

Three new “caecate” earthworm species from Sulawesi, Indonesia (Oligochaeta, Megascolecidae)

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Abstract

Three new earthworm species are described from Sulawesi, Indonesia. Two belong to the genus *Pithemera* Sims & Easton, 1972, namely *P. suwastikai* Fahri, Amaliah & Atmowidi, **sp. n.** and *P. tadulako* Fahri, Amaliah & Atmowidi, **sp. n.** The new species, *P. suwastikai* **sp. n.** is distinguished by a medium size (135–165 mm long, 4.5–6.5 mm diameter), four pairs of spermathecal pores in 5/6/7/8/9, 7–12 setae between male pores, no genital markings, holandry, and simple intestinal caeca. *Pithemera tadulako* **sp. n.** is recognized by a large size (217–340 mm long, 13–15 mm diameter), two pairs of spermathecal pores in 7/8/9, no setae between male pores, no genital markings, holandry, and simple intestinal caeca. Another new species, *Metaphire rusydyi* Fahri, Amaliah & Nguyen, **sp. n.**, is diagnosed by its large size (250–280 mm long, 12–16 mm diameter), two pairs of spermathecal pores in 7/8/9, no setae between male porophores, presence of genital markings in the male region, holandry, and complex intestinal caeca. Additionally, an identification key to “caecate” species is provided to the Sulawesi’s fauna.

Keywords

Caecate earthworms, Indonesia, *Metaphire*, new species, *Pithemera*, Sulawesi

Introduction

Earthworms with intestinal caeca consists of four genera belonging to family Megascollecidae, namely *Pithemera* Sims & Easton, 1972, *Amyntas* Kinberg, 1867, *Pheretima* Kinberg, 1867, and *Metaphire* Sims & Easton, 1972. This group is distributed in the Oriental to Australian region (Sims and Easton 1972). Of those genera, *Metaphire* can be easily recognized by the presence of intestinal caeca in segment xxvii, the presence of copulatory pouches, and no nephridia on spermathecal ducts (Sims and Easton 1972). *Pithemera* is recognized by paired male pores discharging directly onto surface of xviii, small spermathecal pores, 3–5 pairs between 4/5–8/9 and intestinal caeca originating in or near xxii, rarely xxiv, paired laterally or single mid-ventrally (Sims and Easton 1972). The genus is mainly distributed in the Solomon Islands, New Britain, Fiji, Samoa, and Philippines (Sims and Easton 1972). Although two genera *Pithemera* and *Metaphire* have been reported from various regions surrounding Sulawesi, for example, the Philippines, Malaysia, Japan, Vietnam, Taiwan, New Guinea and other parts of Indonesia (Ude 1905, 1932; Gates 1975; Benham 1897; Beddard 1899; Michaelsen 1899; Hong et al. 2008; Nguyen et al. 2016), they both have never been recorded in Sulawesi until this research.

Earthworms from Sulawesi have been reported by Perrier (1872), Fletcher (1886), Michaelsen (1891, 1899), Beddard and Fedarb (1895), and Benham (1896). All species belong to four genera, *Polypheretima* Michaelsen, 1934, *Planapheretima* Michaelsen, 1934, *Pheretima* Kinberg, 1867, and *Amyntas* Kinberg, 1867. Recently, Fabri et al. (2017) described more four new species of the genus *Polypheretima* from this region. However, regarding the caecate earthworms, there are no reports for this group from Sulawesi except Benham's (1896). Our work herein contributes to a better understanding of earthworm diversity in Sulawesi though the description of three new species.

Materials and methods

Fresh specimens were collected from yards at Lomba village (00°53'05.9"S, 123°17'50.0"E), Banggai district, 26 March 2016 and Puncak Jiti near Lore Lindu National Park (01°29'18.94"S, 120°02'09.28"E), Toro village, South Kulawi sub-district, Sigi district, Central Sulawesi, Indonesia, 28 May 2017. Hiking trail 1 (01°25'18.44"S, 119°55'00.14"E) 25 November 2017 and hiking trail No.2 (01°25'17.54"S, 119°53'53.4"E) 24 November 2017, natural forest of Mt. Torompupu, Quarlesi Mountain, Salua village, Kulawi sub-district, Sigi district, Central Sulawesi, Indonesia (Fig. 1).

The earthworms were killed in formalin 2%, transferred to 4% formalin for fixation for approximately 24 hours, and then transferred to fresh 4% formalin for long-term preservation and morphological studies. Specimens were dissected from the dor-

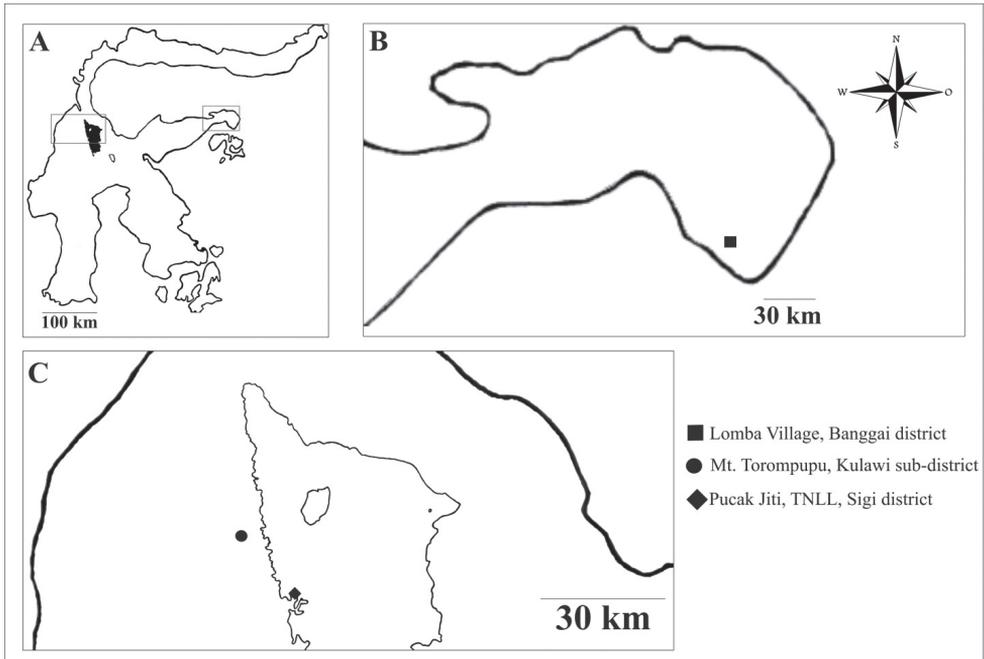


Figure 1. Location of earthworm study in Central Sulawesi Province. **A** Sulawesi Island **B** Banggai district, Central Sulawesi, **C**. Lore Lindu National Park, Central Sulawesi.

sal side for internal observation. Both external and internal morphology were observed under a Nikon type 104 C-LEDS stereo microscope. Holotypes and paratypes are deposited in Museum of Zoology in Bogor (MZB); some are housed in Tadulako University (UNTAD).

Taxonomic part

Family Megascolecidae Rosa, 1891

Genus *Pithemera* Sims & Easton, 1972: 202

Type species. *Perichaeta bicincta* Perrier, 1875, by original designation.

Remarks. *Pithemera* members are easily recognized by the origin of intestinal caeca at xxii. Sims & Easton (1972) divided *Pithemera* into three groups: *P. sedgwicki* group with intestinal caeca characters being single in mid-ventral, *P. bicincta* group with intestinal caeca being paired laterally and first spermathecal pores in 4/5, and *P. pacifica* group with intestinal caeca being paired laterally, first spermathecal pores in 5/6 and four thecal segments. Currently, the genus consists of 26 nominal species distributed mainly in New Guinea, and the Philippines (<http://taxo.drilobase.org>).

***Pithemera suwastikai* Fabri, Amaliah & Atmowidi, sp. n.**

<http://zoobank.org/BBC7F172-0AA8-4468-9715-41ECF5A1B2A7>

Fig. 2

Material examined. Holotype. 1 mature (MZB Oli. 062), yards (00°53'05"S, 123°17'50"E), elevation of 5 m a.s.l., Lomba village, Banggai district, Central Sulawesi, Indonesia, 26 March 2016, coll. Mihwan Sataral, Sofyan Ladjatang, Endang Prasetyawati Wahyuningsih, and F. Fabri. **Paratypes.** 4 matures (MZB Oli. 063) and 3 matures (UNTAD Oli. 008), same data as for holotype.

Diagnosis. Medium size, length 135–165 mm, diameter 4.5–5.5 mm at x and 4.5–6.5 mm at xx, segments 110–127. Prostomium epilobous. First dorsal pore in 12/13. Setae 27–38 in v, 33–49 in vii, 38–54 in viii and 64–74 in xxv, and 7–12 between male porophores in xviii. Spermathecal pores arranged in four pairs, 5/6–8/9. Male pores paired, discharging directly onto surface of xviii. Genital markings absent. Holandric. Intestinal caeca originating from xxii, paired laterally.

Etymology. The species is named after Dr I Nengah Suwastika, head of the Biology Department of Tadulako University for his kind support of our study on Sulawesi earthworms.

Description. *External characters.* Body generally cylindrical. Medium size, length 135–165 mm, diameter 4.5–5.5 mm at x and 4.5–6.5 mm at xx, segments 110–127. Brownish red on dorsum, dark brown around clitellum and yellowish white on ventrum, especially in living specimens (Fig 2A). After fixation, coloration brownish red on dorsum and whitish on ventrum.

Prostomium epilobous. First dorsal pore in 12/13. Setae regularly distributed around segmental equators: 27–38 in v, 33–49 in vii (Table 1), 38–54 in viii and 64–74 in xxv, 7–12 between male porophores in xviii; setae distance aa=1–1.2ab, zz=1–3zy. Clitellum annular, xiv–xvi, smooth without setae and dorsal pores. Female pore single, mid-ventral in xiv.

Spermathecal pores small, slightly rounded, lateroventrally paired in 5/6–8/9 (Fig. 2A). No genital markings in the spermathecal region (Fig. 2B).

The openings of male pores small, on the setal ring of xviii, paired and discharging directly onto surface of xviii (Fig. 2E); ventral distance between male pores approx. 0.2x body circumference. Genital markings absent in the male region.

Internal characters. Septa 3/4/5/6/7/8 thick, 8/9 absent, 9/10/11/12/13 thin. Gizzard round within viii–x. Last hearts in xiii. Intestine origin at xv; caeca originating at xxii, extending anteriorly to xx, simple and paired laterally (Fig. 2F). Esophageal pouches absent. Typhlosole simple.

Four pairs of spermathecae paired in vi–ix. Ampulla round; duct enlarged, stout, approx. 1/4–1/2 as long as ampulla; no nephridia on spermathecal ducts. Diverticulum cylindrical, longer than ampulla, attached to base of ducts (Fig. 2C). No accessory glands.

Holandric. Testes sacs paired in x–xi, small, separated, ventral, yellowish. Seminal vesicles in xi–xii. Ovaries paired on xiii. Prostate gland racemose paired within xvi–xx or xvii–xx. Prostatic ducts long and U-shaped (Fig. 2D). No accessory glands.

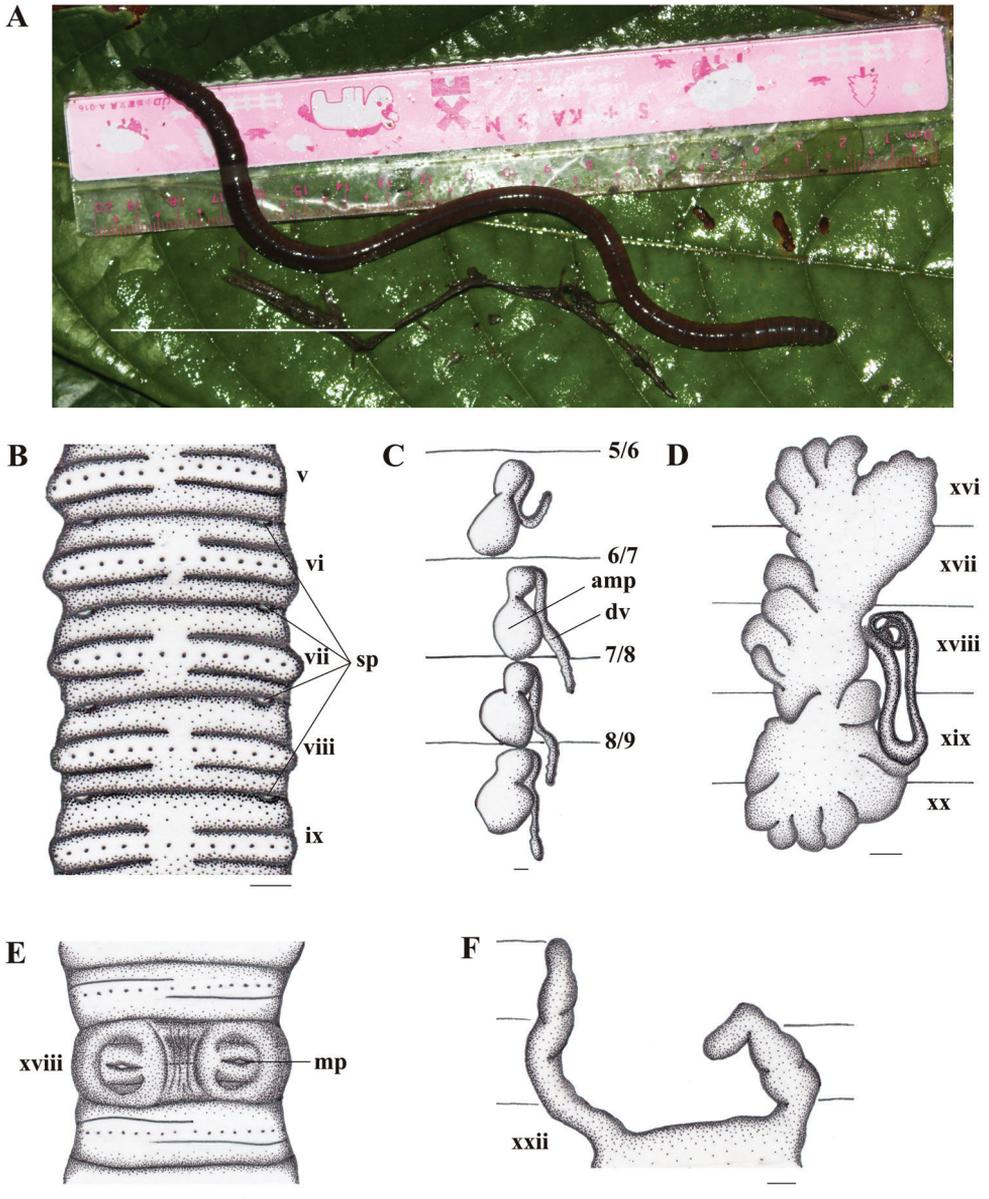


Figure 2. *Pitbamera suwastikai* sp. n., holotype. **A** Living specimen (dorsal view); **B** Spermathecal pore; **C** Spermathecae, right side on intrasegmental 5/6/7/8/9 (am = ampulla; dv = diverticulum); **D** Prostate gland; **E** Male pore region (mp = male pore); **F** Intestinal caecum. Scale bars: 50 mm (**A**), 1 mm (**B–F**).

Habitat and ecology. Specimens were collected in yards at Lomba village, Banggai district, Central Sulawesi, Indonesia at 5 m a.s.l. The species was found in sandy soils at depths of 0–10 cm, around the roots of banana trees planted 1–2 m away from houses. No other specimens were collected despite continued collecting effort. The

specimens were collected at an elevation of 50 meters above sea level. When collected, earthworms were moving actively on the ground.

Remarks. This new species belongs to the *Pithemera pacifica* group characterized by having the first spermathecal pores in 5/6 and four thecal segments (Sims and Easton 1972). This group currently consists of three species, *P. pacifica* (Beddard, 1899) from New Guinea and Samoa, *P. dabli* (Ude, 1905) from New Guinea, and *P. donvictoriano* (Aspe & James, 2015) from the Philippines. Although *Pithemera suwastikai* sp. n. is classified into *Pithemera pacifica* group because of the presence of four thecal segments (5/6–8/9), the new species is totally differentiated from *P. pacifica* (Beddard, 1899) in having larger size (length 135–165 mm vs. up to 56 mm), holandric (vs. metandric), a single female pore (vs. a pair of female pores (see James et al. 2004)), clitellum in xiv–xvi without setae (vs. in xiv–xv/xvi with setae), absence of genital markings (vs. presence of genital markings).

The new species has similar characters to *P. donvictoriano* Aspe & James, 2015, e.g., in the number of spermathecal pores, but different in clitellum (xiv–xvi vs. xiv–xv), setae on vii (33–49 vs. 42–48). *P. suwastikai* sp. n. also has different length with *P. donvictoriano* (135–165 mm vs. 41–58 mm) and diameter (4.5–5.5 mm vs. 2.5–3.0 mm). In addition, *P. donvictoriano* is a white worm, with small, narrow, oval spermathecal ampulla; ducts short, slender; diverticulum stalk short, attached to ducts, terminating in short ovate receptacle. In contrast, *P. suwastikai* sp. n. has brownish red pigment on dorsum, dark brown around clitellum and yellowish white on ventrum; ampulla rounded; ducts enlarged, approx. 1/4–1/2 as long as ampulla; diverticulum cylindrical, longer than ampulla, attached to base of ducts.

This new species is also similar to *P. dabli* (Ude, 1905) by having spermathecal pores in 5/6–8/9 and dorsal pore in 12/13. However, it differs from *P. dabli* in larger size (length: 135–165 mm vs. 70 mm; diameter 4.5–6.5 mm vs. 2.5 mm), absence of genital markings (vs. genital markings in x, xi, xvii–xxi), holandric (vs. metandric), and prostate glands in xvi–xx or xvii–xx (vs. in xvi–xxii). *P. suwastikai* sp. n. has also similar characters to *P. pacifica* (Beddard, 1899) in spermathecal pores (5/6–8/9) and dorsal pore (12/13), but it is totally different in absence of genital markings (vs. present in x, xi, xvii–xxi) and holandric (vs. metandric). The comparison of the four species is presented in Table 1.

***Pithemera tadulako* Fabri, Amaliah & Atmowidi, sp. n.**

<http://zoobank.org/AA5F18DC-2EFC-4EC8-A5A9-3C9DDD08E4CC>

Fig. 3

Material examined. Holotype. 1 mature (MZB Oli. 064), Puncak Jiti, natural forest, Lore Lindu National Park, Sigi district, Central Sulawesi, Indonesia (01°29'18"S, 120°02'09"E), elevation 1,370 m a.s.l., 28 May 2017, coll. Rizki Amaliah, Mus'af, Donny Aprilyanto. **Paratypes.** 2 matures (MZB Oli. 065), same data as for holotype. 1 mature (UNTAD Oli. 009), ca. 50 meters southwest of Kalimpa'a Lake (riverside entrance/inlet Kalimpa'a Lake), secondary forest, Lore Lindu National Park, Poso dis-

Table 1. Character comparison among species of the *Pithemera pacifica*-group.

