length	48.8	45.8–50.6	48.7	1.2	45.5–50.3	48.9	1.1	48.8	1.2
Orbital diameter	16.1	13.5–16.6	15.5	0.7	13.4–16.9	14.9	0.9	15.2	0.9
Interorbital width	36.1	35.1–38.7	37.1	0.9	34.1–39.0	36.2	1.3	36.6	1.2
Head depth	40.5	39.0–45.0	42.0	1.5	38.6–47.2	42.5	1.9	42.3	1.7
Suborbital depth	17.2	14.9–18.8	16.6	0.9	14.9–20.3	17.0	1.6	16.8	1.3
Mandibular ramus	9.7	8.1–10.5	9.3	0.6	8.3–15.6	9.6	1.4	9.5	1.1
Meristics									
Left lateral scutes	22	21–23	22	-	21–23	22	-	22	-
Left premaxillary teeth	19	15–21	17	-	13–21	19	-	17	-
Left dentary teeth	19	11–19	14	-	13–21	16	-	16	-

(medial) cusp large and rounded, minor (lateral) cusp minute and pointed. Accessory patch of teeth absent on dentary and premaxilla. Oral disk oval, covered with papillae uniformly distributed on base of dentary and premaxilla and slightly decreasing in size distally. Lower lip larger than upper lip; its border fringed. Maxillary barbel present and joined to lower lip. Presence of conspicuous *V*-shaped buccal papilla located immediately anterior to buccal valve. Tip of snout with large rostral plate.

Dorsal fin II,7; its origin slightly posterior to pelvic-fin origin. Tip of adpressed dorsal fin surpassing vertically through end of anal-fin origin. Dorsal-fin spinelet short and *V*-shaped; dorsal-fin lock functional. Pectoral fin I,6; its tip reaching middle of pelvic-fin length when depressed. Pectoral-axillary slit present between pectoral-fin insertion and lateral process of cleithrum. Pectoral spine supporting sharp odontodes on dorsal and ventral surfaces (well developed posteriorly). Pelvic fin I,5; its tip reach-

Figure 3. Live specimen of *H. vespuccii*, LBP 19491, paratype, 32.4 mm SL, from Minas Gerais State, municipality of Pirapora, rio São Francisco.

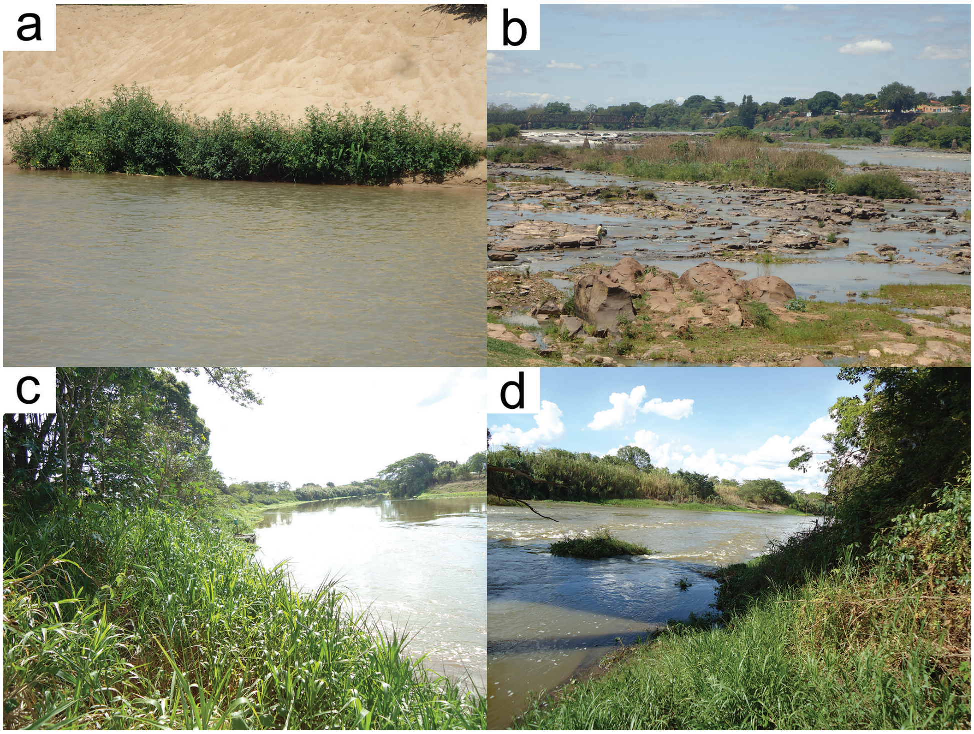

Figure 4. (a) (b) Type locality of *H. vespuccii* at rio São Francisco, municipality of Pirapora, Minas Gerais State, 17°21'00"S, 44°57'08"W. (c) (d) Paratypes locality of *H. vespuccii* at rio das Velhas, municipality of Presidente Juscelino, Minas Gerais State, 18°40'21"S, 44°11'33"W. Photo: LH Roxo.

ing anal-fin origin when depressed in males and far from reaching anal-fin origin in females. Pelvic-fin unbranched ray with dermal flap along its dorsal surface in males. Pectoral spine supporting sharp odontodes on ventral surface turned mesially.