Character	<i>P. donvictoriano</i> Aspe & James, 2015	<i>P. pacifica</i> (Beddard, 1899)	<i>P. dabli</i> (Ude, 1905)	<i>P. suwastikai</i> sp. n.
Length (mm)	41–58	56	70	135–165
Diameter (mm)	2.5–3.0	-	2.5	4.5–5.5
Segment number	85–100	90	120	110–127
Clitellum	xiv to xv	xiv–xvi/ xiv–xv*	xvi–xvi	xiv–xvi
Female pore	single	paired*	single	single
Spermathecae pore	5/6–8/9 (inconspicuous)	5/6–8/9	5/6–8/9	5/6–8/9
Dorsal pore	12/13	-	12/13	12/13
Copulatory pouches	absent	absent	absent	absent
Genital marking	absent	present in xii–xiii, xvii–xviii, xx–xxii	present in x, xi, xvii–xxi	absent
Setae on vii or viii	42–48 (vii)	47 (viii)	70 (viii)	33–49 (vii)
Setae bet. male pore	8	10	-	10–12
Septa	8/9 absent	8/9 present, thin	9/10 absent	8/9 absent
Intestinal caeca	xxii to xxi	-	-	simple (xxii–xx)
Last hearts	xiii	xii	xiii	xiii
Testis	holandric	metandric	metandric	holandric
Prostate gland	xvi to xix	xvii–xix	xvi–xxii	xvi–xx, xvii

Note: *: data from James et al. (2004).

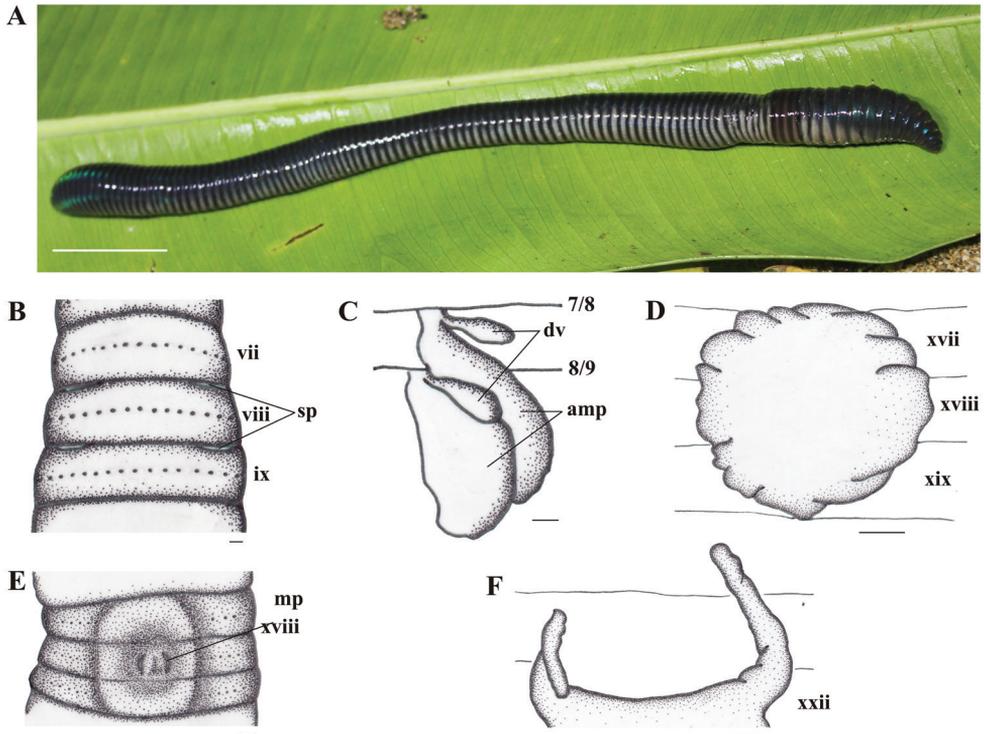


Figure 3. *Pithemera tadulako* sp. n., holotype. **A** Living specimen (lateral view); **B** Spermathecal pore; **C** Spermathecae, right side on intrasegmental 7/8/9 (am = ampulla; dv = diverticulum); **D** Prostate gland; **E** Male pore region (mp = male pore); **F** Intestinal caecum. Scale bars: 50 mm (**A**), 1 mm (**B–F**).

trict, Central Sulawesi, Indonesia (01°19'33"S, 120°18'29"E), elevation 1,600 m a.s.l., 26 August 2017, coll. F Fahri, Sahlan, Evans Madiyono, Sucipto Suherman. 1 mature (**UNTAD Oli. 010**), ca. 50 meters north of the edge of Kalimpa'a Lake, around a water reservoir, same data as for paratypes, 11 November 2017, coll. Sahlan.

Diagnosis. Large size, length 217–340 mm, diameter 13–15 mm, segments 120–123; darkish blue on dorsum, purplish brown around clitellum and yellowish white on ventrum. Prostomium epilobous. First dorsal pore in 12/13. Setae 42–56 in v, 48–65 in vii, 44–69 in viii and 55 in xxv, and no setae between male porophores in xviii. Spermathecal pores lateroventrally paired in 7/8/9. Male pores paired, discharging directly onto surface of xviii. Genital markings absent. Holandric.

Etymology. The species is named after the well-known Tadulako University in central Sulawesi. 'Tadulako' means a 'leader' in indigenous culture of central Sulawesi.

Description. *External characters.* Body generally cylindrical; large size, length 217–340 mm, diameter 13–14 mm at x and 15 mm at xx, segments 120–123. Darkish blue on dorsum, purplish brown around clitellum and yellowish white on ventrum, especially for living specimens (Fig. 3A). After fixation, color grayish blue on dorsum and yellowish white on ventrum.

Prostomium epilobous. First dorsal pore in 12/13. Setae 42–56 in v, 48–65 in vii, 44–69 in viii and 55 at xxv, no setae between male porophores in xviii; setae distance aa=1–1.2ab, zz=1–2zy. Clitellum annular, xiv–xvi, smooth without setae and dorsal pores. Female pore single, mid-ventral in xiv.

Spermathecal pores small, lateroventrally paired in 7/8/9 (Fig. 3B). No genital markings in the spermathecal region.

Male pores small, forming vertical lines, paired and discharging directly onto surface of xviii (Fig. 3E); copulatory pouches absent; ventral distance between pores approx. 0.02x body circumference. Genital markings absent in the male region.

Internal characters. Septa 3/4/5/6/7/8 thick, 8/9 absent, 9/10/11/12/13 thin. Pharyngeal gizzard within viii–x. Last hearts in xiii. Intestine originating at xv; caeca originating at xxii, extending anteriorly to xx, simple (Fig. 3F). Oesophageal pouches absent. Typhlosole simple.

Two pairs of large spermathecae in viii–ix. Spermathecal ampulla oval; duct stout and very short; no nephridia on spermathecal ducts. Diverticulum claviform, much shorter than ampulla, attached to ducts (Fig. 3C). No accessory glands.

Holandric. Testes sacs paired in x–xi, large, separated, ventral, yellowish. Seminal vesicles in xi–xii. Ovaries paired on xiii. Prostate glands racemose, paired in xvii–xix (Fig. 3D). Prostatic ducts U-shaped, but invisible from dorsal view because of being hidden under prostate glands. No accessory glands.

Habitat and ecology. Specimens were collected in Puncak Jiti, Toro village, South Kulawi sub-district, Sigi district at 1,370 m a.s.l. and near Kalimpa'a Lake, Lore Lindu National Park at 1,600 m a.s.l. This species was found on the surface of soils after rains that contains a lot of leaf litter.

Remarks. The new species is totally different from species groups divided by Sims and Easton (1972) in first spermathecal pores in 7/8 and two thecal segments. The new species is clearly different from all other *Pithemera* species in its very large size (length

217–340 mm, diameter 13–14 mm at x and 15 mm at xx, segments 120–123), and color of living specimens (dark blue on dorsum, purplish brown around clitellum, and yellowish white on ventrum, color after fixation grayish blue on dorsum and yellowish white on ventrum).

The new species is somewhat similar to *P. viengthongensis* Hong & James, 2008 from Laos by having spermathecal pores in 7/8/9 and absence of genital markings. However, *P. tadulako* sp. n. is long (217–340 mm), and has more setae on vii (48–65), spermathecal ampulla being oval, ducts enlarged, short and stout; diverticulum cylindrical, shorter than ampulla. In contrast, *P. viengthongensis* is short (39 mm), has fewer setae on vii (37), spermathecal ampulla being ovate, smooth surface, duct short, thick; diverticulum stalk long and slender, chamber and chili-shaped. Moreover, two species are also distinguished by ventral distance between male porophores (0.02x body circumference in *P. tadulako* vs. 0.31x in *P. viengthongensis*).

Genus *Metaphire* Sims & Easton, 1972

Type species. *Rhodopis javanica* Kinberg, 1867, by monotypy.

Remarks. This genus currently contains approximately 198 species widely distributed in the Oriental regions from Japan southwards through the Indo-Australasian archipelago to the rain forests of Australasia eastwards through Oceania (<http://taxo.drilobase.org/index.php?title=Metaphire>).

Metaphire rusydiei Fahri, Amaliah & Nguyen, sp. n.

<http://zoobank.org/CB4326F8-A15E-46DA-8F37-D8DE58E828D0>

Fig. 4

Material examined. Holotype. 1 mature (MZB Oli. 066), hiking trail No.1 (01°25'18.44"S, 119°55'00.14"E), elevation of 1,120 m a.s.l., 25 November 2017, natural forest of Mt. Torompupu (Quarlesi Mountain), Salua village, Kulawi sub-district, Sigi district, Central Sulawesi, Indonesia, coll. Anna J Holmquest, F Fahri. **Paratypes.** 1 mature (UNTAD Oli. 011), hiking trail No.2 (01°25'17.54"S, 119°53'53.4"E), elevation 1,360 m a.s.l., 24 November 2017, same data as for holotype, coll. Jackie Childers & S Sarino.

Diagnosis. Large size, length 250–280 mm, diameter 12–16 mm, segments 117–119; purplish blue on dorsum, and paler on ventrum. Prostomium 1/3 epilobous. First dorsal pore in 11/12. Setae 36–51 in v, 45–54 in vii, 41–59 in viii and 43–51 in xxv, and no setae between male porophores in xviii. Male pores located in xviii, within copulatory pouches. Genital markings present only in the male region. Spermathecal pores lateroventrally paired in 7/8/9. Holandric. Intestinal caeca complex or lobed mesially.

Etymology. The species is named after Dr H M Rusydi Hasanuddin, Dean of Faculty of Sciences at Tadulako University, for his kind support to the authors for this research.

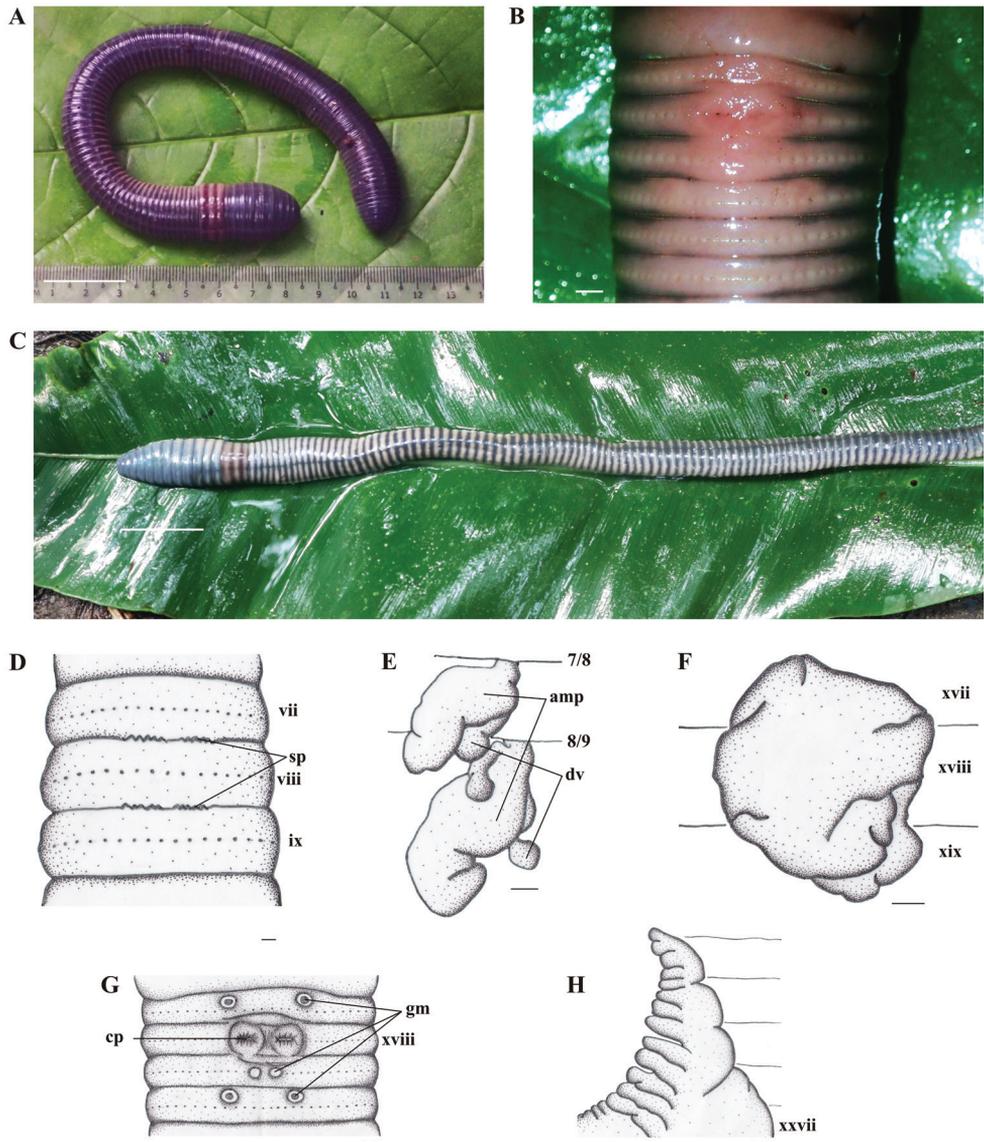


Figure 4. *Metaphire rusydiei* sp. n., holotype. **A** Living specimen (dorsal view); **B** Living specimen (ventral view of male pore region); **C** Preserved specimen (dorsal view); **D** Spermathecal pore; **E** Spermathecae, right side on intrasegmental 7/8/9 (am = ampulla; dv = diverticulum); **F** Prostate gland; **G** Male pore region (cp = opening copulatory pouch); **H** Intestinal caecum. Scale bars: 50 mm (**A**), 1 mm (**C–H**).

Description. *External characters.* Body generally cylindrical. Large size, length 250–280 mm, diameter 12–16 mm at x and 13–15 mm at xx, segments 117–119. Purplish blue on dorsum through the lateral region, clitellum purplish brown on dorsum through the lateral region and paler on ventrum, especially for living specimens (Fig. 4A–C). After fixation, color grayish blue on dorsum and yellowish white on ventrum.

Prostomium 1/3 epilobous. First dorsal pore in 11/12. Setae regularly distributed around segmental equators, 36–51 in v, 45–54 in vii, 41–59 in viii and 43–51 in xxv, no setae between male porophores in xviii; setae distance aa=ab, zz=1–1.2zy. Clitellum annular, within xiv–xvi, smooth without setae and dorsal pores. Female pore single, mid-ventral in xiv.

Spermathecal pores obviously visible, horizontally elongated, jagged, or small, ventrally paired in 7/8/9 (Fig. 4D). Ventral distance between spermathecal pores 0.04x body circumference, and horizontal length of pores ca. 2–3 mm.

Male pores deeply located inside copulatory pouches in the setal ring of xviii. The openings of copulatory pouches horizontally elongated, with swollen edges; ventral distance between male porophores 0.02x body circumference (Fig. 4G). Three pairs of small, rounded genital markings including two in front of the setal rings of xvii and xx, and one medially located in the setal ring of xix (Fig. 4G). Ventral distance between genital markings in xvii and xx about 0.07x body circumference, and less than 0.01x body circumference in xix.

Internal characters. Septa 3/4/5/6/7/8 and 10/11/12/13 thick, 8/9 membranous and 9/10 absent. Gizzard in viii. Last hearts in xiii. Intestine beginning in xv; caeca laterally paired, complex or lobed mesially, originating at xxvii, then extending anteriorly to xxii (Fig. 4H). Pharyngeal micronephridia developed on anterior faces of 5/6/7. Lymph glands not seen. Typhlosole simple, poorly developed.

Spermathecae paired in viii and ix. Spermathecal ampulla large, oval shaped; ducts stout and short, 1/5 as long as ampulla. Diverticulum cylindrical, much shorter than ampulla, attached to ducts; distal part enlarged to a rounded seminal chamber (Fig. 4E). No nephridia on spermathecal ducts. No accessory glands in the spermathecal region.

Holandric. Testes sacs paired in x–xi, large, separated, ventral, yellowish. The copulatory pouches hidden inside body wall. Seminal vesicles in xi–xii. Ovaries paired on xiii, oviduct and ovisac developing in xiii. Prostate glands racemose, paired in xvii–xix (Fig. 4F). Prostatic duct U-shaped, invisible from dorsal view since being hidden under prostate glands. No accessory glands.

Habitat and ecology. Specimens were collected in Mt. Torompupu (Quarlessi Mountain), natural forest at 1,120 m a.s.l. and 1,360 m a.s.l. This species was found on soil surface in piles of leaf litter after rains. According to local hunters in Mt. Torompupu, the species can be mostly found after rains and usually observed on old trails in the forest. We did not find this species at an altitude of less than 1,000 m a.s.l.; presumably, the species may be distributed in an altitude of more than 1,000 m a.s.l.

Remarks. The new species, *Metaphire rusydiei* sp. n., belongs to the *schmardae*-group, which is characterized by two thecal segments, holandry, and having structure multiple/complex of intestinal caeca (Sims and Easton 1972). This new species is fairly similar to *M. schmardae* (Horst, 1883) by having spermathecal pores in 7/8/9, holandry, and complex intestinal caeca in xxvii. However, they are different in number of setae between male porophores (0 vs. 12–14 setae). *M. rusydiei* sp. n. is also similar to *M. xuanlocensis* (Nguyen & Lam, 2017) by having first spermathecal pore in 7/8 and first dorsal pore in 11/12. However, *M. xuanlocensis* has only one pair of spermathecal

pores (in 7/8) whereas *M. rusydii* sp. n. has two pairs of spermathecal pores in 7/8/9. This new species is somewhat similar to *Metaphire isselii* (Cognetti, 1908) by having small male pores and holandry. However, they are different in the position of male pores (xviii vs. xix), spermathecal pores (7/8/9 vs. 6/7–8/9) and first dorsal pore (11/12 vs. 12/13).

Discussion

To date, a total of 17 earthworm species has been recorded from Sulawesi (Perrier 1872; Fletcher 1886; Beddard & Fedarb 1895; Benham 1896; Michaelsen 1891, 1899; Fabri et al. 2017). Almost all species are endemic to Sulawesi, except the cosmopolitan species *Polypheretima elongata* (Perrier, 1872), *Polypheretima everetti* (Beddard & Fedarb, 1895), and *Pheretima darnleiensis* (Fletcher, 1886). However, this number is still far from reflecting the earthworm diversity of Sulawesi due to lack of intensive surveys. More new species are certainly awaiting discovery.

Key to caecate earthworm species recorded in Sulawesi, Indonesia

- | | | |
|---|--|-----------------------------------|
| 1 | Intestinal caecum, origin at xxii | 2 |
| – | Intestinal caecum, origin at xxvii..... | 3 |
| 2 | Spermathecal pores in 5/6–8/9..... | <i>Pithemera suwastikai</i> sp.n. |
| – | Spermathecal pores in 7/8/9..... | <i>Pithemera tadulako</i> sp.n. |
| 3 | Copulatory pouches absent; one to six pairs of spermathecal pores..... | 4 |
| – | Copulatory pouches present; two or five pairs of spermathecal pores..... | 9 |
| 4 | Spermathecal pores from 7/8 | 5 |
| – | Spermathecal pores absent or in 3/4/5/6/7/8/9 | 8 |
| 5 | One pair of spermathecal pores in 7/8..... | <i>Amyntas zebrus</i> |
| – | Two pairs of spermathecal pores in 7/8/9 | 6 |
| 6 | Genital marking absent; the base with 12 secondary caeca | 7 |
| – | Genital markings present | <i>Amyntas purpurus</i> |
| 7 | Dark olive-green. Ampulla with globular sac, with narrow (undulating) diverticulum, expanded terminally..... | <i>Amyntas jampeanus</i> |
| – | Stone-grey to French-grey posteriorly. Ampulla with pyriform sac, long duct, receiving an undulating diverticulum, terminally dilated..... | <i>Amyntas digitatus</i> |
| 8 | Spermathecal pores absent..... | <i>Amyntas bonthainensis</i> |
| – | Six pairs of spermathecal pores in 3/4/5/6/7/8/9 | <i>Amyntas hexathecus</i> |
| 9 | Spermathecal ducts with micronephridia. Three to five pairs of spermathecal pores in 4/5/6/7/8/9 | <i>Pheretima darnleiensis</i> |
| – | Spermathecal ducts without micronephridia. Two two pairs of spermathecal pores in 7/8/9 | <i>Metaphire rusydii</i> sp. n. |

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First report of the genus *Rhyncholagena* Lang, 1944 from the South China Sea, with the description of a new species (Crustacea, Copepoda, Harpacticoida, Miraciidae)

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Abstract

During analysis of sediment samples from South China Sea, a new species belonging to the genus *Rhyncholagena* Lang, 1944 was found and described here. *Rhyncholagena paraspinifer* sp. n. differs from its congeners by the following combined characteristics: body ornamented dorsally with at least one row of spinules on each somite except penultimate urosomite; A2 exopod two-segmented; P1 enp-2 with one inner seta; P3 exp-3 with two inner setae, P3 enp-2 with one inner seta; female P5 exopod with five setae; male P5 baseoendopod with two setae and exopod with four setae. This is the first report of the genus *Rhyncholagena* in the China seas. In addition, a key to all valid species of *Rhyncholagena* is given, along with tables of morphological characters of all valid species and their distributions.

Keywords

Benthic copepods, Crustacea, new species, taxonomy

Introduction

The harpacticoid genus *Rhyncholagena* Lang, 1944 belongs to the large family Miraciiidae Dana, 1846, comprising nine species and subspecies (Walter et al. 2015), plus the new species described here. The genus *Rhyncholagena* was erected to accommodate three species previously assigned to *Amphiascus* Sars G.O., 1905. The genus *Rhyncholagena* was distinguished from *Amphiascus* by subtle morphological characteristic such as rostrum flask shape (Lang 1948). Por (1967) thought that the main characters of the genus were the incision between the apical setae of the P5 exopod and the bottle-like or elongated rostrum.

Species of the genus *Rhyncholagena* are benthic forms that inhabit different marine environments: gravels (Por 1964), mud (Present contribution), sand (Sars 1911), mangrove (Malt 1990), and coral reefs (Sarmiento and Santos 2012). Members of this genus range from intertidal to subtidal areas of continental shelves (Lang 1948; Por 1964, 1967; Malt 1990). Species of *Rhyncholagena* were reported from different regions of world: *R. lagenirostris* (Sars G.O., 1911) was from Norway; *R. spinifer* (Farran, 1913) from Ireland and France; *R. pestai pestai* (Monard, 1935) from France, Algeria and North Carolina of the USA; *R. pestai americana* Rouch, 1962 from Argentina; *R. levantina* Por, 1964 from coasts of Israel and France in Mediterranean; *R. josaphatis* Por, 1967 from the Red Sea and Suez Canal; *R. littoralis* Por, 1967 from the Red Sea, Suez Canal and Brazil; *R. profundorum* Por, 1967 from the Red Sea; and *R. bermudensis* Malt, 1990 from Bermuda.

The South China Sea is a semi-enclosed marginal sea of the tropical Indo-Pacific region. The knowledge about the composition and distribution of benthic harpacticoids are considered as insufficient (Chertoprud et al. 2011). During a survey of the local macrobenthos along the coasts of Hainan Island in the South China Sea, we took some sediment samples from subtidal of east Hainan Island. Harpacticoid copepods were sorted from these samples. A new species of *Rhyncholagena* was found and is described here. This is the first report of the genus from the South China Sea. Finally, data about the depth and sample locality of all valid species were collected to discuss the distribution of the genus *Rhyncholagena* and a worldwide identification key to species is provided.

Materials and methods

Sediment samples were collected from the South China Sea, fixed in 10% formalin. Sediment samples were washed through a 38 µm sieve with tap water. The harpacticoid specimens were extracted from remaining sediment samples by centrifugation with the colloidal silica Ludox TM-50 suspension as flotation medium. Specimens were preserved in 75% alcohol. For their identification, the specimens were cleared in lactic acid and observed with a light microscope. Before dissection, the habitus was drawn and the whole body length was measured temporarily mounted in lactophenol. Speci-

mens were dissected in lactic acid and mounted on slides in lactophenol, subsequently sealed with nail-polish. The observations and drawings were made with a differential interference contrast microscope (Nikon Eclipse Ni), equipped with a drawing tube. The illustration of habitus were drawn at 400× magnification, the others were drawn at 1000× magnification, with oil immersion lens.

The terminology used is after Huys et al. (1996). Abbreviations used in the text and figures are:

A2	antenna;	enp	endopod;
aes	aesthetasc;	enp-1 (-2-3)	the first (second, third) segment of the endopod;
exp	exopod;	P1-P6	swimming legs 1-6.
exp-1 (-2-3)	the first (second, third) segment of the exopod;		

Body length was measured from the anterior margin of the rostrum to the posterior margin of the caudal rami. The type material is deposited in the Marine Biological Museum, Chinese Academy of Sciences, Qingdao, China (**MBMCAS**).

Results

Order Harpacticoida Sars, 1903

Family Miraciidae Dana, 1846

Subfamily Diosaccinae Sars, 1906

Genus *Rhyncholagena* Lang, 1944

Rhyncholagena paraspinifer sp. n.

<http://zoobank.org/E4E9C696-1020-47DF-960B-E6ADE07C2C6B>

Figs 1-8

Type locality. South China Sea, sampling locality (18°35.81'N, 110°43.44'E), 30.1 m depth, soft mud, collected by JB Wang, LM Shuai, J Zhou, QX Han and L Ma, 19 October 2007.

Material examined. Holotype 1♀ dissected on three slides (MBM189117). Paratypes: 1♀ on one slide (MBM189079), 1♂ (MBM189080) on one slide and 6 ♀♀, 4 ♂♂ (MBM189081) in 70 % ethanol. Allotype 1 ♂ on two slides (MBM189118). All paratypes and allotype were collected from the type locality.

Description. *Female* (based on holotype and one paratype).

Habitus (Figs 1A, 2A, B). Total length of holotype female (body plus caudal rami, excluding caudal setae): 710µm. Body long and cylindrical, widest at head, tapering posteriorly. Prosome four-segmented: cephalothorax (including two thoracic somites bearing maxilliped and P1) and three articulated somites bearing P2 to P4; all prosomites with row of spinules on posterior margins, respectively. Urosome five-

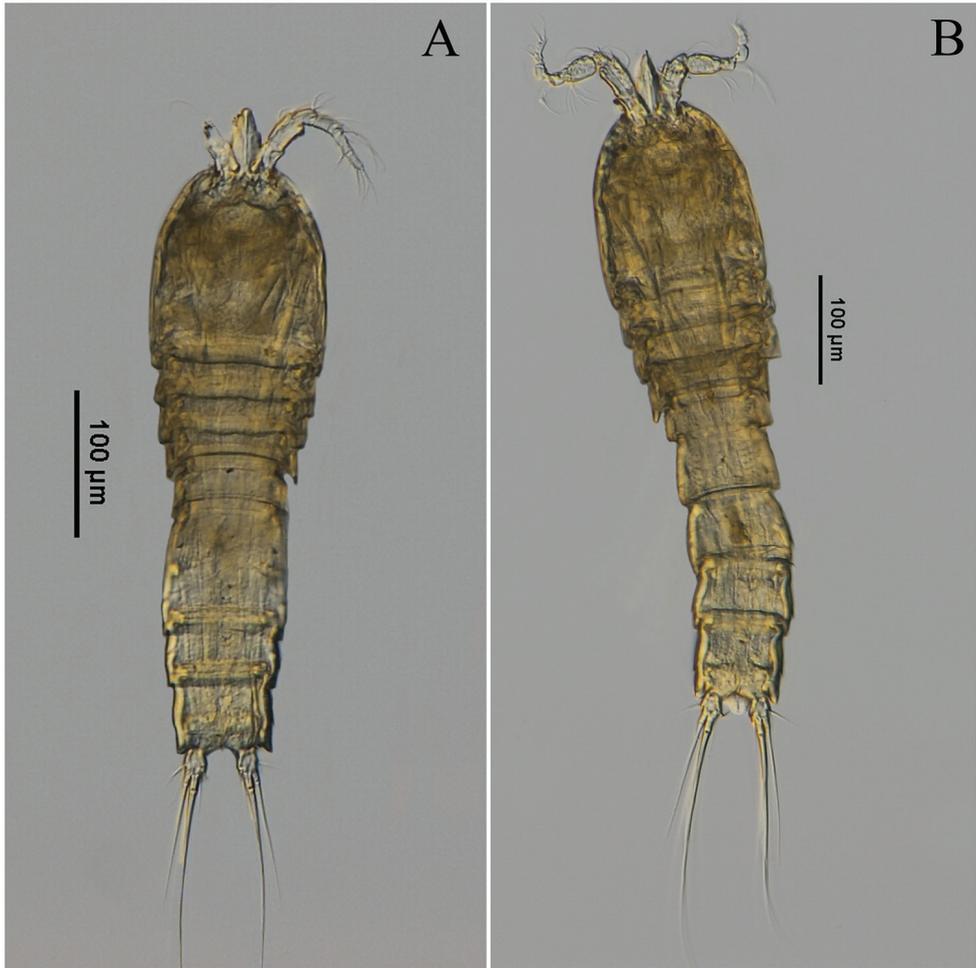


Figure 1. *Rhyncholagena paraspinifer* sp. n. **A** Paratype (female, MBM189079) habitus, dorsal **B** Paratype (male, MBM189080) habitus, dorsal.

segmented, comprising P5-bearing somite, genital double-somite, and three abdominal somites. Urosomites with rows of hyaline frills on dorsal edge respectively, excluding penultimate urosomite; urosomites ornamented with hyaline frills on ventral side. Genital field (Figure 2B) located rather proximally, genital apertures situated ventrally, covered by reduced P6 on both sides. Anal somite slightly cleft in posterior, unornamented, 0.4 times as long as wide; anal operculum narrow, unornamented. Caudal ramus almost as long as broad, carrying six setae: two outer setae, smooth; two medial setae, well developed; two inner setae, slender.

Rostrum (Figs. 2A, 4A) demarcated from cephalothorax, elongated, almost triangular with pair of sensillae on each side of rostrum approx. 1/3 from acute tip.

Labrum (Figure 2C) somewhat hexagonal, with toothed fringe at tip.

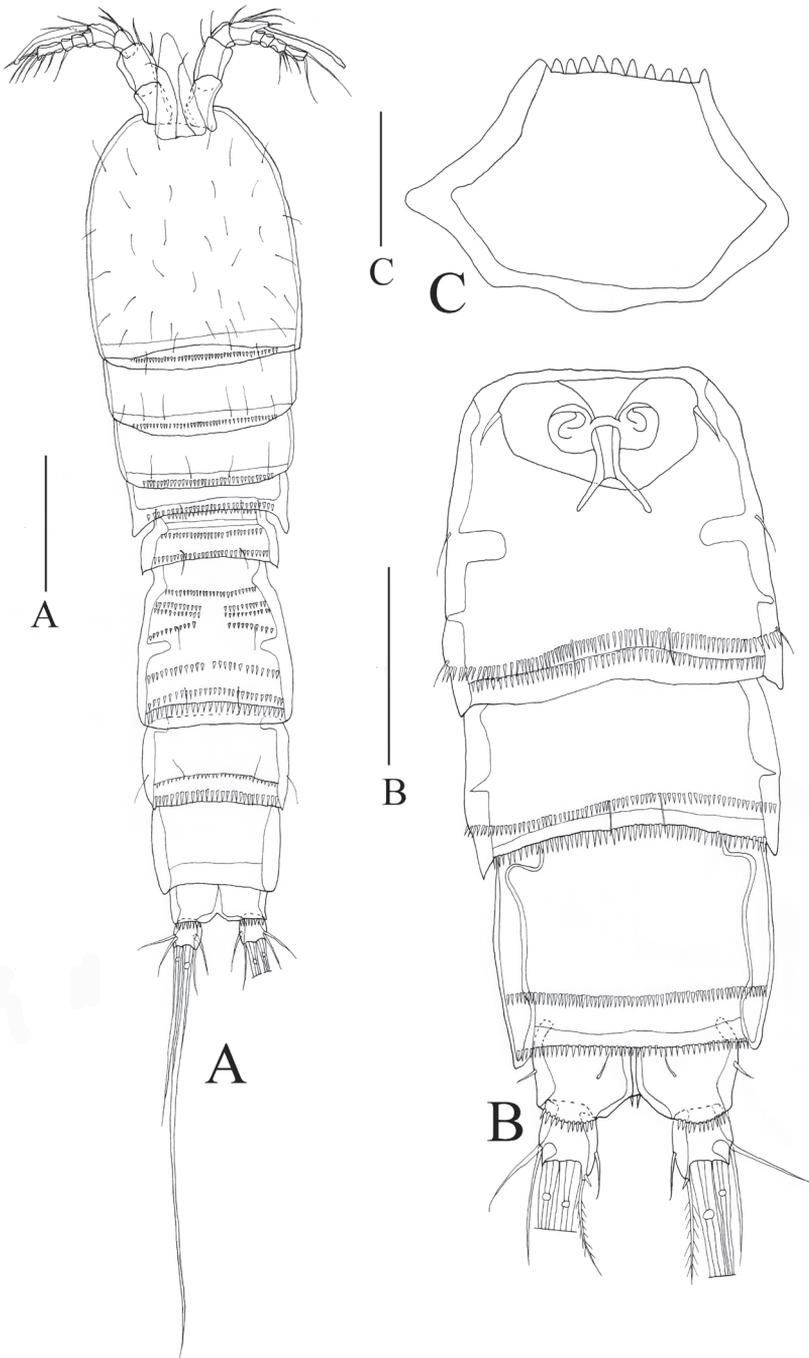


Figure 2. *Rhyncholagena paraspinifer* sp. n. Holotype **A** habitus, dorsal **B** urosome, ventral **C** labrum. Scale bars: 100µm (**A, B**); 50µm(**C**).

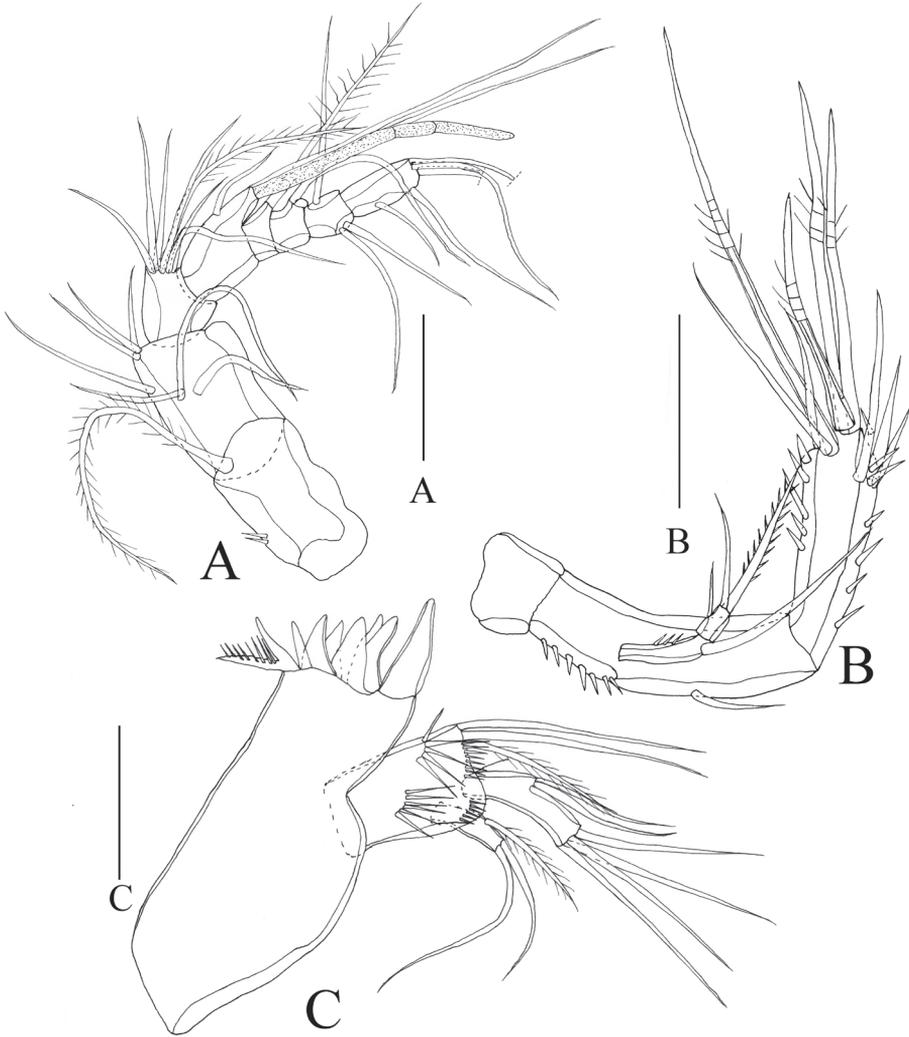


Figure 3. *Rhyncholagena paraspinifer* sp. n. Holotype **A** antennule **B** antenna; paratype (female, MBM189079) **C** mandible. Scale bar: 50 μ m.

Antennule (Figure 3A) with eight segments; first segment and second segment the longest; aesthetasc on fourth segment reaching beyond distal end of terminal segment. Armature formula: 1-[1], 2-[7], 3-[7], 4-[3+aes], 5-[1], 6-[1], 7-[3], 8-[5].

Antenna (Figure 3B) biramous, small coxa without ornamentation. Allobasis elongated, about three times as long as coxa, with spinules on lateral margin. Exopod two-segmented, with 1:1.2 setae; exp-1 long, almost two times as long as exp-2. Endopod one-segmented, with row of spines on inner and out edge, respectively; lateral armature consisting of three smooth setae; apical armature consisting of six elements: four geniculate setae, two slender and smooth setae.