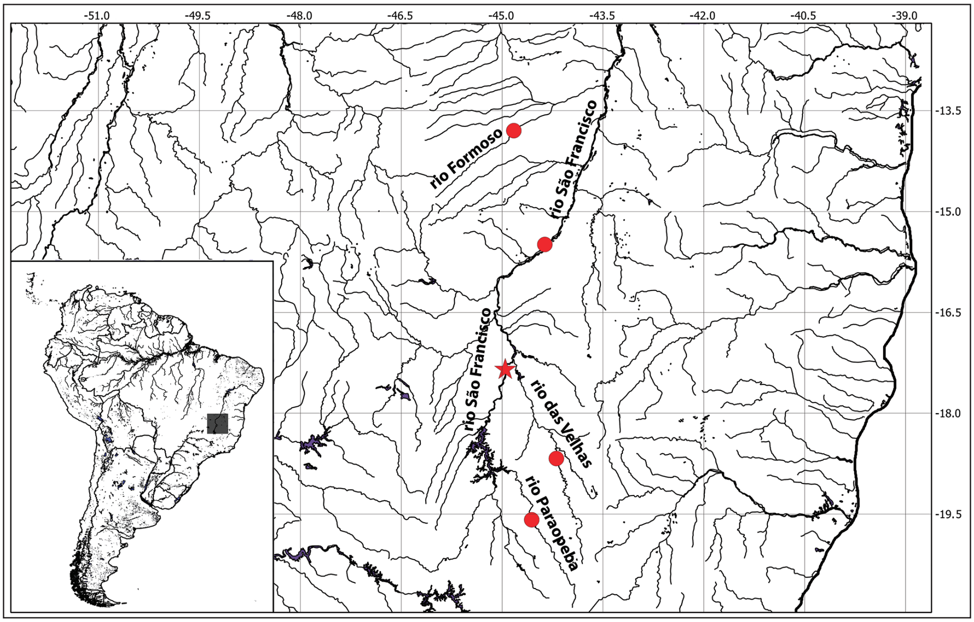

Figure 5. Map of the distribution of *H. vespuccii*. Red Star = type locality, at rio São Francisco, municipality of Pirapora, Minas Gerais State. Red Circles = paratypes localities of *H. vespuccii* at rio das Velhas, rio Paraopeba and rio Formoso, Minas Gerais State.

Anal fin i,5; its tip reaching seventh or eighth plate from its origin. Caudal-fin i,7–7,I; distal margin forked. Adipose fin absent. Total vertebrae 27 (in 7 c&s specimens). Body almost entirely covered by bone plates, except on ventral portion of head, around pectoral- and pelvic-fin origins, on dorsal-fin base and area around anus. Abdomen partially covered by bony plates randomly distributed and surrounded by naked areas (in some specimens abdomen is completely covered by bony plates). Laterally, body completely covered by plates; mid-dorsal and mid-ventral plate series well developed reaching vertical through half of caudal peduncle; median plate series continuous in median portion of body. Coracoid and cleithrum completely exposed, covered with odontodes. Arrector fossae partially enclosed by ventral lamina of coracoids.

Color in alcohol. Ground color of dorsal surface of head and body dark gray to lighter brown (juveniles lighter than adults). Ventral surface light brown to yellow in juveniles. All body and fins covered by scattered chromatophores, more visible on ventral portions and around fins insertions (Fig. 1). Caudal-fin hyaline, except for one black spot at its origin extending to ventral lobe and two dark spots at end of rays (Fig. 2a). In some specimens, caudal-fin with chromatophores irregular distributed and sometimes badly forming two dark strips (more visible in juveniles). Neither variation nor variability of caudal-fin coloration patter found in samples we examined (holotype and 249 specimens widely distributed in rio São Francisco basin) with specific emphasis to variability between populations and variation depending on feeding.

Color in life. Similar to pattern described for alcohol individuals, but with ground color light green (Fig. 3).

Sexual dimorphism. Adult males distinguished from females by five characters: (1) presence of a papilla at urogenital opening in males (*vs.* papilla absent in females); (2) pelvic-fin extending beyond anal-fin origin in males, mean 19% SL (*vs.* pelvic fin far from reaching anal-fin origin in females, mean 17% SL); (3) unbranched pelvic-fin ray supporting a dermal flap (flap slightly wider in basal portion and progressively narrowing distally) on proximal dorsal surface in males (*vs.* dermal flap absent in females); (4) nares opening wider in males (13–18% HL) than females (10–13% HL); (5) body size smaller in males (mean 26 mm SL) and larger in females (mean 30 mm SL). See Table 1 for values of morphometric characters between males and females.

Habitat and distribution. *Hisonotus vespuccii* was found associated with marginal vegetation (Fig. 4) in the rio São Francisco and in three of its tributaries, rio das Velhas, rio Paraopeba and rio Formoso (Fig. 5). The new species seems to be abundant through all rio São Francisco basin.

Etymology. The specific name "vespuccii" comes from Italian and is in reference to Américo Vespúcio (Amerigo Vespucci in Italian), navigator and explorer to whom is attributed the discovery of the rio São Francisco in 1501.

Comparative remarks and discussion

The new species *H. vespuccii* has one character proposed by Schaefer (1998) to diagnose the genus *Hisonotus*: the rostrum with enlarged odontodes. Moreover, the new species also shares three characters with many species of *Hisonotus*: a single rostral plate on the tip of the snout, an arrector fossae partially enclosed by a ventral lamina of the coracoid, a character also used by Schaefer (1998) as synapomorphy of all Otothyrini except the New Taxon 3, and a functional *V*-shaped spinelet. This last character was firstly proposed by Carvalho and Datovo (2012) with pers. comm. of Roberto E. Reis, and posteriorly was reported by Silva et al. (2014) as a possible synapomorphy that may help delimit a new genus within *Hisonotus*. However, to better understand the relationship of the new species with other species assigned to *Hisonotus* a phylogenetic analysis is still necessary.

We used seven characters to distinguish the new species *H. vespuccii* from congeners. The first character was the caudal fin with one black spot extending from its origin to the ventral lobe and two dark spots at the end of the lobe's rays, a pattern unique among *Hisonotus* species (see Fig. 2b–u for caudal-fin coloration pattern of some species of *Hisonotus*). Britski and Garavello (2007) discussing about the coloration pattern of the teeth in *H. chromodontus* Britski & Garavello, 2007 suggested that this aspect of the organism could be a result of physiological features changing according to the individual's foraging success and physiological efficiency, as well as according to the characteristics of the water where the species lives. However, the pattern of caudal-fin coloration seems to be conserved among species of *Hisonotus* (Fig. 2), with a pattern varying more drastically in *H. acuen* Silva, Roxo & Oliveira, 2014, a species widely distributed through headwaters of the rio Xingu basin (see Fig. 5 in Silva et al. 2014). In *H. vespuccii*, the pattern of the caudal-fin with one black spot extending from its origin to the ventral lobe and two dark spots at the end of the lobe`s rays is present in the holotype and the 249 paratypes analyzed.

Moreover, the new species *H. vespuccii* was distinguished from congeners by present a combination of the following characters: (2) odontodes forming longitudinally aligned rows (one odontode after the other, but not necessarily forming parallel series) on head and trunk, a character shared with *H. insperatus*, *H. luteofrenatus*, *H. oliveirai*, and *H. paresi*; (3) a functional *V*-shaped spinelet as reported previously (see Fig. 2 in Silva et al. 2014 to description of this character state) shared with *H. acuen*, *H. bockmanni*, *H. chromodontus*, *H. insperatus*, *H. luteofrenatus*, *H. oliveirai*, *H. paresi*, and *H. piracanjuba*; (4) the presence of a single rostral plate at tip of the snout, a character also present in *H. insperatus*, *H. luteofrenatus*, *H. oliveirai*, *H. paresi*, and *H. piracanjuba*; (5) the lacking of contrasting dark geometric spots on the anterodorsal region of the body, a character used to distinguish the new species of *H. bockmanni* and *H. paresi*; (6) a lower caudal-peduncle depth (6.2–8.0% of SL) used to distinguish the new species of *H. acuen* (8.6–11.1% of SL); and (7) lower counts of the lateral median plates (21–23) and higher counts of premaxillary (13–21) and dentary teeth (11–21) used to distinguish *H. vespuccii* of *H. insperatus* (25–26; 10–12; 8–11, respectively).

Members of Loricariidae are known to have intense sexual dimorphisms (Py-Daniel and Fernandes 2005) as we can observe in species of the genera *Ancistrus* Kner, 1854 (Sabaj et al. 1999), *Neoplecostomus* Eigenmann & Eigenmann, 1888 (Zawadzki et al. 2008; Roxo et al. 2012; Andrade and Langeani 2014), *Pareiorhaphis* Miranda Ribeiro, 1918a (Pereira et al. 2007), *Hisonotus* (Martins and Langeani 2012), *Hypostomus* Lacepède, 1803 and *Chaetostoma* Tschudi, 1846 (Nomura and Mueller 1980; Lopez and Roman-Valencia 1996), *Farlowella* Eigenmann & Eigenmann, 1889 (Retzer and Page 1996) and many other. In *H. vespuccii*, we observed five sexual dimorphic characters: the presence of a papilla at the urogenital opening, a pelvic-fin that extends beyond the anal-fin origin, the unbranched pelvic-fin ray supporting a dermal flap on their proximal dorsal surface, the nares opening wider and a body size that seems to be smaller in males than in females. The first three characters are very common among species of *Hisonotus*, however differences in size of nares were only previously reported in the original description of *H. piracanjuba* (Martins and Langeani 2012) and differences in body size in *H. ringueleti* (Aquino et al. 2001). Carvalho and Reis (2009) reported that the presence of the dermal flap on proximal dorsal surface of pelvic-fin on males is a plesiomorphic character shared among most members of Otothyrinae and that the derived condition evolved several times within this subfamily at the genera *Schizolecis* Britski & Garavello, 1984, *Epactionotus* Reis & Schaefer, 1998, and within Hypoptopomatinae in *Acestridium* Haseman, 1911, *Oxyropsis* Eigenmann & Eigenmann, 1889 and *Hypoptopoma* Günther, 1868.

Comparative material

All from Brazil, except when stated otherwise.