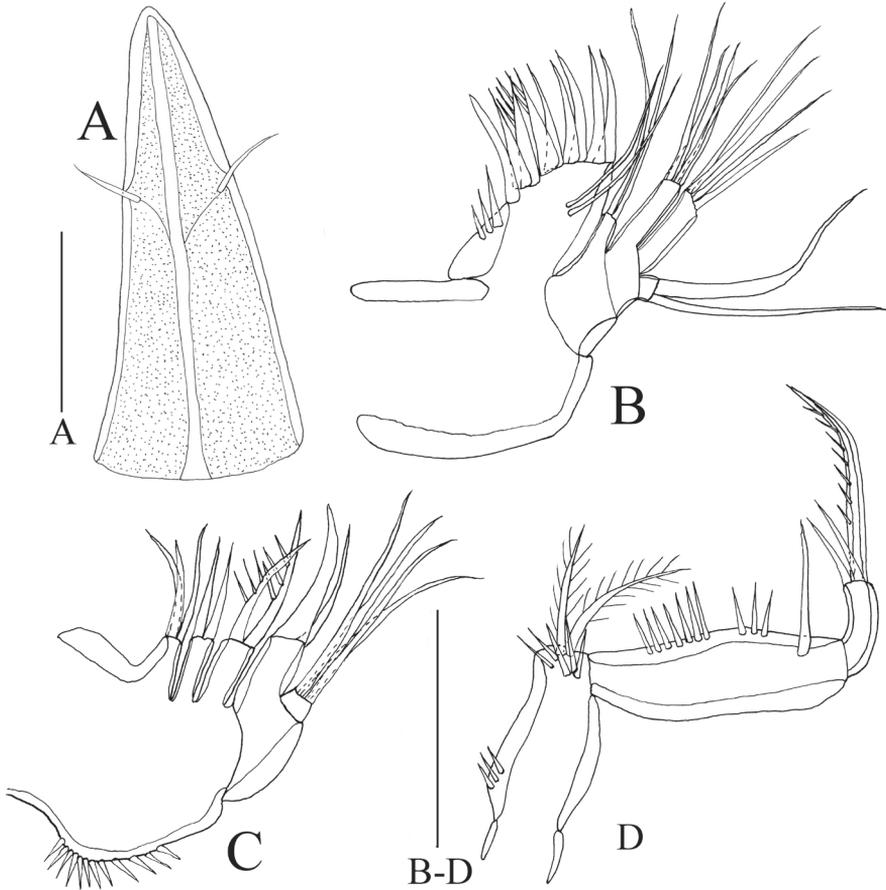


Figure 4. *Rhyncholagena paraspinifer* sp. n. Holotype **A** rostrum **B** maxillule **C** maxilla **D** maxilliped. Scale bar: 50 μ m.

Mandible (Figure 3C) gnathobase with eight large, smooth teeth and one seta, outmost teeth combined with seta on the base. Basis with four rows of spinules and three setae. Exopod one-segmented, with one lateral seta, two terminal setae. Endopod one-segmented, with two lateral setae, four terminal setae.

Maxillule (Figure 4B). Praecoxa and coxa demarcated. Arthrite with nine apical spines, two juxtaposed setae on surface. Coxal endite with two setae. Basis with four naked setae. Endopod one-segmented, with four naked setae. Exopod one-segmented, with two setae.

Maxilla (Figure 4C). Syncoxa with spinules along outer margin; with three endites bearing three, two, two setae, respectively. Allobasis with one claw and one seta. Endopod one-segmented, with four setae, respectively.

Maxilliped (Figure 4D). Subchelate. Syncoxa with several spinules along inner and distal margins, two setae located at distal margin. Basis with row of spinules and one seta on inner margin. Endopod one-segmented; with two setae and one strong claw.

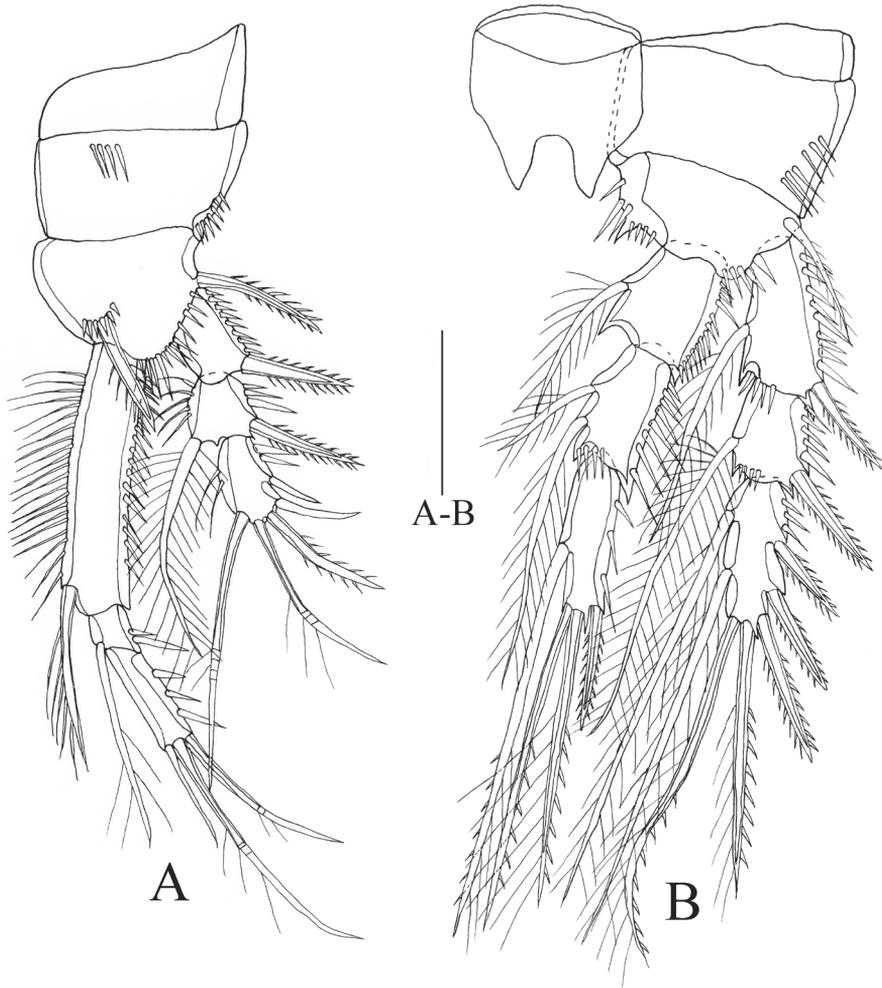


Figure 5. *Rhyncholagena paraspinifer* sp. n. Holotype **A** P1, anterior **B** P2, anterior. Scale bar: 50 μ m.

P1 (Figure 5A). Coxa with row of spines on anterior surface, row of spinules along outer margin. Basis bearing one outer plumose seta and one strong inner spinulose spine, terminal margin with spinules, surface with setules. Exopod three-segmented, short, reaching to nearly $4/5$ length of enp-1; outer margins of each segment ornamented with spinules; inner margins of exp-2 and exp-3 with setules; exp-2 with one plumose seta; exp-3 with two geniculate setae, two spinulose spines and one smooth spine. Endopod three-segmented, outer margins of each segment with spinules; enp-1 elongated, 1.8 times as long as enp-2 plus enp-3, inner margin with setules and one plumose seta; enp-2 short, with one inner seta; enp-3 longer than exp-2, approx. twice as long as enp-2.

P2–P3 (Figs. 5B, 6A). Intercoxal sclerites approximately triangular, with two distal (or apical) projections. Coxae with row of spines on outer margins. Basis with rows of

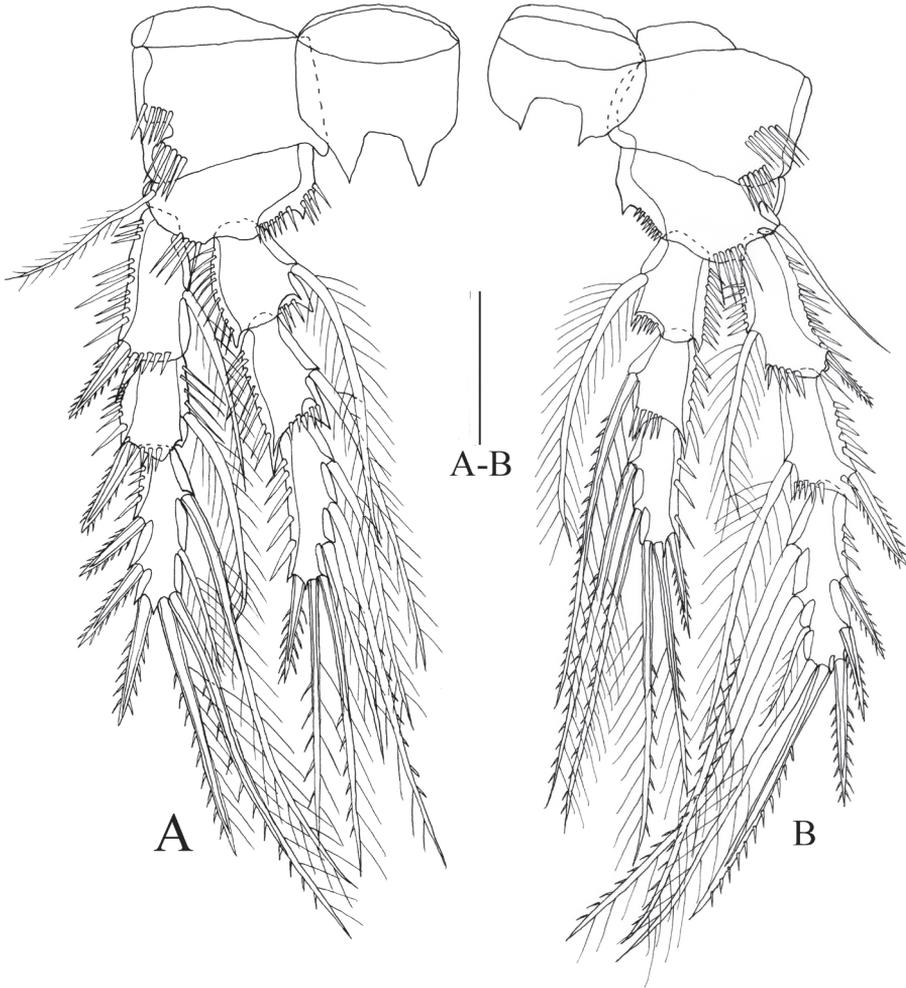


Figure 6. *Rhyncholagena paraspinifer* sp. n. Holotype **A** P3, anterior **B** P4, anterior. Scale bar: 50 μ m.

spines on anterior margins. Exopods and endopods three-segmented, outer margins of each segment ornamented with spinules; endopod nearly as long as exopod.

P4 (Figure 6B) Intercoxal sclerites almost quadrate, with two distal blunt projections. Coxa of almost rectangular shape with two rows of spinules on anterior surface. Basis with row of spines on anterior margin. Exopods and endopods three-segmented, endopod shorter than exopod. Setal formulae of female P1–P4 as follows:

	Exp	Enp
P1	0-1-1, 2, 2	1-1-0, 2, 1
P2	1-1-2, 2, 3	1-2-1, 2, 1
P3	1-1-2, 2, 3	1-1-3, 2, 1
P4	1-1-3, 2, 3	1-1-2, 2, 1

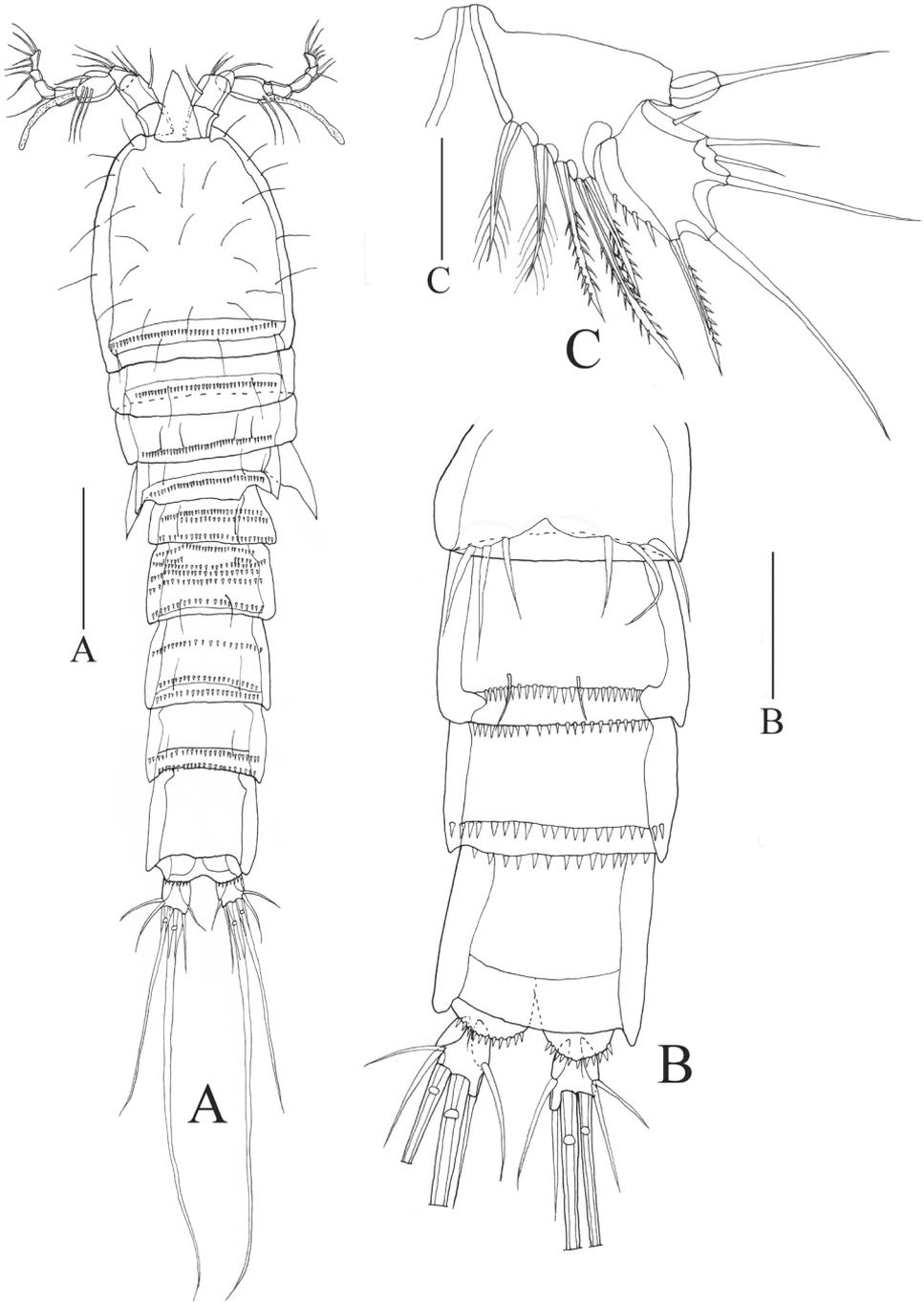


Figure 7. *Rhyncholagena paraspinifer* sp. n. Allotype **A** habitus, dorsal **B** urosome, ventral; holotype **C** P5. Scale bars: 100 μm (**A**, **B**); 50 μm (**C**).

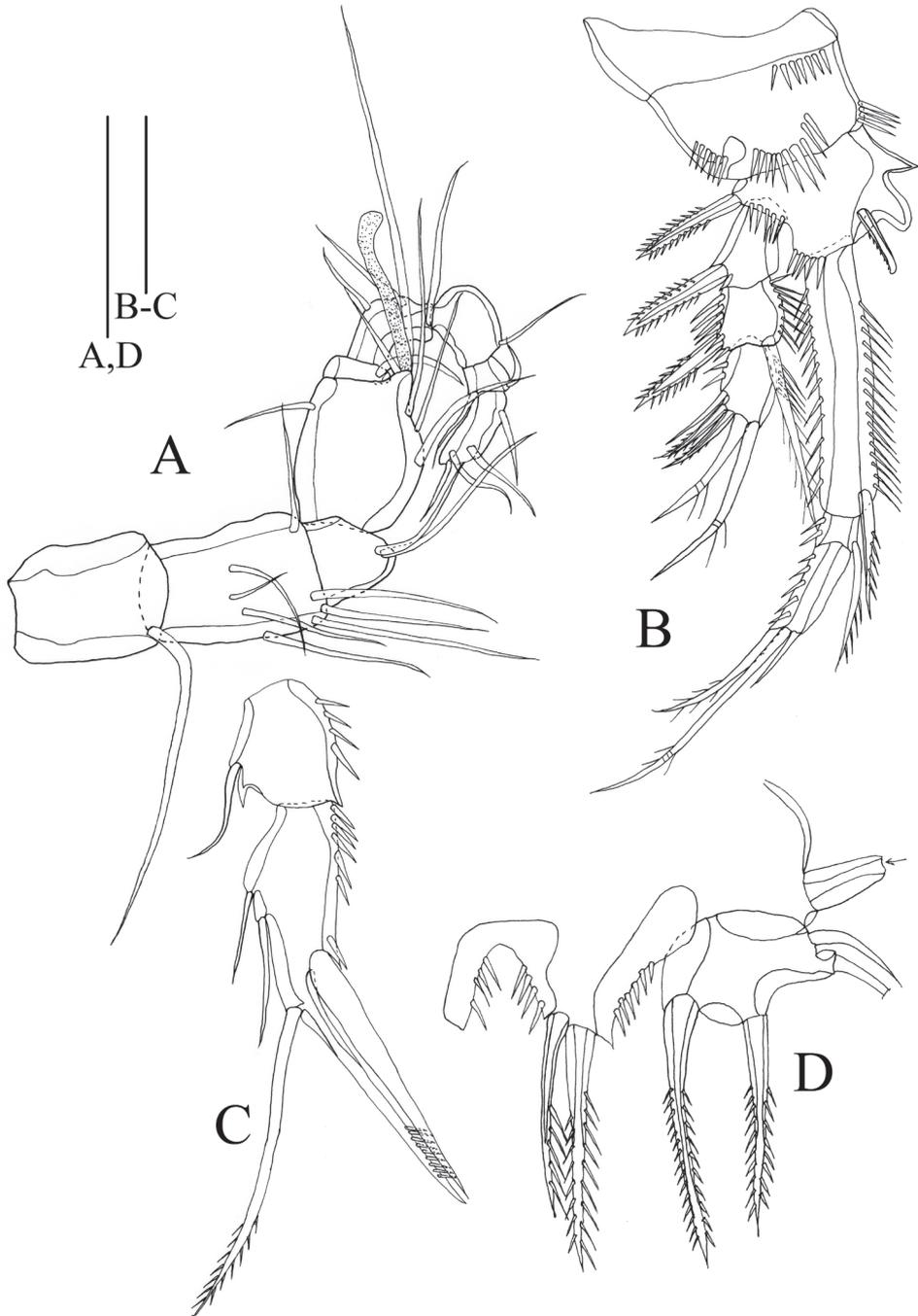


Figure 8. *Rhyncholagena paraspinifer* sp. n. Allotype **A** antennule **B** P1, anterior **C** P2 endopod, anterior **D** P5 with one outer seta cutting; paratype (male, MBM189080; small arrow meaning one seta missing). Scale bars: 50 μ m.