Hisonotus acuen Silva, Roxo & Oliveira, 2014: MZUSP 115350, 1, 25.9 mm SL, holotype, tributary of rio Toguro, Querência, Mato Grosso State; LBP 15755, 16, 19.5–26.0 mm SL, paratypes, tributary of rio Suiá-Missu, ribeirão Cascalheira, Mato Grosso State; LBP 16274, 27, 20.2–29.1 mm SL, 2 c&s, 23.6–24.2 mm SL, paratypes, tributary of rio Culuene, Gaúcha do Norte, Mato Grosso State; LBP 16275, 29, 16.7–25.2 mm SL, 2 c&s, 19.3–20.8 mm SL, paratypes, tributary of rio Feio, Querência, Mato Grosso State; LBP 16278, 12, 18.8–25.1 mm SL, 2 c&s, 26.8–27.1 mm SL, paratypes, córrego Xavante, Primavera do Leste, Mato Grosso State.

Hisonotus aky (Azpelicueta, Casciotta, Almirón & Koerber, 2004): MHNG 2643.039, 2, 33.1–34.2 mm SL, paratypes, arroio Fortaleza, Argentina.

Hisonotus armatus Carvalho, Lehmann, Pereira & Reis, 2008: MZUSP 93884, 5, 37.6–44.4 mm SL, paratypes, arroio Arambaré, Pedro Osório, Rio Grande do Sul State.

Hisonotus bocaiuva Roxo, Silva, Oliveira & Zawadzki, 2013: MZUSP 112204, 1, 24.2 mm SL, holotype, córrego Cachoeira, Bocaiúva, Minas Gerais State; LBP 9817, 9, 3 c&s, 18.3–23.2 mm SL, paratypes, córrego Cachoeira, Bocaiúva, Minas Gerais State.

Hisonotus brunneus Carvalho & Reis, 2011: MZUSP 104947, 4, 37.2–41.3 mm SL, paratypes, rio Passo Novo, Cruz Alta, Rio Grande do Sul State.

Hisonotus carreiro Carvalho & Reis, 2011: MCP 40943, 3, 33.6–35.8 mm SL, arroio Guabiju, Guabiju, Rio Grande do Sul State.

Hisonotus charrua Almirón, Azpelicueta, Casciotta & Litz, 2006: LBP 4861, 1, 35.9 mm SL, arroio Guaviyú, Artigas, Uruguay; MHNG 2650.051, 1, 34.2 mm SL, paratype, arroio Aspinillar, Uruguay.

Hisonotus chromodontus Britski & Garavello, 2007: LBP 7964, 25, 24.0–28.3 mm SL, 4 c&s, 24.9–28.9 mm SL, rio dos Patos, Nova Mutum, Mato Grosso State; LBP 7974, 26, 17.7–24.8 mm SL, rio dos Patos, Nova Mutum, Mato Grosso State; LBP 12278, 2, 26.7–28.7 mm SL, 1 c&s, 26.7 mm SL, rio Sumidouro, Tangará da Serra, Mato Grosso State; MZUSP 45355, 1, 25.9 mm SL, holotype, tributary of rio Preto, Diamantino, Mato Grosso State; MZUSP 70758, 7, 19.4–23.9 mm SL, paratype, riacho Loanda, Sinop, Mato Grosso State; NUP 10924, 24, 19.5–31.5 mm SL, rio Preto, Diamantino, Minas Gerais State.

Hisonotus depressicauda (Miranda Ribeiro, 1918b): MZUSP 5383, 1, 24.4 mm SL, paralectotype, Sorocaba, São Paulo State; LBP 17474, 5 c&s, 18.1–24.0 mm SL, rio Araquá, Botucatu, São Paulo State.

Hisonotus francirochai (Ihering, 1928): LBP 13923, 22, 25.7–35.7 mm SL, córrego sem nome, Capetinga, Minas Gerais State; MZUSP 3258, 1, 29.4 mm SL, lectotype, rio Grande, São Paulo State.

Hisonotus heterogaster Carvalho & Reis, 2011: LBP 3335, 39, 20.8–30.1 mm SL, arroio sem nome, rio Grande, Rio Grande do Sul State; MZUSP 104948, 3, 40.3–43.0 mm SL, paratypes, arroio Felício, Júlio de Castilho, Rio Grande do Sul State.

Hisonotus insperatus Britski & Garavello, 2003: LBP 4945, 5, 27.3–28.5 mm SL, 2 c&s, 28.2–29.9 mm SL, Botucatu, São Paulo State; LBP 6770, 5, 25.1–28.2 mm SL, 3 c&s, 20.0–27.0 mm SL, ribeirão Cubatão, Marapoama, São Paulo State; LBP 13336, 1 c&s, 26.0 mm SL, rio Capivara, Botucatu, São Paulo State; LBP 13337, 2 c&s, 27.4–28.6 mm SL, rio Araquá, Botucatu, São Paulo State; MZUSP 22826, 1, 25.4 mm SL, paratype, córrego Água Tirada, Três Lagoas, Minas Gerais State; MZUSP 24832, 1, 23.8 mm SL, paratype, rio Corumbataí, Corumbataí, São Paulo State; MZUSP 78957, 1, 29.6 mm SL, holotype, rio Capivara, Botucatu, São Paulo State; MZUSP 78960, 31, 12.6–26.0 mm SL, paratypes, 5 c&s, 22.7–24.7 mm SL, rio Pardo, Botucatu, São Paulo State; MZUSP 78965, 10, 15.6–28.6 mm SL, paratypes, rio Araquá, Botucatu, São Paulo State; MZUSP 78968, 5, 24.1–27.3 mm SL, paratypes, córrego da Figueira, Lins, São Paulo State.

Hisonotus iota Carvalho & Reis, 2009: LBP 13072, 5, 32.3–33.0 mm SL, rio Chapecó, Coronel Freitas, Santa Catarina State.

Hisonotus laevior Cope, 1894: LBP 3377, 1, 25.2 mm SL, arroio dos Corrientes, Pelotas, Rio Grande do Sul State; LBP 6037, 8, 33.4–47.0 mm SL, rio Maquiné, Osório, Rio Grande do Sul State; LBP 13187, 7, 19.4–45.8 mm SL, córrego sem nome, Camaquá, Rio Grande do Sul State.

Hisonotus leucofrenatus (Miranda Ribeiro, 1908): LBP 2085, 7, 38.3–50.6 mm SL, rio Sagrado, Morretes, Paraná State; LBP 6837, 36, 35.1–43.5 mm SL, rio Fau, Miracatu, São Paulo State.

Hisonotus leucophrys Carvalho & Reis, 2009: LBP 13065, 6, 17.2–33.6 mm SL, rio Ariranhas, Xavantina, Santa Catarina State; LBP 13073, 1, 36.8 mm SL, rio Guarita, Palmitinho, Rio Grande do Sul State.

Hisonotus luteofrenatus Britski & Garavello, 2007: MZUSP 62593, 1, 28.6 mm SL, holotype, córrego Loanda, Cláudia, Mato Grosso State; MZUSP 62594, 8, 22.4–30.5 mm SL, paratypes, riacho Selma, Sinop, Mato Grosso State; MZUSP 87144, 8, 16.8–27.9 mm SL, paratypes, córrego Loanda, Cláudia, Mato Grosso State.

Hisonotus megaloplax Carvalho & Reis, 2009: LBP 13108, 6, 36.4–37.8 mm SL, córrego sem nome, Saldanha Marinho, Rio Grande do Sul State.

Hisonotus montanus Carvalho & Reis, 2009: LBP 13051, 3, 26.4–27.2 mm SL, rio Goiabeiras, Vargem, Santa Catarina State; LBP 13055, 5, 24.8–31.9 mm SL, rio Canoas, Vargem, Santa Catarina State.

Hisonotus nigricauda (Boulenger, 1891): LBP579, 16, 34.1–40.1 mm SL, rio Guaíba, Eldorado do Sul, Rio Grande do Sul State.

Hisonotus notatus Eigenmann & Eigenmann, 1889: LBP 3472, 20, 21.0–34.3 mm SL, 3 c&s, 25.8–26.5 mm SL, rio Aduelas, Macaé, Rio de Janeiro State; LBP 10742, 25, 24.4–43.3 mm SL, rio Macabu, Conceição de Macabu, Rio de Janeiro State.

Hisonotus notopagos Carvalho & Reis, 2011: MZUSP 104943, 4, 35.3–37.3 mm SL, arroio Boici, Pinheiro Machado, Rio Grande do Sul State.

Hisonotus oliveirai Roxo, Zawadzki & Troy, 2014b: MZUSP 115061, 1, 26.4 mm SL, holotype, ribeirão Cambira, tributary of rio Ivaí, Cambira, Paraná State; LBP 13332, 1 23.2 mm SL, 1 c&s, 23.7 mm SL, paratype, rio Mourão, Campo

Mourão, Paraná State; LBP 17578, 5, 25.4–30.4 mm SL, paratypes, rio Mourão, between Engenheiro Beltrão and Quinta do Sol, Paraná State; NUP 3578, 15, 24.7–28.1 mm SL, 2 c&s, 25.5–27.6 mm SL, paratypes, ribeirão Salto Grande, Maria Helena, Paraná State.

Hisonotus paresi Roxo, Zawadzki & Troy, 2014b: MZUSP 115062, 1, 26.2 mm SL, holotype, riacho Águas Claras, Santo Afonso, Mato Grosso State; LBP 13351, 9, 14.7–24.3 mm SL, paratype, riacho Águas Claras, Santo Afonso, Mato Grosso State; LBP 13352, 1, 23.7 mm SL, paratype, riacho Águas Claras, Santo Afonso, Mato Grosso State; NUP 10928, 2, 23.2–24.2 mm SL, paratype, 2 c&s, 23.6–24.2 mm SL, riacho Águas Claras, Santo Afonso, Mato Grosso State; NUP 10976, 3, 16.7–20.5 mm SL, paratype, riacho São Jorge, Santo Afonso, Mato Grosso State.

Hisonotus piracanjuba Martins & Langeani, 2012: LBP 17256, 9, 17.2–26.3 mm SL, 1 c&s, 27.1 mm SL, córrego sem nome, Morrinhos, Goiás State; NUP 5059, 1, 24.7 mm SL, córrego Posse, Anápolis, Goiás State; MZUSP 110491, 3, 17.5–24.4 mm SL, paratypes, rio Quente, Marcelânia, Goiás State; NUP 10979, 3, 21.4–21.8 mm SL, ribeirão Bocaina, Piracanjuba, Goiás State.