Right and left P5 (Figure 7C) not fused medially, baseoendopod and exopod separated. Baseoendopod reaching nearly to 1/5 length of exopod; with two plumose and three spinulose setae, second innermost one longer than others. Exopod nearly rectangular, 1.3 times as long as greatest width, ornamented with one spinulose and four naked setae, distalmost one longest.

Male based on allotype and one paratype differs from female as follows:

Body (Figs 1B, 7A) slightly shorter than female holotype, total length of allotype male (body plus caudal rami, excluding caudal setae): 610 μm . Urosome (Figure 7B) six-segmented, genital somite and the first abdominal somite separate, urosomites with rows of small spinules except penultimate urosomite. Caudal ramus as long as broad, with six setae.

Antennule (Figure 8A) nine-segmented, haplocer. Armature formula: 1-[1], 2-[8], 3-[2], 4-[6+aes], 5-[1], 6-[3], 7-[1], 8-[2], 9-[4], geniculation between sixth and seventh segments.

Antenna, mandible, maxillule, maxilla, maxilliped, P3 and P4 similar to female.

P1 (Figure 8B). Coxa with four rows of spines on anterior surface and inner margin. Basis bearing one fingerlike spine and two spinous projections on inner margin; exp-1 without spines on outer margin. Other characters as in female.

P2 with protopod and exopod as in female holotype. Endopod (Figure 8C) two-segmented; enp-1 with one slender inner seta; enp-2 modified as common in genus, with two slender setae on inner margin; one seta and one spinous spine on distal margin; one stout spine on outer margin.

P5 (Figure 8D) baseoendopod unseparated, with two spinous spines, reaching beyond the end of the exopod; exopod with denticles and four unequal setae, two pinnate, two slender and naked.

P6 (Figure 7B) reduced each to three setae inserted on distal margin of somite.

Variability. Most morphological features are conservative, except body length. Body length of female varies from 450 μm to 710 μm and male from 460 μm to 610 μm .

Etymology. The species is named according to many spines on the body.

Discussion

The new species can be easily placed in the genus *Rhyncholagena* by the following two characters: the incision between the apical setae of the P5 exopod and the very elongated rostrum (see Por 1967).

In Table 1, all currently valid species of *Rhyncholagena* are listed, together with some of their most prominent morphological characters. All morphological characters were collected from publications, except for the new species described here. Some original species descriptions were not thorough, and additional data are collected from subsequent publications attributed to the same species.

It is clear from Table 1, that the species of genus *Rhyncholagena* can be separated into two groups based on the number of inner seta in P1 enp-2. The group 1 without

Table 1. List of valid species of *Rhyncholagena* Lang, 1944, with their most prominent morphological features according original descriptions and additional data about the same species.

Species	A2 exopod segment	Setal formulae of swimming legs (exp/emp)					Setal formulae of swimming legs (exp/emp)		Female P5 exopod long/wide	Distal of female P5 baseoendopod	References
		P1	P2	P3	P4	female P5	male P5				
<i>R. bermudensis</i> Malt, 1990	2	0.1.122/1.0.120	1.1.223/1.2.130	1.1.223(2)/ 1.1.231	1.1.323/1.1.230	6/5	Unknown	≈3	not exceeding half-length of exopod	Malt 1990	
<i>R. josphatis</i> Por, 1967	3	0.1.122/1.0.120	1.1.223/1.2.121	1.1.223/1.2.321	1.1.323/1.1.221	6/4	5 (2)	≈1.9	exceeding half-length of exopod	Por 1967	
<i>R. lagenirostris</i> (Sars, 1911)	3	0.1.122/1.1.120	1.1.123/1.2.121	1.1.123/1.1.321	1.1.223/1.1.221	6/5	5 (3)	≈2.4	slightly exceeding half-length of exopod	Sars 1911; Lang 1948; Jakobi 1959; Wells 2007	
<i>R. levantina</i> Por, 1964	Unknown	0.1.122/1.1.120	1.1.123/1.1.121	1.1.123/1.1.321	1.1.323/1.1.221	5/5	5 (2)	≈2.2	exceeding half-length of exopod	Por 1964	
<i>R. littoralis</i> Por, 1967	3	0.1.122/1.0.120	1.1.223/1.2.121	1.1.223/1.1.321	1.1.323/1.1.221	6/5	Unknown	≈1.6	not exceeding half-length of exopod	Por 1967	
<i>R. pestai pestai</i> (Monard, 1935)	3	0.1.122/1.1.120	1.1.223/1.2.121	1.1.223/1.2.321	1.1.323/1.1.221	6/5	6(3)	≈2.1	slightly exceeding half-length of exopod	Monard 1935; Lang 1948; Jakobi 1959; Wells 2007	
<i>R. pestai americana</i> Rouch, 1962	3	0.1.122/1.1.120	1.1.223/1.2.121	1.1.223/1.1.321	1.1.323/1.1.221	6/5	Unknown	≈2.5	exceeding half-length of exopod	Rouch 1962	
<i>R. profundorum</i> Por, 1967	3	0.1.122/1.1.120	1.1.223/1.2.121	1.1.223/1.2.321	1.1.323/1.1.221	5/5	Unknown	≈1.9	not exceeding half-length of exopod	Por 1967	
<i>R. spinifer</i> (Farran, 1913)	3	0.1.122/1.0.120	1.1.123/1.2.121	1.1.123/1.1.321	1.1.223/1.1.221	6/5	5 (3)	≈2.9	slightly exceeding half-length of exopod	Farran 1913; Lang 1948; Jakobi 1959; Wells 2007	
<i>R. panispinifer</i> sp. n.	2	0.1.122/1.1.120	1.1.223/1.2.121	1.1.223/1.1.321	1.1.323/1.1.221	5/5	4(2)	≈1.2	not exceeding half-length of exopod	Present contribution	

*Bodin (1964) mentioned that caudal ramus of the species were not twisted inside as type species, but bulbous-shaped; exopod of male P5 with five setae instead of six.

Table 2. The distributions of valid species of genus *Rhyncholagena* Lang, 1944.

Species	Distribution	Depth	References
<i>R. bermudensis</i> Malt, 1990	Bermuda (mangrove)	9–11m	Malt 1990; Warwick et al. 1990
<i>R. josaphatis</i> Por, 1967	Red Sea; Suez Canal	5–300m	Por 1967, 1977; Por and Marcus 1972
<i>R. lagenirostris</i> (Sars, 1911)	Norway	36.58–54.87m	Sars 1911; Lang 1948
<i>R. levantina</i> Por, 1964	Nahariya (Israel); Banyuls Sur Mer (France)	3m	Por 1964; Guille and Soyer 1966
<i>R. littoralis</i> Por, 1967	Red Sea; Suez Canal; Brazil (coral reefs)	0.5–1m (gravels)	Por 1967; Por and Marcus 1972; Sarmento and Santos 2012
<i>R. pestai pestai</i> (Monard, 1935)	France (Roscoff; North Brittany); Algeria (Castiglione); North Carolina (USA); France (Marseilles)	10–30m	Monard 1935, 1937; Lang 1948; Coull 1971; Bodin 1964; Bodin and Le Guellec 1992
<i>R. pestai americana</i> Rouch, 1962	Argentina (Punta Canteras)	250m	Rouch 1962
<i>R. profundorum</i> Por, 1967	Red Sea	700m	Por 1967
<i>R. spinifer</i> (Farran, 1913)	Ireland (Killary harbour in Mayo); France (North Brittany)	43.9m	Farran 1913; Monard 1928; Bodin and Le Guellec 1992
<i>R. paraspinifer</i> sp. n.	South China Sea	30.1m	Present contribution

inner seta on P1 enp-2, includes *R. spinifer*, *R. josaphatis*, *R. littoralis*. The group 2 with one inner seta on P1 enp-2, comprises *R. lagenirostris*, *R. pestai pestai*, *R. pestai americana*, *R. levantina*, *R. profundorum*, *R. bermudensis* and *R. paraspinifer* sp. n. Within this genus, *R. pestai pestai* may be a doubtful species. Monard (1935) described the species with the caudal ramus bulbous-shaped and twisted inside; exopod of male P5 with six setae. Bodin (1964) mentioned the caudal ramus of the species as bulbous-shaped, but not twisted inside as in type species; and the exopod of male P5 with five setae. We can't know if the differences can be attributed to intraspecific variability or can be an error of observation. The new species differs from its congeners by the combined morphological features: body ornamented with hyaline frills except penultimate urosomite on distal margin; A2 exopod two-segmented; P1 enp-2 with one inner seta; P3 exp-3 with two inner setae; P3 enp-2 with one inner seta; female P5 exopod with five setae; male P5 baseoendopod with two setae, exopod with four setae. The shape of P5 is another particular character useful to differentiate the *Rhyncholagena* species. According to our observations, P5 of our specimens resembles those of *R. littoralis* Por, 1967 and *R. profundorum* Por, 1967. These three species share the following characters in the female P5: distal of P5 baseoendopod not exceeding half-length of exopod; P5 exopod less than twice as long as wide; projection of two apical setae in exopod nearly the same length.

However, *R. paraspinifer* sp. n. differs from *R. littoralis* by the following characteristics: rostrum almost triangular (needle-like in *R. littoralis*); A2 exopod two-segmented (three-segmented in *R. littoralis*); P1 enp-2 with one inner seta (without inner seta in *R. littoralis*); P5 exopod bearing five setae (six setae in *R. littoralis*). *Rhyncholagena paraspinifer* sp. n. can be distinguished from *R. profundorum* by the following features: A2 exopod two-segmented (three-segmented in *R. profundorum*); P3 enp-2 with one inner

seta (two inner setae in *R. profundorum*); P5 exopod 1.15 times as long as wide (1.85 times in *R. profundorum*); P5 exopod nearly rectangular (oval in *R. profundorum*).

Rhyncholagena paraspinifer sp. n. bears two inner setae in P3 exp-3, in contrast to *R. lagenirostris*, *R. levantina*, and *R. spinifer* which bear only one inner seta. However, *R. paraspinifer* sp. n. differs from *R. josaphatis* and *R. pestai pestai* by having two and four setae in male P5 baseoendopod and exopod, respectively (two and five setae in *R. josaphatis*; three and six setae in *R. pestai pestai*). The new species can be distinguished from *R. bermudensis* by the characters of the two apical projections of P5 exopod being as long as each other in female (the longer one nearly twice as long as shorter one in *R. bermudensis*). *Rhyncholagena paraspinifer* sp. n. and *R. pestai americana* shares similar setal formulae of P1-P4. However, the two species also have differences: *R. paraspinifer* sp. n. bears five setae on female P5 exopod (six setae in *R. pestai americana*); distal of P5 baseoendopod not exceeding half-length of exopod in female (exceeding half-length of exopod in *R. pestai americana*).

The distributions and depths of all valid species of the genus *Rhyncholagena* are listed in Table 2. From the Table 2, we can consider that the genus *Rhyncholagena* is mainly distributed in the Atlantic Ocean, the Red Sea, and the Mediterranean and ranges from intertidal to deep sea. No cosmopolitan species were found. The recent record from the South China Sea considerably extended the distribution range of the *Rhyncholagena* species to Indo-Pacific Ocean. The fact that most species of *Rhyncholagena* were reported in single localities only, does not indicate that they are endemic. The low number of known *Rhyncholagena* species from the Pacific Ocean maybe due to lack of sampling of this taxon. More samples have to be analyzed to gain more knowledge about the distribution of the taxon *Rhyncholagena*.

From the Table 2, we can found that species of the genus *Rhyncholagena* are mainly distributed in temperate zone, except *R. paraspinifer* in subtropical zone, *R. littoralis* in temperate and tropical zone. It is interesting to note that the species *R. littoralis* is eurythermal and inhabits in both sides of Atlantic. More studies would be necessary to elucidate the distribution of the species.

Lang (1948) established a key to species of the genus *Rhyncholagena*, which included three species, *R. lagenirostris*, *R. spinifer* and *R. pestai pestai*. Below we present an updated key, which is modified from the earlier keys by Lang (1948) and Wells (2007). Since some species lack descriptions of male, the key is made based on females.

Key to the species of the genus *Rhyncholagena* Lang, 1944 (female)

- | | | |
|---|---------------------------------------|---------------------------------|
| 1 | P5 baseoendopod with four setae | <i>R. josaphatis</i> Por, 1967 |
| – | P5 baseoendopod with five setae | 2 |
| 2 | P5 exopod with five setae | 3 |
| – | P5 exopod with six setae..... | 5 |
| 3 | P3 enp-2 with two inner setae..... | <i>R. profundorum</i> Por, 1967 |
| – | P3 enp-2 with one inner seta..... | 4 |
| 4 | P2 enp-2 with two inner setae..... | <i>R. paraspinifer</i> sp. n. |
| – | P2 enp-2 with one inner seta..... | <i>R. levantina</i> Por, 1964 |

- 5 P2-P3 exp-3 with one inner seta..... 6
 – P2-P3 exp-3 with two inner setae..... 7
 6 Urosomites without hyaline frills; second segment of A1 produced a well-marked and incurved spinous projection in middle inside *R. lagenirostris* (Sars G.O., 1911)
 – Urosomites with 8 strong and separated spines on posterior dorsal margins; second segment of A1 without spinous projection in middle inside
 *R. spinifer* (Farran, 1913)
 7 P2 enp-2 with two inner setae..... *R. pestai pestai* (Monard, 1935)
 – P3 enp-2 with one inner seta..... 8
 8 P5 exopod with two apical projections, longer one about two times as long as shorter one..... *R. bermudensis* Malt, 1990
 – Two apical projections of P5 exopod mostly as long as each other..... 9
 9 P1 exopod not exceeding to middle length of P1 enp-1; P5 exopod less than two times as long as greatest wide *R. littoralis* Por, 1967
 – P1 exopod exceeding to middle length of P1 enp-1; P5 exopod more than two times as long as greatest wide *R. pestai americana* Rouch, 1962

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An updated and illustrated dichotomous key for the Chagas disease vectors of *Triatoma brasiliensis* species complex and their epidemiologic importance

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Abstract

In the subfamily Triatominae, *Triatoma* exhibits the largest number of species, which are arranged in complexes. For the *T. brasiliensis* species complex, recent investigations based on results of geometric morphometrics combined with phylogeny have provided evidence that it should be composed of seven species: *T. brasiliensis*, *T. bahiensis*, *T. juazeirensis*, *T. lenti*, *T. melanica*, *T. petrocchia*, and *T. sherlocki*, in which *T. brasiliensis* is divided in two subspecies: *T. b. brasiliensis* and *T. b. macromelasoma*. A taxonomic key is presented to identify each taxon. Among members of this complex, *T. b. brasiliensis* is the most important in an epidemiologic context, due to its high prevalence in natural infection by *Trypanosoma*

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cruzi combined with a pronounced adaptation to domiciliary habitats. However, some members may be currently invading and colonizing homes, a process known as domiciliation. Therefore, the key presented here may be potentially useful for researchers as well as those involved in vector control measures.

Keywords

kissing bugs, morphological key, species group

Introduction

Chagas disease is an infection caused by the etiologic agent *Trypanosoma cruzi* (Chagas, 1909), a protozoan transmitted to humans and other mammals through the feces of infected hematophagous insects of subfamily Triatominae. Currently, this group consists of more than 150 species, of which more than 65 are found in Brazil (Costa and Lorenzo 2009; Galvão 2014; Oliveira and Alevi 2017; Oliveira et al. 2018). In addition to vector-borne transmission (the main route), several other modes are known, including congenital transmission, accidental intake of contaminated food (e.g., açai juice and sugarcane juice), organ transplantation, blood transfusion, breastfeeding, and laboratory accidents (WHO 2017). In the subfamily Triatominae, *Triatoma* exhibits the largest number of species, which are arranged in complexes, a kind of grouping that was initially based in varied rationalities, as ecology, geographic distribution, cytogenetics, among others (see Oliveira et al. 2017). Phylogenetic reconstruction based on multiple mitochondrial genes did not recover *Triatoma* as a monophyletic unit (Gardim et al. 2014; Justi et al. 2014). Despite this, it is a genus with several species of epidemiological importance, as *T. infestans* in several countries of South America, *T. dimidiata* in Central America and *T. brasiliensis*, *T. pseudomaculata* and *T. sordida* in Brazil (Coura 2015). Justi et al. (2014) presented a comprehensive phylogenetic study of Triatomini, proposing the species complexes should be composed by natural groups.

Triatoma brasiliensis species complex represents a monophyletic unit (Oliveira et al. 2017) and was first suggested as a group (Costa et al. 2013) based on data on morphology (Costa et al. 1997), biology (Costa and Marchon-Silva 1998), crossing experiments (Costa et al. 2003b), ecology (Costa et al. 1998; Almeida et al. 2009), isoenzymes (Costa et al. 1997), dispersal abilities (Almeida et al. 2012), and DNA variation analyses (Monteiro et al. 2004). Recent cytogenetic, morphological and molecular studies (Alevi et al. 2013, 2014, 2015, 2018; Mendonça et al. 2014, 2016; Oliveira et al. 2017) have shown that other species, in addition to those previously identified (Costa et al. 2013), should be included in the *T. brasiliensis* complex, which currently consists of *T. brasiliensis* Neiva, 1911, *T. bahiensis* Sherlock & Serafim, 1967, *T. juazeirensis* Costa & Felix, 2007, *T. lenti* Sherlock & Serafim, 1967, *T. melanica* Neiva & Lent, 1941, *T. petrocchia* Pinto & Barreto,

1925, and *T. sherlocki* Papa et al., 2002, in which *T. brasiliensis* is divided in two subspecies *T. b. brasiliensis* Neiva, 1911 and *T. b. macromelasoma* Galvão, 1956.

To date, most of measures to combat the transmission of Chagas disease have been focused on vector control. Defining the taxonomic status and correctly identifying vectors of the *T. brasiliensis* complex is crucial to the success of surveillance actions, because each species exhibits its own epidemiological importance (Costa et al. 2003a, 2013). Because the *T. brasiliensis* species complex suffered rearrangements after phylogenetic and morphometric studies, an update of the dichotomous key by Costa et al. (2013) for members of the *T. brasiliensis* complex is proposed, according to the new consensus for defining this group.

Materials and methods

Most of insects studied here are deposited in the Entomological Collection of Oswaldo Cruz Institute (CEIOC), Oswaldo Cruz Foundation, Rio de Janeiro, Brazil. The type species were always checked if possible, as previously detailed (Costa et al. 2013). For the newly included members (*T. petrocchiae*, *T. lenti*, and *T. bahiensis*) material from the insectary of Araraquara was also used that was deposited in the Dr Jose Maria Soares Barata Triatominae Collection (CTJMSB) of the São Paulo State University Julio de Mesquita Filho (UNESP), School of Pharmaceutical Sciences (FCFAR), Araraquara, São Paulo, Brazil. Insects from this insectary were also used for taking the photographs. The terminology of Lent and Wygodzinsky (1979) is followed.