Hisonotus prata Carvalho & Reis, 2011: MCP 40492, 18, 19.5–33.2 mm SL, rio da Prata, Nova Prata, Rio Grande do Sul State; LBP 9918, 14, 21.7–32.6 mm SL, Laguna dos Patos system, Nova Prata, Rio Grande do Sul State.

Hisonotus ringueleti Aquino, Schaefer & Miquelarena, 2001: FMNH 108806, 2, 25.7–32.2 mm SL, rio Quaraí basin, Uruguay; LBP 13148, 1, 24.5 mm SL, arroio Putiá, Uruguaiana, Rio Grande do Sul State.

Hisonotus vireo Carvalho & Reis, 2011: MZUSP 104946, 4, 30.4–39.5 mm SL, rio dos Sinos, Caraá, Rio Grande do Sul State.

Hisonotus sp. 1 n.: LBP 8276, 1 c&s, 25.6 mm SL, rio Verde Grande, Jaíba, Minas Gerais State.

Hisonotus sp. 2 n.: MZUSP 95687, 8, 19.8–21.5 mm SL, ribeirão da Anta, Gaúcha do Norte, Mata Grosso State.

Hisonotus sp. 3 n.: MZUSP 84157, 6, 20.1–23.6 mm SL, rio Manuel Alves, Porto Alegre do Tocantins, Tocantins State.

Microlepidogaster arachas Martins, Calegari & Langeani, 2013: LBP 10882, 3, 22.8–35.3 mm SL, rio Paraná basin, Arachas, Minas Gerais State.

Microlepidogaster dimorpha Martins & Langeani, 2011: LBP 10683, 2, 28.8–35.6 mm SL, rio Uberaba, Uberaba, Minas Gerais State.

Otothyropsis marapoama Ribeiro, Carvalho & Melo, 2005: LBP 4698, 6, 23.9–36.3 mm SL, ribeirão Cubatão, Marapoama, São Paulo State.

Parotocinclus maculicauda (Steindachner, 1877): LBP 2869, 15, 20.2–44.7 mm SL, rio Fau, Miracatu, São Paulo State.

Parotocinclus prata Ribeiro, Melo & Pereira, 2002: LIRP 1136, 38, 19.8–41.9 mm SL, paratypes, ribeirão Quiricó, Presidente Olegário, Minas Gerais State.

Parotocinclus robustus Lehmann & Reis, 2012: LBP 8258, 29, 18.7–39.1 mm SL, córrego Cachoeira, Bocaiúva, Minas Gerais State.

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References

Almirón AE, Azpelicueta MM, Casciotta JR, Litz T (2006) A new species of *Hisonotus* (Siluriformes, Loricariidae, Otothyrini) from the República Oriental del Uruguay. Revue suisse de Zoologie 113(1): 87–94.

Andrade BN, Langeani F (2014) A new species of *Neoplecostomus* Eigenmann & Eigenmann, 1888 (Siluriformes: Loricariidae: Neoplecostominae) from the upper rio Paraná basin, 1–7. doi: 10.1590/1982-0224-20130195

Aquino AE, Schaefer SA, Miquelarena AM (2001) A new species of *Hisonotus* (Siluriformes, Loricariidae) of the Upper Río Uruguay basin. American Museum Novitates 3333: 1–12. doi: 10.1206/0003-0082(2001)333<0001:ANSOHS>2.0.CO;2

Armbruster JW (2004) Phylogenetic relationships of the sucker-mouth armored catfishes (Loricariidae) with particular emphasis on the Hypostominae and the Ancistrinae. Zoological Journal of the Linnean Society 141: 1–80. doi: 10.1111/j.1096-3642.2004.00109.x

Azpelicueta MM, Casciotta JR, Almirón AE, Koerber S (2004) A new species of Otothyrini (Siluriformes: Loricariidae: Hypoptopomatinae) from the Río Uruguay basin, Argentina. Verhandlungen der Gesellschaft für Ichthyologie 4: 81–90.

Boulenger GA (1891) An account of the siluroid fishes obtained by Dr. H. von Ihering and Herr Sebastian Wolff in the Province Rio Grande do Sul, Brazil. Proceedings of the Zoological Society of London 2: 231–235.

Britski HA, Garavello JC (1984) Two new southeastern Brazilian genera of Hypoptopomatinae and a redescription of *Pseudotocinclus* Nichols, 1919 (Ostariophysi, Loricariidae). Papéis Avulsos do Departamento de Zoologia (São Paulo) 35(21): 225–241.

Britski HA, Garavello JC (2003) *Hisonotus insperatus*: new species, from the upper rio Paraná basin (Pisces: Ostariophysi: Loricariidae). Copeia 2003(3): 588–593. doi: 10.1643/CI-02-23R

Britski HA, Garavello JC (2007) Description of two new sympatric species of the genus *Hisonotus* Eigenmann and Eigenmann, 1889, from upper rio Tapajós, Mato Grosso state, Brazil (Pisces: Ostariophysi: Loricariidae). Brazilian Journal of Biology 67(3): 413–420. doi: 10.1590/S1519-69842007000300005

Carvalho TP, Lehmann PA, Pereira EHL, Reis RE (2008) A New Species of *Hisonotus* (Siluriformes: Loricariidae: Hypoptopomatinae) from the Laguna dos Patos basin, Southern Brazil. Copeia 3(3): 510–516. doi: 10.1643/CI-07-130

Carvalho TP, Reis RE (2009) Four new species of *Hisonotus* (Siluriformes: Loricariidae) from the upper rio Uruguay, southeastern South America, with a review of the genus in the rio Uruguay basin. Zootaxa 2113: 1–40.