Results

According to Lent and Wygodzinsky (1979), the genus *Triatoma* comprises species in most cases with less than 30 mm. Other features include femora denticulate or not; ventral connexival plates distinct, although narrow in some cases. The sides of abdomen are rarely membranous, with membrane connecting dorsal and ventral connexival plates. The posterior process of pygophore is narrowly tapering apically. Members of *T. brasiliensis* species complex share a combination of characteristics: (i) they compose a natural group of (ii) inhabitants of rocky outcrops, (iii) distributed in semi-arid zones of Brazilian Northeast in the Caatinga Biome. The only exception is *T. melanica*, which can be also found in connections between Caatinga and Cerrado in the state of Minas Gerais. They are spread in many states, such as Bahia (BA), Ceará (CE), Maranhão (MA), Minas Gerais (MG), Paraíba (PB), Pernambuco (PE), Piauí (PI), and Rio Grande do Norte (RN).

A pictorial dichotomous key for the *T. brasiliensis* species complex was built up as follows:

- 1 Brachypterous specimens (short wings for both genders), hemelytra not extending beyond the posterior margin of urotergite VI; legs unusually long; overall color dark brown to black, connexiva and femora with reddish orange markings *T. sherlocki* (BA)



- Macropterous specimens, hemelytra reaching or almost reaching urotergite VII..... 2



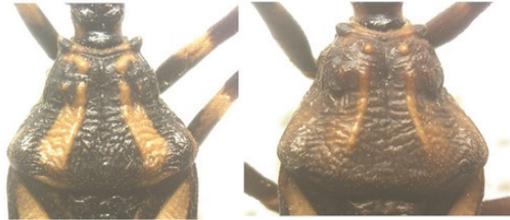
- 2 Short first antennal segment, not close to reaching apex of clypeus
..... *T. petrocchia* (BA, CE, PB, PE, RN)



- First antennal segment reaching or almost reaching the level of apex of clypeus 3



3 Pronotum with 1+1 pale colored areas or stripes 4



– Pronotum with entirely dark anterior lobe 6



4 Pronotum with 1+1 narrow brownish-yellow stripes; membrane of hemelytra with lumen of cells partially darkened..... *T. b. macromelasoma* (PE)



– Pronotum with 1+1 broad, elongated brownish yellow areas; membrane of hemelytra with lumen of cells entirely darkened or not 5

5 Pronotum with 1+1 brownish yellow areas extending from the posterior portion of anterior lobe to posterior lobe; femora with broad brownish yellow rings; membrane of hemelytra with lumen of cells not darkened; males with fossula spongiosa on fore tibia only..... *T. b. brasiliensis* (CE, MA, PB, PI, RN)



– Pronotum with 1+1 brownish yellow areas only on posterior lobe; femora with narrow brownish yellow rings; membrane of hemelytra with lumen of

cells entirely darker; males with fossula spongiosa on fore tibiae.....
..... *T. melanica* (BA, MG)



6 Pronotum with black anterior lobe and wrinkled posterior lobe; rarely with few inconspicuous brownish yellow marks; light yellow corium with dark areas of variable extent; dark legs with light colored areas on trochanter.....
..... *T. juazeirensis* (BA)



– Pronotum entirely black, non-granular, with anterolateral angles short and apically rounded; corium and clavus dark brown to black, and dark brown membrane; legs uniformly black7



7 Scutellum with posterior portion of central depression pointed; first abdominal segment without prominences; anterior region of prothorax (near the stridulatory sulcus) with a depression in ventral view; posterior region of stridulatory sulcus with rounded and well defined edges; mesothorax smooth and rounded *T. lenti* (BA)

– Scutellum with posterior portion of central depression rounded; first abdominal segment with two lateral prominences; no depression on anterior region of prothorax; mesothorax with a central longitudinal projection, rectangular in shape *T. bahiensis* (BA)

Discussion

The epidemiological profile of Chagas disease has changed, both in endemic areas and in other regions due to human migration, resulting in dissemination to countries where there is no vector transmission (Coura 2013; Dias et al. 2014). In Brazil, despite the control of *T. infestans*, the main Chagas disease vector in the past (Dias et al. 2002; Moncayo and Silveira 2017) each geographic region presents distinct challenges due to different ecological profiles of the distinct vectors and also due to dramatic environmental modifications. For instance, oral transmissions have been observed in the north region of Brazil (Coura 2013). In the south of Brazil, the persistent *T. rubrovaria* requires intensive monitoring actions (Almeida et al. 2002) and in the northeast region, species of the *T. brasiliensis* complex have been showing rapid changes in their behavior and ecology due to environmental anthropization (Costa et al. 2014). Therefore, in endemic areas, monitoring the synanthropic behavior of Chagas disease vectors is a challenge (Costa 1999; Costa and Lorenzo 2009). This can be illustrated by the case of *T. sherlocki*: a species described as sylvatic was later found invading and colonizing domiciles in a quarry mining community in a remote area of Gentio do Ouro, Bahia state (Almeida et al. 2009). Therefore, a comprehensive taxonomic key is crucial to be used by researchers and by those involved in vector control (Lent and Wygodzinsky 1979).

Members of the *T. brasiliensis* complex have been found in 12 Brazilian states and show mainly allopatric and parapatric distribution patterns, (Costa et al. 2003a, 2014; Gurgel-Gonçalves et al. 2012; Mendonca et al. 2016). However, some species of this complex are known to be occasionally found in sympatry, as *T. b. brasiliensis*, *T. b. macromelasoma*, and *T. juazeirensis* (Costa et al. 2014, 2016) which are all sympatric with the newly included *T. petrocchiai* (Oliveira et al. 2017), which renders geography alone as an imperfect tool for confidently identifying species. Other species may also be found later to be sympatric with each other. For instance, a hybrid zone between *T. b. brasiliensis* and *T. juazeirensis* was found (Costa et al. 2009, 2016), highlighting the utility of this key in detecting intermediate forms between them.

Studies on members of the complex have demonstrated that *T. b. brasiliensis* is the most important species in epidemiological terms. This species exhibits high intra-domiciliary infestation and infection rates (Costa et al. 2003a), which led Liliuso et al. (2017) to attribute a possible role to this species in a recent Chagas disease outbreak in Rio Grande do Norte State (Vargas et al. 2018). Additionally, via molecular markers, the existence of perennial and uncontrollable foci has been demonstrated in the sylvatic areas of populations with high *T. cruzi* prevalence (Almeida et al. 2008, 2016).

We recommend disseminating a version of this document in Portuguese to those involved in vector control measures. However, despite the contribution presented here, we still face some taxonomic challenges regarding this complex. There is no available key to differentiate immature stages for all members of this complex, which may complicate the correct identification of these forms. As mentioned above (Oliveira et al. 2017), some members are sympatric (e.g., *T. petrocchiai* and *T. brasiliensis*), and if immature forms of *T. petrocchiai* are found in domiciles, it may be operationally recorded as *T. brasiliensis* during regular vector inspections, because this last species is

the most frequently found in domiciles wherever it occurs. Therefore, a comprehensive taxonomic key is a crucial tool for use by researchers and by those involved in vector control, which should include also immature forms.

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A new genus and species of Brontinae from Borneo (Coleoptera, Silvanidae)

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Abstract

A new silvanid genus *Borneophanus* **gen. n.** is described based on specimens collected from Malaysian Borneo. A new species, *B. spinosus* **sp. n.**, is described herein. Digitiform sensilla on the apical maxillary palpomere is reported in Silvanidae for the first time.

Keywords

Borneophanus, Cucujoidea, digitiform sensilla, Malaysia, Telephanini

Introduction

The family Silvanidae Kirby, 1837 (Coleoptera, Cucujoidea) includes two subfamilies, Brontinae Blanchard, 1845 and Silvaninae Kirby, 1837, and 62 extant described genera (Thomas and Nearn 2008; Thomas and Leschen 2010; Thomas 2011; Karner et al. 2015; Yoshida et al. 2017). Thomas and Leschen (2010) stated that there are 58 genera in Silvanidae, but they may not have included *Australophanus* Thomas, 2008 described in Thomas and Nearn (2008). In the Brontinae, 12 new genera have been described since the beginning of the 21st Century, and the subfamily contains 23 genera (Thomas 2004, 2011; Thomas and Nearn 2008; Karner et al. 2015). Thomas and Nearn (2008) provided diagnostic character states of the brontine tribe Telephanini LeConte, 1861 and a key to the genera of this tribe. In addition, Karner et al. (2015) described a new telephanine genus *Bolianus* Karner, Salvato & Uliana, 2015 and added the genus

to the key of genera by Thomas and Nearn (2008). According to Thomas and Nearn (2008) and Karner et al. (2015), the telephanine genera can be identified by the absence or presence and number of frontal grooves; the presence or absence of the frontoclypeal suture; the shape of antennae; the shape of tarsomere III; the shape of the terminal labial palpomere and/or maxillary palpomere; and the presence or absence of a scutellary striole. The genus *Telephanus* Erichson, 1846 is the most species-rich genus among Silvanidae and is distributed in the New World, Madagascar, and the Mascarene Islands (Thomas 1992; Thomas and Leschen 2010). Although some *Telephanus* species of Madagascar are known to have a scutellary striole, the remaining species of the genus lack it (Thomas 1992; Thomas and Nearn 2008). According to the molecular phylogenetic study of McElrath et al. (2015), the Malagasy *Telephanus* are not sister to New World *Telephanus* species but to the genus *Psammoecus* Latreille, 1829 and likely represent a distinct group. Additionally, Karner (2014) stated that *Psammoecus* is likely composed of several distinct species groups and predicted a further subdivision of this genus. As stated above, among Telephanini, generic and subgeneric classification involves many problems, thus, further taxonomic studies are still needed for the tribe Telephanini. In this paper, we describe a new telephanine genus, represented by a single species, *Borneophanus spinosus* Yoshida & Hirowatari, gen. et sp. n., from Malaysian Borneo.

Materials and methods

Observations of external characters and dissections were performed under a stereomicroscope (Olympus SZX10). The dissections were made according to the methods of Yoshida and Hirowatari (2014). After observation, the dissected parts were mounted in Euparal on cover glasses, each glued to a piece of cardboard and pinned with the specimens.

Photographs were taken with a digital camera (Canon EOS 7D) and a macro lens (Canon MP-E 65 mm), and composite images were produced using stacking software (Combine ZM). The scanning electron microscopy (SEM) images were obtained using a Hitachi S-3000N.

Depository of the holotype is in the Ehime University Museum, Matsuyama, Japan (**EUMJ**); paratypes are deposited there and in the Australian National Insect Collection, CSIRO, Canberra (**ANIC**).

Technical terms follow Williams (1938), Halstead (1980), Thomas and Leschen (2010) and Yoshida and Hirowatari (2016). Abbreviations and measurements are as follows:

BL	HL + PL + EL.	HW	greatest width of head across eyes.
EL	length of elytra measured along the median line.	IE	narrowest width of interspace between eyes.
EW	greatest combined width of elytra	PL	length of pronotum measured along the median line.
HL	length from anterior margin of clypeus to imaginary line between posterior margins of temples in dorsal view measured along the median line.	PW	greatest width of pronotum, excluding teeth.

Taxonomy

Borneophanus gen. n.

<http://zoobank.org/E5B80A06-C636-4CFF-AA37-A3A86EB7EB49>

Type species. *Borneophanus spinosus* Yoshida & Hirowatari, sp. n.

Diagnosis. Among telephanine genera, this new genus shares the following character states with *Telephanus*, *Psammoecus*, and *Indophanus* Pal, 1982: apical maxillary palpomere securiform; apical labial palpomere securiform; scutellary striole absent (some species of Malagasy *Telephanus* have a scutellary striole). This new genus differs from these genera by the combination of the following character states: distinct pair of longitudinal frontal lines present (absent in *Telephanus*); scutellar shield with a transverse carina and excavate posteriorly (flat in *Psammoecus*); antennomere IV normal (markedly long, approximately twice as long as combined length of II and III in *Indophanus*) (Thomas and Nearn 2008; Sen Gupta and Pal 1996). In addition, this new genus possesses the following characteristic morphology: the asymmetric shaped antennomere X (somewhat asymmetric in *Bolianus*); the sharply protruding elytral apices; the non-folded internal sac; the partly coiled flagellum; and the very long and rolled up spermathecal duct.

Description. Body densely covered with pubescence. Head (Figs 1–3) with indistinct frontoclypeal suture, with distinct pair of longitudinal frontal lines; eyes somewhat small, hemispherical; temples moderate in size; labrum (Fig. 3B) rectangular; antenna (Fig. 3A) long, with long scape; antennomere X asymmetrically enlarged; mandible (Fig. 3C, D) tridentate, with a ventral tooth and an inner lateral tooth near apex, ventrally with asperities near the inner tooth, with fine, random punctation, dorsolaterally with medium length to long setae, dorsally with a mycangium near base; maxilla (Fig. 3E) with lacinia and galea; galea divided into distigalea and basigalea; maxillary palp 4-segmented; apical palpomere securiform, dorsally and largely with digitiform sensilla on middle of apical palpomere; labium (Fig. 3F) divided from ligula; prementum widened distally; articulation of palps tight; labial palp 3-segmented; palpomere 2 extended outwards strongly and broadly, with large distal area; palpomere 3 securiform, strongly widened distally; mentum widened proximally, widest near base. Pronotum (Figs 1A, 2) without teeth on lateral margins, with rounded anterior angles, densely covered with setae of various lengths, without microsculpture. Thoracic ventrites (Fig. 1B) with narrowly separated pro- and mesocoxal cavities, with somewhat widely separated metacoxal cavities. Scutellar shield (Figs 1A, 2) with a transverse carina, excavate posteriorly. Legs (Figs 1, 4A, B) somewhat thin; tarsomeres 2 and 3 lobed, not bilobed. Abdominal ventrites (Fig. 4A) with somewhat wide intercoxal process, without sexual dimorphism. Elytra (Figs 1A, 2) long, without scutellary striole; lateral margins very narrowly explanate; apices somewhat elongate and narrowly rounded, with short setae on interstices. Male tergite and sternite VIII square and not divided (Fig. 4D); spiculum gastrale (Fig. 4E) thin and Y-shaped, with branches covered with membrane; median lobe (Fig. 4H) without setae; internal sac (Fig. 4H) not folded, with partly coiled flagellum, exposed around apex of median lobe; parameres (Fig. 4F, G) flat. Female with elongate gonostyli (Fig. 6B); gonocoxite

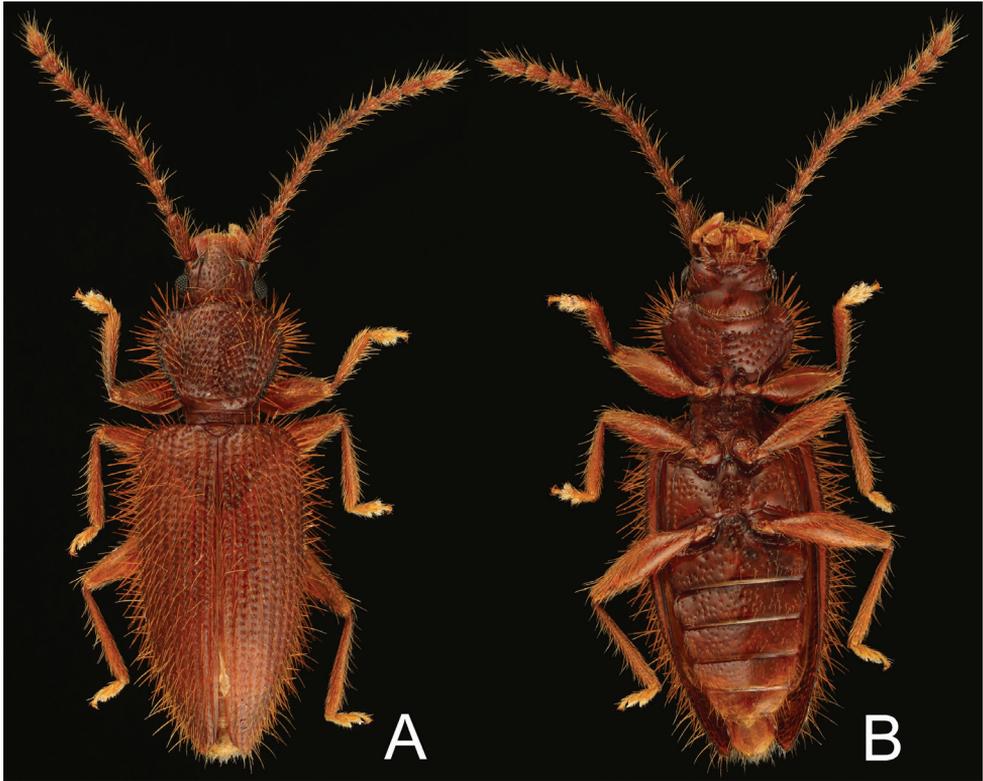


Figure 1. Habitus of *Borneophanus spinosus* gen. et sp. n., holotype, male. **A** dorsal **B** ventral aspect.

(Fig. 6B) with setae of various lengths; spermathecal duct (Figs 6A, 7A) connected to basal portion of bursa copulatrix, very long, rolled up and forming large ellipsoid.

Distribution. Malaysia (Sabah and Sarawak states).

Etymology. The new genus name is composed of two words, the locality, Borneo where this new genus was collected, and the Greek *phanos* meaning bright.

Remarks. We found sensilla, called digitiform sensilla, each located in a groove on the dorsum of the apical maxillary palpomere. Lawrence and Ślipiński (2013) stated that such sensilla on apical maxillary palpomere may be present in aedephantan and polyphantan beetles, but they have never been described in Silvanidae. We confirmed these in genera possessing securiform apical maxillary palpomeres (Telephanini: *Psammoeucus dentatus* Grouvelle, 1883; *Telephanus paradoxus* Reitter, 1874; *Cryptamorpha desjardinsi* (Guérin-Méneville, 1844), Brontini: *Australobyliota mcleayi* (Olliff, 1885), Cucujidae: *Cucujus bicolor* Smith, 1851), although, these sensilla vary in the position and size of the area among the genera (Fig. 5).

The spermathecal duct of this new genus is extremely long, likely correlated to the partly coiled flagellum of the male genitalia. However, among Telephanini, female genital structures have not been studied. For comparison, we examined the female genitalia of *P. dentatus* (Fig. 7B) and *C. desjardinsi* (Fig. 7C) and found that their sper-



Figure 2. Close-up image of head, pronotum, scutellar shield and basis of elytra of *Borneophanus spinosus* gen. et sp. n., holotype, male.

mathecal ducts are apparently shorter than in the new genus. Additionally, we found further differences in the female genitalia (e.g., gonostyli; spermatheca), thus, future comprehensive study of telephanine female genitalia seems likely to provide some useful taxonomic characters and/or their phylogenetic insights.

The biology of the new genus is unknown except for the information that one paratype of the type series was collected by beating foliage. This new genus possesses lobed tarsomeres which are shared by most telephanines and seem to be related to the ecology living on dead leaves (Thomas 1984), thus, they may have ordinary habits of telephanine beetles.

***Borneophanus spinosus* sp. n.**

<http://zoobank.org/D8D16E65-0970-49BE-BC6E-DB0A4D1A4805>

Figs 1–4, 6, 7A

Type series. Holotype: male, Poling near Ranau, Sabah State, Malaysia, 26 Apr 1980, M & A Sakai leg. (EUMJ). **Paratypes:** [Sabah State] 1 male and 1 female, same data as

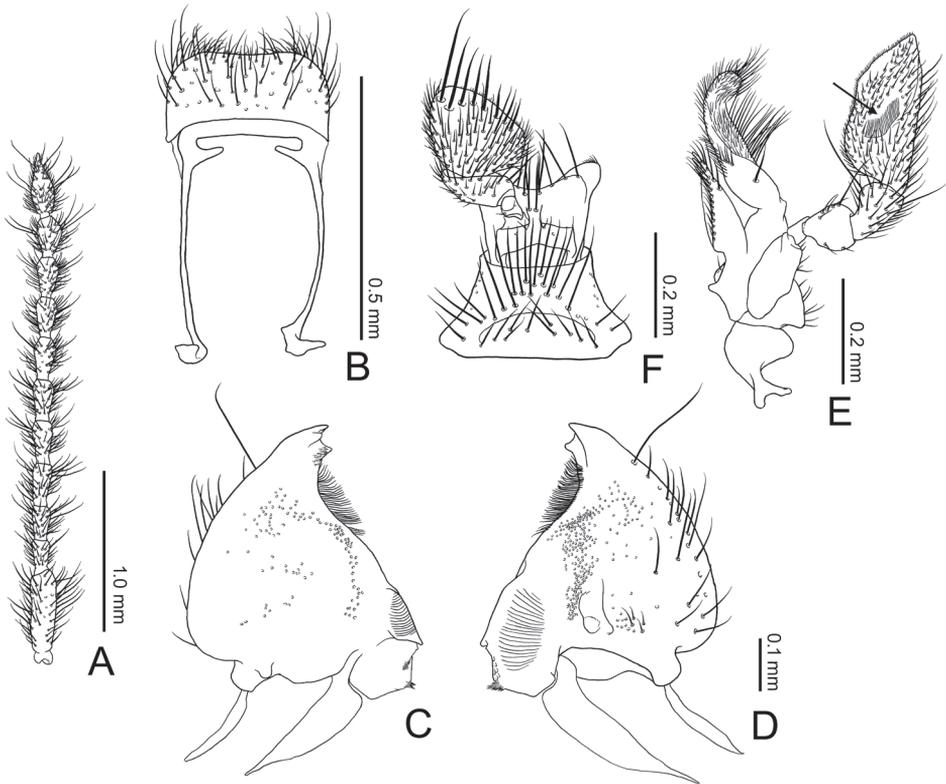


Figure 3. Antenna and mouth parts of *Borneophanus spinosus* gen. et sp. n., paratype, male. **A** Right antenna **B** labrum, dorsal view **C, D** right mandible, ventral view (**C**) and dorsal view (**D**) **E** right maxilla, dorsal view **F** labium, ventral view. An arrow indicates digitiform sensilla.

the holotype (EUMJ); 1 female, Sandakan Bay (SW), Sapagaya Lumber Camp (2–20 m), 1 Nov 1957, JL Gressitt leg. (ANIC); 1 female, Poring Hot Springs, Mt. Kinabalu National Park (486 m), 8–14 May 1987, DE Bright leg., Beating foliage. (ANIC; Loan from USNMNH 2031682). [Sarawak State] 1 male, Gunong Matang (120 m), 13 Sept 1958, JL Gressitt leg. (ANIC).

Diagnosis. This new species is superficially similar to some *Telephanus* species bearing long spines on lateral pronotum and elytra. This new species can be easily distinguished from these species by the distinct pair of longitudinal frontal lines, the asymmetric shaped antennomere X, and the sharply protruding elytral apices.

Description. **BL:** 4.47–5.28 mm (n = 5). **Coloration** (Fig. 1). Surface yellowish to reddish brown, mostly unicolorous; legs and setae lighter colored. **Head** (Figs 1–3) subquadrate, HL 0.61–0.70 mm; HW 0.87–1.03 mm; HW/HL 1.37–1.46; IE/HL 0.90–1.04 (n = 5). Eye roundly protruding, as long as length of antennomere IX. Punctuation strong and distinct, absent laterally to frontal lines; ventral surface with sparser punctuation, impunctate medially. Pubescence fine, composed of short to long

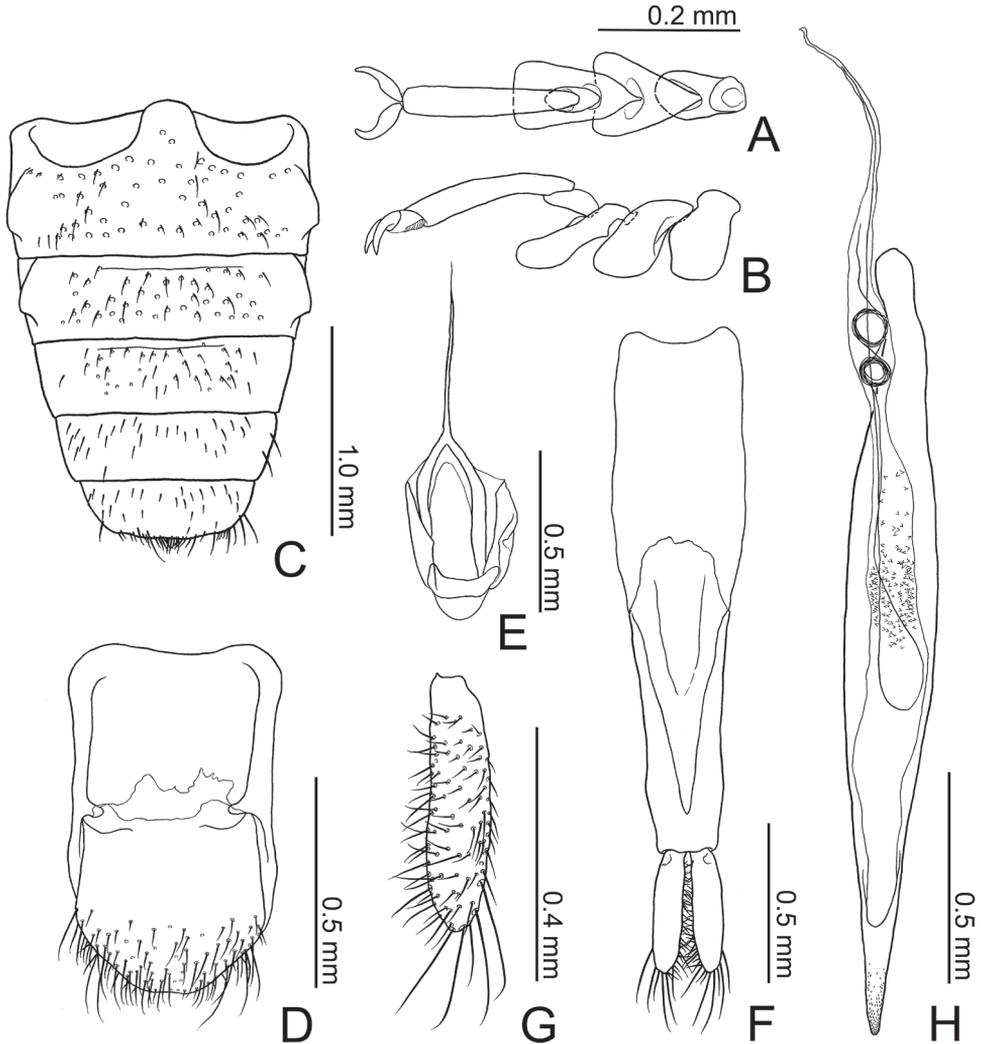


Figure 4. Tarsomeres and abdominal parts including the male genital structures of *Borneophanus spinosus* gen. et sp. n., holotype. **A, B** Tarsomeres, dorsal view (**A**) and lateral view (**B**) **C** abdominal ventries **D** eighth abdominal segments, ventral view **E** spiculum gastrale, ventral view **F** tegmen, ventral view **G** paramere, dorsal view **H** median lobe and internal sac, ventral view.

setae, setae located on posterior margin of each puncture or on very minute tubercles lateral to frontal lines. Labrum (Fig. 3B) ventrally with many setae along anterior margin, dorsally with somewhat dense pubescence composed of short to medium length setae. Antenna (Fig. 3A) with long and somewhat thick scape, three times as long as antennomere II; very densely covered with fine and medium length to long setae; antennal length and approximate ratios of antennomere lengths of holotype as follows: 3.10 mm; 3.0 : 1.0 : 1.3 : 1.4 : 1.4 : 1.4 : 1.4 : 1.4 : 1.4 : 1.3 : 2.2. Mandible (Fig. 3C, D) ventrally with a stout tooth protruding apically, with a wide tooth on

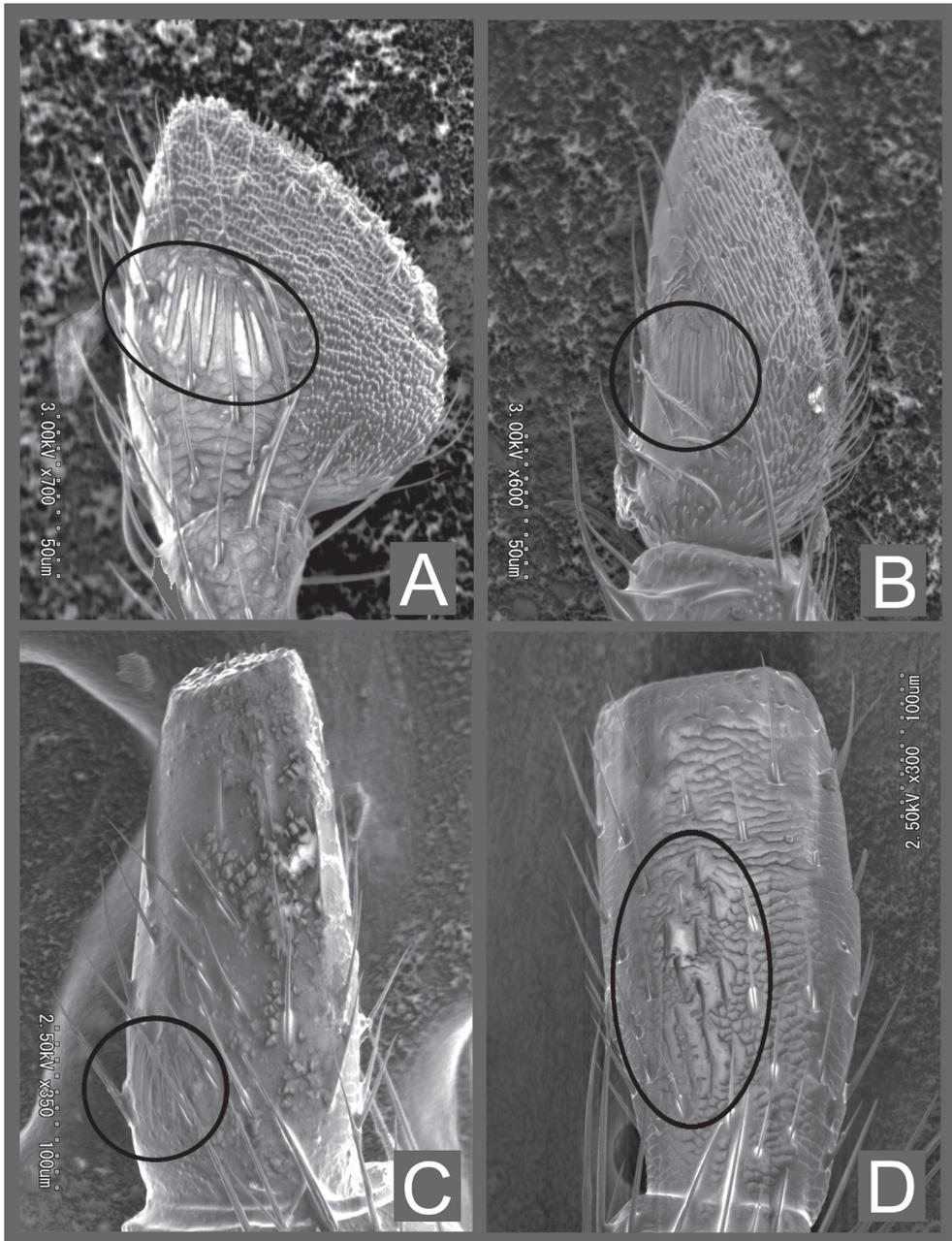


Figure 5. SEM images of apical palpomere of left maxillae (A–C) and a right maxilla (D), dorsal view, with digitiform sensilla. **A** *Psammoecus dentatus* **B** *Telephanus paradoxus* **C** *Australohyliota mcleayi* **D** *Cucujus bicolor*. Circles indicate digitiform sensilla.

inner margin near apex, ventrally densely covered with many asperities near the inner tooth, densely, finely pubescent on approx. anterior 1/3 of inner margin, punctuation very fine and partly very dense, sparse or absent near apex, lateral and molar regions,

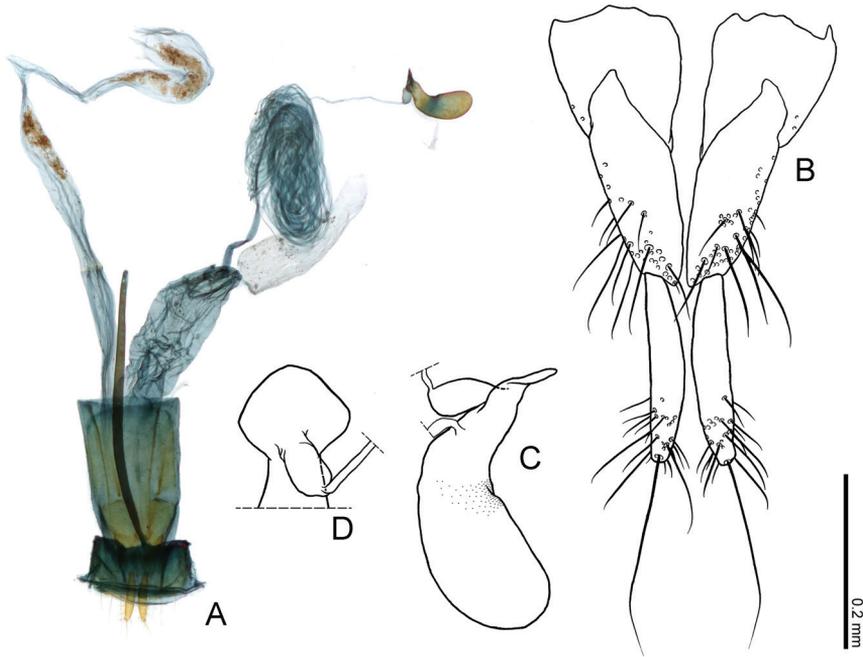


Figure 6. Female genital structures of *Borneophanus spinosus* gen. et sp. n. **A** female genital structures **B** gonocoxites and gonostyli **C, D** spermatheca, lateral view (**C**) and basal view (**D**). Scale bar provided for **B-D**.

dorsally with one long seta near apex and some setae of medium length on outer lateral region, with some short setae near mycangium; mola widely extended posteriorly, with some teeth and dense cuticular spines on posterior 1/3 of inner margin; mycangium located on middle of posterior area, opening towards outer lateral margin, longitudinally depressed on and around mycangium. Maxilla (Fig. 3E): lacinia with two long apical blunt teeth, dorsally with some setae in a longitudinal row along inner margin, few apically, these setae long, with several long setae along apical 2/5 of lateral margin; galea long and flattened, somewhat membranous; distigalea with short to very long, dense pubescence, dorsally with a short row of several short setae and one long seta on posterior half, connected to basigalea by a membrane; palpifer longitudinally oblong, ventrally with several short setae; palpomere 1 very small, extended at inner distal portion; palpomere 2 approx. twice as long as palpomere 1, strongly widened distally, with some short setae, with one very long seta on inner distal portion; palpomere 3 longer than palpomere 2, widened distally, covered with setae of various length, with one very long seta on inner distal portion; palpomere 4 securiform, strongly expanded, 2.5 times as long as palpomere 3, densely covered with short to medium length setae, densely with very short setae along distal margin; stipes ventrally with some medium length setae. Labium (Fig. 3F) distinctly divided from ligula; prementum gradually widened distally, with several long setae along distal margin, with pair of long setae and few short setae near palps; palpomere 1 very small, with few short setae, with a puncture on inner side; palpomere 2 densely covered

with many setae of various lengths; palpomere 3 densely covered with many setae of medium length, ventrally with several thick and long to medium length setae near distal margin, distally and densely covered with minute setae; mentum somewhat strongly widening proximally, partly somewhat densely covered with long setae. *Thorax and abdomen* (Figs 1, 2, 4A–C). Pronotum wider than long, PL 1.00–1.18 mm; PW 1.14–1.44 mm; PW/PL 1.15–1.24 (n = 6), enlarged around anterior angles and anterior 1/3 of lateral margins, with numerous minute setiferous tubercles densely covering lateral margins and sparser on anterior and posterior margins, with a long spine on each tubercle, somewhat densely covered with fine and long pubescence except on margins; punctation coarse, similar to vertex. Thoracic ventrites with punctation sparser than on dorsum, with pubescence shorter and sparser than on dorsum, densely covered with numerous short setae on anterior margin of proventrite; intercoxal process of procoxae widest at posterior 2/5, strongly narrowed around anterior 1/5 to 2/5, somewhat extended around posterior angles; mesocoxal process narrowed posteriorly, widened around apex. Scutellar shield (Figs 1A, 2) approx. twice as wide as long, wider than eye length, with few short setae. Legs somewhat thin; trochanters small, with sparse setae of various lengths, with one long seta; femora somewhat thin, densely covered with thin and medium length setae; profemora a little expanded; tibiae thin but gradually widening distally, with similar pubescence of femora, with some conical setae around apices; tarsomere 5 long, approx. 3 times as long as 4 (Fig. 4A,B). Abdomen (Fig. 4C) 1.5 times as long as wide; intercoxal process somewhat wide and moderately rounded anteriorly; 1st and 2nd abdominal ventrites with strong lateral protuberances; punctation sparse, weaker toward posterior; setae similar to those on thoracic ventrites. *Elytra* (Figs 1A, 2) long, sub-parallel for approximately the anterior 2/3, EL 2.84–3.40 mm (n = 6); EW 1.46–1.76 mm at approximately 1/3 length (n = 6); EW/EL 0.51–0.52 (n = 6); EW/BL 0.32–0.34 (n = 5); apices sharply protruding and triangular, with rows of punctures almost as wide as interstices, with short and thin setae on anterior margins of the punctures, with very minute setiferous tubercles on the spaces between rows, with long and thin setae on the tubercles, these setae near lateral margins thick, densely with many spines of long and medium lengths on lateral margins. *Male genitalia* (Fig. 4D–H). Tergite VIII (Fig. 4D) square, longer than wide, with rounded posterior margin, with many setae of various lengths around posterior margin; lateral margins protruding inwards near middle and connected with sternite VIII; sternite VIII (Fig. 4D) square, almost as long as wide, with rounded posterior margin, with many setae of various lengths on posterior half, with few long setae along posterior margin near posterior angles; spiculum gastrale (Fig. 4E) Y-shaped, with thin strut, bifurcating at around midlength, with simple branches; branches covered with membrane. Median lobe (Fig. 4H) very long and thin, gradually narrowed toward apex, with internal sac exposed for the apical 1/6, densely punctate around apex. Parameres (Fig. 4F, G) long, flattened, subparallel, dorsally excavated near bases, dorsally without punctures and setae, ventrally densely covered with many setae of various lengths except on bases, with a few long setae along apical margins. Phallobase (Fig. 4F) long and subparallel; tegminal strut connected to basal piece around midlength; basal piece long; posterior margin of upper layer very deeply and sharply