Carvalho TP, Reis RE (2011) Taxonomic review of *Hisonotus* Eigenmann and Eigenmann (Siluriformes: Loricariidae: Hypoptopomatinae) from the laguna dos Patos system, southern Brazil. Neotropical Ichthyology 9(1): 1–48. doi: 10.1590/S0074-02762011000900001

Chiachio MC, Oliveira C, Montoya-Burgos JI (2008) Molecular systematic and historical biogeography of the armored Neotropical catfishes Hypoptopomatinae and Neoplecostominae (Siluriformes: Loricariidae). Molecular Phylogenetic and Evolution 49: 606–617. doi: 10.1016/j.ympev.2008.08.013

Cope ED (1894) On the fishes obtained by the Naturalist Expedition in Rio Grande do Sul. Proceedings of the American Philosophical Society 33: 84–108, Pls. 4–9.

Eigenmann CH, Eigenmann RS (1888) Preliminary notes on South American Nematognathi. I. Proceedings of the California Academy of Sciences 1(2): 119–172.

Eigenmann CH, Eigenmann RS (1889) Preliminary notes on South American Nematognathi. Proceedings of the California Academy of Sciences 1: 119–172.

Günther A (1868) Diagnoses of some new freshwater fishes from Surinam and Brazil, in the collection of the British Museum. Annals and Magazine of Natural History 1(6): 475–481. doi: 10.1080/00222936808695733

Haseman JD (1911) Descriptions of some new species of fishes and miscellaneous notes on others obtained during the expedition of the Carnegie Museum to central South America. Annals of the Carnegie Museum 7 (3-4) (17): 315–328, Pls. 46–52.

Ihering R von (1928) Uma nova espécie de *Otocinclus* (Pisces. Nematognatha) "cascudinho" de S. Paulo. Boletim Biologia, Trabalho Laboratório de Parasitologia Faculdade de Medicina, São Paulo 11(42): 1–3.

International Commission on Zoological Nomenclature (1999) International code of zoological nomenclature. Fourth Edition. The International Trust for Zoological Nomenclature, London.

Kner R (1854) Die Hypostomiden. Zweite Hauptgruppe der Familie der Panzerfische. (Loricata vel Goniodontes). Denkschriften der Kaiserlichen Akademie der Wissenschaften in Wien, Mathematisch-Naturwissenschaftliche Classe 7: 251–286.

Lacépède BGE (1803) Histoire naturelle des poissons. Vol. 5. P. Plassan, Paris (ed.) 5(1): i–lxviii, 1–803.

Lehmann AP, Reis RE (2012) A new species of *Parotocinclus* (Siluriformes: Loricariidae) from the upper Rio São Francisco, Brazil. Zootaxa 3390: 56–64.

Lopez J, Roman-Valencia C (1996) Sobre la biologia del corroncho *Chaetostoma fischeri* (Steindachner, 1879) (Pisces: Loricariidae) en el río de La Vieja, Alto Cauca, Colombia. Boletin Ecotrópica Ecossistemas Tropicales 3: 37–57.

Martins FO, Calegari BB, Langeani F (2013) *Microlepidogaster arachas*, a new species of hypoptopomatine catfish (Siluriformes: Loricariidae) from the upper rio Paraná basin, Brazil. Zootaxa 3608(5): 379–388. doi: 10.11646/zootaxa.3608.5.6

Martins FO, Langeani F (2011) *Microlepidogaster dimorpha*, a new species of Hypoptopomatinae (Siluriformes: Loricariidae) from the upper Rio Paraná system. Neotropical Ichthyology 9(1): 79–86. doi: 10.1590/S1679-62252011000100005

Martins FO, Langeani F (2012) *Hisonotus piracanjuba*, a new species of Hypoptopomatinae (Siluriformes: Loricariidae) from the rio Paranaíba, upper rio Paraná system, central Brazil. Ichthyological Exploration of Freshwaters 23: 29–36.

Miranda Ribeiro A de (1908) Peixes da Ribeira. Resultados de excursão do Sr. Ricardo Krone, membro correspondente do Museu Nacional do Rio de Janeiro. Kosmos, Rio de Janeiro 5(2): 5.

Miranda Ribeiro A de (1918a) *Hemipsilichthys*, Eignm. & Eignm., e gêneros aliados. Revista da Sociedade Brasileira de Ciências (Rio de Janeiro) 2: 101–107.

Miranda Ribeiro A de (1918b) Três gêneros e dezessete espécies novas de peixes Brasileiros. Revista do Museu Paulista 10: 631–646.

Nomura H, Mueller IMM (1980) Biologia do cascudo, *Plecostomus hermanni* Ihering, 1905 do Rio Mogi Guaçu, São Paulo (Osterichthyes, Loricariidae). Revista Brasileira de Biologia 40(2): 267–275.

Pereira EHL, Vieira F, Reis RE (2007) A new species of sexually dimorphic *Pareiorhaphis* Miranda Ribeiro, 1918 (Siluriformes: Loricariidae) from the rio Doce basin, Brazil. Neotropical Ichthyology 5(4): 443–448. doi: 10.1590/S1679-62252007000400003

Py-Daniel LHR, Fernandes CC (2005) Dimorfismo sexual em Siluriformes e Gymnotiformes (Ostariophysi) da Amazônia. Acta Amazonica 35(1): 97–110. doi: 10.1590/S0044-59672005000100015

Reis RE, Pereira EHL, Armbruster JW (2006) Delturinae, a new loricariid catfish subfamily (Teleostei, Siluriformes), with revisions of *Delturus* and *Hemipsilichthys*. Zoological Journal of the Linnean Society 147: 277–299. doi: 10.1111/j.1096-3642.2006.00229.x

Reis RE, Schaefer SA (1998) New cascudinhos from southern Brazil: systematics, endemism, and relationships (Siluriformes, Loricariidae, Hypoptopomatinae). American Museum Novitates 3254: 1–25.

Retzer ME, Page LM (1996) Systematics of the stick catfishes, *Farlowella* Eigenmann & Eigenmann (Pisces, Loricariidae). Proceedings of the Academy of Natural Sciences of Philadelphia 147: 33–88.

Ribeiro AC, Carvalho M, Melo ALA (2005) Description and relationships of *Otothyropsis marapoama*, a new genus and species of Hypoptopomatinae catfish (Siluriformes: Loricariidae) from rio Tietê basin, southeastern Brazil. Neotropical Ichthyology 3(4): 489–498. doi: 10.1590/S1679-62252005000400006

Ribeiro AC, Melo ALA, Pereira EHL (2002) A new species of *Parotocinclus* (Siluriformes: Loricariidae) from the rio São Francisco basin, southeastern Brazil. Ichthyological Exploration of Freshwaters 13(3): 217–224.

Roxo FF, Oliveira C, Zawadzki CH (2012) Three new species of *Neoplecostomus* (Teleostei: Siluriformes: Loricariidae) from the Upper Rio Paraná basin of southeastern Brazil. Zootaxa 3233: 1–21.

Roxo FF, Silva GSC, Oliveira C, Zawadzki CH (2013) *Hisonotus bocaiuva*, a new species from the rio São Francisco basin, Brazil (Teleostei: Loricariidae). Ichthyological Exploration of Freshwaters 23(4): 319–326.

Roxo FF, Albert JS, Silva GS, Zawadzki CH, Foresti F, Oliveira C (2014a) Molecular Phylogeny and Biogeographic History of the Armored Neotropical Catfish Subfamilies Hypoptopomatinae, Neoplecostominae and Otothyrinae (Siluriformes: Loricariidae). PLoS ONE 9(8): e105564. doi: 10.1371/journal.pone.0105564

Roxo FF, Zawadzki CH, Troy WP (2014b) Description of two new species of *Hisonotus* Eigenmann & Eigenmann, 1889 (Ostariophysi, Loricariidae) from the rio Paraná-Paraguay basin, Brazil. ZooKeys 395: 57–78. doi: 10.3897/zookeys.395.6910

Sabaj MH, Armbruster JW, Page LM (1999) Spawning in *Ancistrus* (Siluriformes: Loricariidae) with comments on the evolution of snout tentacles as a novel reproductive strategy: larval mimicry. Ichthyological Exploration of Freshwaters 10(3): 217–229.

Schaefer SA (1998) Conflict and resolution: impact of new taxa on phylogenetic studies of the Neotropical cascudinhos (Siluroidei: Loricariidae). In: Malabarba LR, Reis RE, Vari RP, Lucena ZMS, Lucena CAS (Eds) Phylogeny and classification of neotropical fishes. Edipucrs, Porto Alegre, RS, 375–400.

Silva GSC, Roxo FF, Oliveira C (2014) *Hisonotus acuen*, a new and phenotypically variable cascudinho (Siluriformes, Loricariidae, Hypoptopomatinae) from the upper rio Xingu basin, Brazil. ZooKeys 442:105–125. doi: 10.3897/zookeys.442.7870

Steindachner F (1877) Die Süsswasserfische des südöstlichen Brasilien. (IV). Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften. Mathematisch-Naturwissenschaftliche Classe 76(1): 217–230.

Taylor WR, Van Dyke GC (1985) Revised procedures for staining and clearing small fishes and other vertebrates for bone and cartilage study. Cybium 9: 107–109.

Tschudi JV (1846) Ichthyologie. ii-xxx+ 1–35, pls. 1–6. Untersuchungen über die Fauna Peruana, Scheitlin & Zollikofer, 1–693.

Zawadzki CH, Pavanelli CS, Langeani F (2008) *Neoplecostomus* (Teleostei: Loricariidae) from the upper Rio Paraná basin, Brazil, with description of three new species. Zootaxa 1757: 31–48.

Electronic references

Eschmeyer W (2014) Catalog of Fishes. Electronic publication in “World Wide Web”. http://research.calacademy.org/ichthyology/catalog [accessed November 2014]

Eschmeyer WN, Fong JD (2014) Species by Family/Subfamily. http://research.calacademy.org/research/ichthyology/catalog/SpeciesByFamily.asp/ [accessed November 2014]

Fricke R, Eschmeyer WN (2014) Catalog of fishes. http://research.calacademy.org/research/ichthyology/catalog/collections.asp [accessed November 2014]