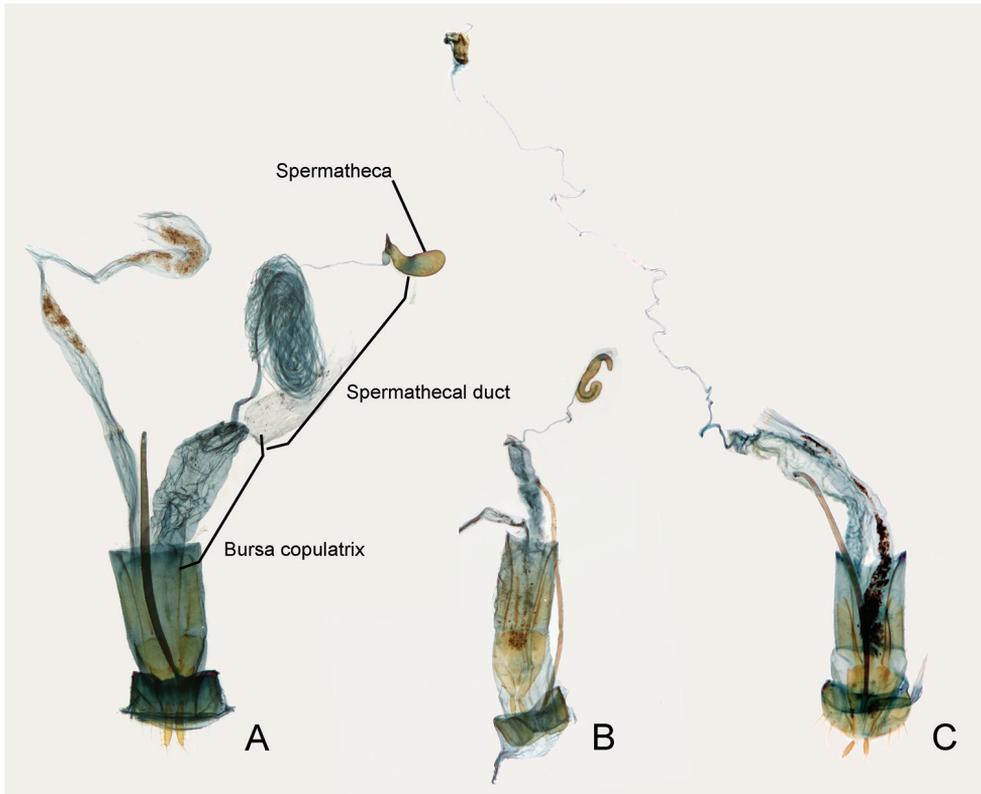


Figure 7. Female genital structures of telephanine species. **A** *Borneophanus spinosus* gen. et sp. n. **B** *Psammoecus dentatus* **C** *Cryptamorpha desjardinsi*.

incised; posterior margin of lower layer widely extended anteriorly, somewhat membranous. Internal sac (Fig. 3H) minutely spinous around midlength; flagellum long, with two coiled sections near posterior 1/3.

Female genitalia (Figs 6, 7A). Gonostyli (Fig. 6B) with a long seta and setae of various length on apical 1/3, shorter than gonocoxite; spermatheca (Fig. 6C, D) bean-shaped and gradually enlarged distally, basally with a small sac connected to spermathecal duct, basis somewhat strongly explanate, with membranous spermathecal gland on basal 1/3, somewhat membranous near midlength.

Distribution. Malaysia (Sabah and Sarawak states).

Etymology. The specific name means thorny and indicates the characteristic long spines.

Remarks. This new species possesses characteristic long spines covering the lateral margins of pronotum and elytra. In possessing such setation, some *Telephanus* species (e.g., *T. paradoxus* and *T. sellatus* Sharp, 1899) are superficially similar to this new species. They can be easily distinguished by the diagnostic character states of these genera. Otherwise, like *Telephanus*, such setation often occurs as a taxonomic character at the species or species group level; thus, the setal situation is not regarded as a character of this new genus.

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New data on the distribution, biology and ecology of the longhorn beetles from the area of South and East Kazakhstan (Coleoptera, Cerambycidae)

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Abstract

New data on the distribution, biology and ecology of the longhorn beetles occurring in southern and eastern regions of Kazakhstan are presented together with a list of 78 species that were collected during two entomological expeditions conducted in May and June 2017. New localities of some rare taxa endemic to this region of Asia, such as *Psilotarsus brachypterus brachypterus* (Gebler, 1830), *Stenocorus minutus* (Gebler, 1841) and *Dorcadion crassipes crassipes* Ballion, 1878 are given. *Exocentrus stierlini* Ganglbauer, 1883 is recorded from Kazakhstan for the first time. Moreover, the occurrence of three species: *Amarysius duplicatus* Tsherepanov, 1980, *Rhopaloscelis unifasciatus* Blessig, 1873 and *Saperda alberti* Plavilstshikov, 1916, which were recently found in the country, is also confirmed. Furthermore, high-quality photographs of several unique taxa, i.e. *Psilotarsus brachypterus pubiventris* (Semenov, 1900), *Xylotrechus adspersus* (Gebler, 1830), *X. alakolensis* Karpiński & Szczepański, 2018, *Anoplistes galusoi* (Kostin, 1974), *A. jacobsoni* Baeckmann, 1904 and *Oberea kostini* Danilevsky, 1988 along with images of their habitats and feeding galleries are also presented. New localities of species considered serious pests or invasive, such as *Turanium scabrum* (Kraatz, 1882) and *Trichoferus campestris* (Faldermann, 1835), respectively, are also given. A new synonymy is proposed: *Cerambyx scalaris* Linnaeus, 1758 = *Cerambyx hieroglyphicus* Pallas, 1773, **syn. n.**

Keywords

Anoplistes, Central Asia, *Dorcadion*, endemic species, *Exocentrus stierlini*, faunistics, invasive species, new records, pests, *Psilotarsus*, synonymy, zoogeography

Introduction

The cerambycid fauna of Kazakhstan is represented by ca. 272 species. Some of these, especially in genera such as *Psilotarsus*, *Dorcadion* and *Politodorcadion*, are represented by several subspecies, the total number of which extends the number of Kazakh taxa to 365 (Danilevsky 2018a).

Due to its huge area and numerous still well-preserved, heavily landlocked regions, the cerambycid fauna of Kazakhstan is quite unique. As many as 111 taxa (approx. 30%) are recognised as occurring exclusively in this country (Danilevsky 2018a). Desert, semi-desert and steppe habitats are inhabited by many endemic species, mainly from the genera *Xylotrechus* (*Kostinicytus* subg.), *Anoplistes*, *Dorcadion*, *Politodorcadion* and *Tetrops*. Additionally, many boreal species, including some that are very rare and threatened in Europe, e.g. *Macroleptura thoracica* (Creutzer, 1799), *Lepturalia nigripes* (DeGeer, 1775) and *Exocentrus stierlini* Ganglbauer, 1883, seem to be rather abundant in the foothills of the West Altai Mountains in the northeastern region of the country.

The state of the knowledge on the longhorn beetles of southern and eastern Kazakhstan as well as information about the biology and ecology of some of the species that are distributed in the region is still poor. Therefore, the present study aims to supplement the knowledge in this field. An additional goal of this work is to gather and disseminate information contained in very valuable but scattered publications, often inaccessible and usually published exclusively in Russian.

Study area and methods

Kazakhstan is the largest landlocked country in the world with an area of 2.72 million square kilometres. Its terrain stretches west to east from the Caspian Sea to the Altai Mountains and north to south from the plains of western Siberia to the oases and deserts of Central Asia. Approximately one-third of the country's area is occupied by the Kazakh Steppe, which is the largest dry steppe region in the world.

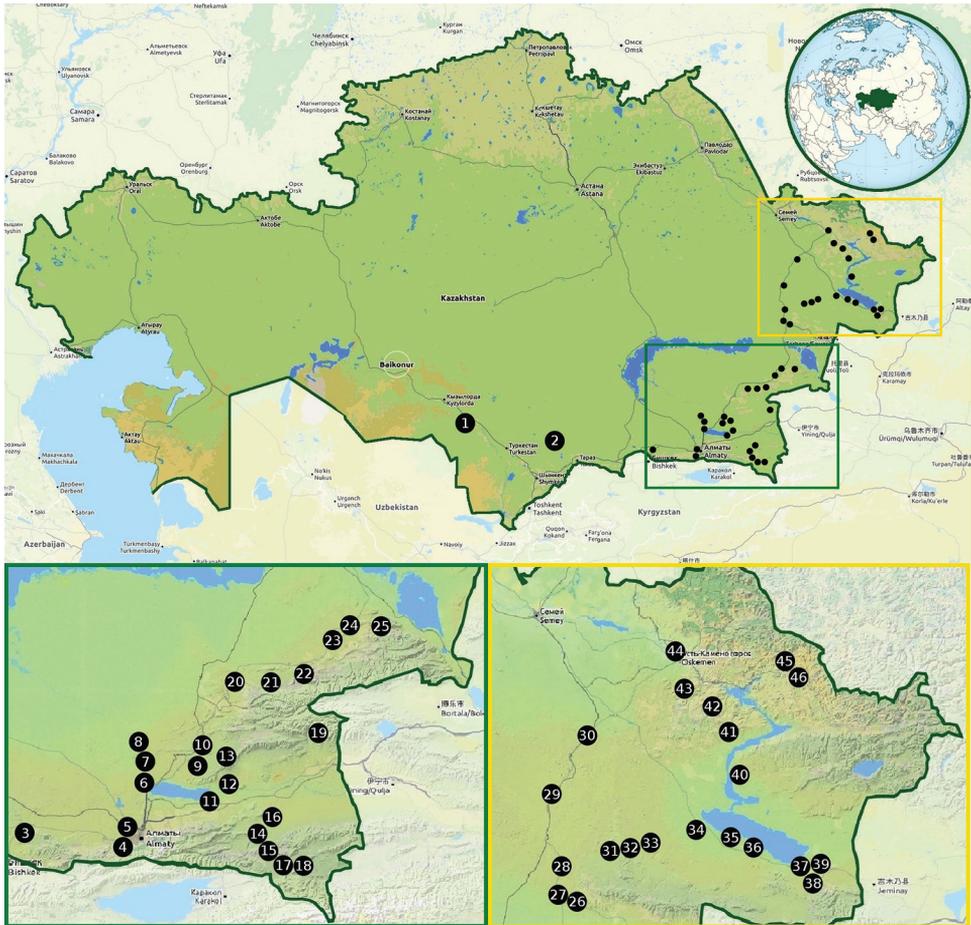
The climate of Kazakhstan is determined by its location in the heart of a huge continent far from the ocean, where sea-air masses do not reach. Therefore, it is of a harshly continental character with average temperatures of between -5 °C and -20 °C in January and between +18 °C and +29 °C in July, depending on the subregion. The differences in the summer-winter as well as the day-night temperatures are extremely high. In winter, the temperature may decrease to -50 °C and in summer rise up to +40 °C. There is practically no precipitation in the central part of Kazakhstan and it

ranges annually from approx. 250 mm in the north to 450 mm in the mountain ranges in the south (de Beurs and Henebry 2004, MEWR 2014).

Due to its unique combination of natural complexes of steppes, deserts and mountains, which are connected via major inland water and river systems, Kazakhstan provides a wide variety of habitats and relevant types of flora. The country is also characterised by a full range of subzonal forms of steppe vegetation, deserts and mountain zones, which are typical for Central Eurasia. Approximately 75% of the area of the country is covered by arid and sub-humid lands. The lowland ecosystems in the plains consist of three main zonal types: forest- and meadow-steppes, steppes and deserts (approx. 2%, 28% and 46% of the total area, respectively). Forest-steppes are located exclusively in the north and they are largely formed by birch and aspen-birch stands. Deserts, in turn, have a high share of shrubs and semi-shrubs and they are characterised by a low species diversity, small projective cover and an absolute dominance of drought-resistant species of xerophytes and hyper-xerophytes. The mountain ecosystems cover approx. 7% of the country and they are considerably more complicated in structure and more diverse than the ecosystems of the plains. Land that is covered with forests constitutes less than 5% of the total area and these are located mainly in the northeastern part of the country (MEWR 2014).

The studies that are presented were conducted in the southern and eastern regions of Kazakhstan in the mountain, desert and steppe (desert-steppe or semi-desert) ecosystems. It is worth noting that surveys were also carried out in riverside and lakeside habitats. The beetles were collected during two entomological expeditions, which were performed by two independent research teams in 2017. The first two-week-long survey, which was primarily focused on the species of the tribe Dorcadiini, was carried out by four scientists (GT, JH, RP and TJ) from the Department of Forest Protection, Forest Research Institute (Poland) and KŁ in May. The second one-month-long expedition, which consisted of three scientists (LK, MW and WTS) from the Department of Zoology, University of Silesia (Poland) and MB, took place in June. During these surveys, many sampling trips were carried out to various locations in the southern and eastern parts of Kazakhstan in the Kyzylorda (Қызылорда), South Kazakhstan (Оңтүстік Қазақстан), Jambyl (Жамбыл), Almaty (Алматы) and East Kazakhstan (Шығыс Қазақстан) Regions (облысы). The investigations were conducted in several research plots, *inter alia*, in the villages or environs of Almaty, Kalinino, Kapchagay, Kegen, Kurshim, Narynkol, Szymkent, Taldykorgan, Taraz, Tarbagatay, Tartogay, Taskesken, Ust-Kamienogorsk, Zaysan and Zyrjanowsk (Map 1). The more stationary part of our study, which was focused especially on species associated with forest stands, was carried out in several localities in the area between the villages of Putintsevo and Bykovo.

The most effective standard methods for collecting beetles, such as attracting them to artificial light sources (Fig. 15G, H), shaking them into an entomological umbrella, sweep netting, luring them into red wine/dark beer traps (Fig. 15F) and analyses of the inhabited material, were used during the field research. The beetles were studied using an Optek SZM7045-J4L and Olympus SZH10 stereo microscope at 7–140× magnifications. Photographs of the cerambycids in nature, their host plants and habitats were taken with Canon EOS 550D and Canon EOS 600D cameras. Photographs of the habitus were taken with a Canon EOS 50D digital camera equipped with a Canon MP-E



Map 1. Research plots in Kazakhstan: **1** Tartogay env. (44°25'N, 66°13'E) **2** 10 km NW of Akkol (43°27'N, 70°35'E) **3** 5 km W of Kenen (43°25'N, 74°58'E) **4** 10 km S of Kaskeleng (43°05'N, 76°35'E) **5** Kaskeleng (43°12'N, 76°38'E) **6** two neighbouring localities: Kapchagay (43°52'N, 77°03'E), 8 km N of Kapchagay (43°56'N, 77°02'E) **7** two neighbouring localities: 22 km N of Kapchagay (44°05'N, 77°02'E), 26 km N of Kapchagay (44°06'N, 77°03'E) **8** 50 km N of Kapchagay (44°18'N, 76°56'E) **9** 2 km E of Arkhaly (44°10'N, 77°56'E) **10** 2 km E of Saryozek (44°22'N, 78°01'E) **11** 5 km N of Karashota (43°41'N, 78°09'E) **12** 25 km SW of Kalinino **13** Karlygash env. (44°16'N, 78°28'E) **14** 38 km SW of Szonzy (43°21'N, 79°03'E) **15** four neighbouring localities: 2 km N of Kegen (43°02'N, 79°13'E), 10 km N of Kegen (43°09'N, 79°12'E and 43°07'N, 79°11'E), 15 km N of Kegen (43°09'N, 79°12'E) **16** 13 km W of Szonzy (43°32'N, 79°17'E) **17** 17 km SE of Kegen (42°55'N, 79°25'E) **18** 5 km E of Saryzhaz (42°55'N, 79°40'E) **19** 7 km N of Sarymbel (44°29'N, 80°04'E) **20** two neighbouring localities: 1 km E of Tambala (45°14'N, 78°38'E), 34 km W of Kapal (45°14'N, 78°39'E) **21** three neighbouring localities: 15 km E of Kapal (45°11'N, 79°12'E), 16 km NE of Kapal (45°12'N, 79°14'E), 22 km E of Kapal (45°13'N, 79°16'E) **22** 10 km SW of Sarkan (45°21'N, 79°48'E) **23** 6 km E of Koylik (45°38'N, 80°19'E) **24** two neighbouring localities: Kabanbay (45°50'N, 80°37'E), 7 km W of Kabanbay (45°48'N, 80°31'E) **25** 10 km E of Gerasimovka (45°48'N, 80°59'E) **26** 3 km N of Taskesken (47°14'N, 80°47'E) **27** 15 km NW of Taskesken (47°18'N, 80°36'E) **28** 50 km S of Ajagöz (47°37'N, 80°38'E) **29** 48 km N of Ajagöz (48°22'N, 80°29'E) **30** two neighbouring localities: 120 km NE of Ajagöz (48°57'N, 80°55'E), 125 km NE of Ajagöz (48°57'N 80°54'E)

65 mm and Canon EF 100mm macro lens. The images that were produced were stacked, aligned and combined using Zerene Stacker software (www.zerene.com). The geographical coordinates were read and recorded using a Garmin Oregon 550T 3-Inch Handheld GPS Navigator. For each specimen collected, the exact location (including the GPS coordinates), altitude, date and the names of the collectors are given. Additionally, information about the general distribution and biology of the species are provided.

The following abbreviations are used in the text:

GT	Grzegorz Tarwacki	TJ	Tomasz Jaworski
LK	Lech Karpiński	KŁ	Krzysztof Łoś
RP	Radosław Plewa	MW	Marcin Walczak
JH	Jacek Hilszczański	WTS	Wojciech T. Szczepański
MB	Marek Bidas		

The specimens are preserved in the entomological collections of the Museum and Institute of Zoology Polish Academy of Sciences (MIZ), the Department of Natural History of the Upper Silesian Museum in Bytom (USMB), the Department of Forest Protection of Forest Research Institute in Sękocin Stary, as well as in the collections of the authors.

This is the third in a series of papers on Cerambycidae from the area of Central-East Asia. The first one (Kadyrov et al. 2016) was devoted to the longhorn beetles of west Tajikistan and the second (Karpiński et al. 2018) concerned the cerambycids of Mongolia.

Results

During our two expeditions, a total of 78 species (81 taxa including subspecies) belonging to four subfamilies (Prioninae, Lepturinae, Cerambycinae, Lamiinae) was recorded. They represent approx. 30% of the known Kazakh cerambycid fauna. *Exocentrus stierlini* Ganglbauer, 1883 is recorded from Kazakhstan for the first time. Moreover, the occurrence of three species: *Amarysius duplicatus* Tsherepanov, 1980, *Rhopaloscelis unifasciatus* Blessig, 1873 and *Saperda alberti* Plavilstshikov, 1916, which were only recently found in the country (Danilevskaya et al. 2009), is also confirmed.

Map I. Conitnued. **31** Tarbagatay env. (47°47'N, 81°17'E) **32** five neighbouring localities: 25 km E of Tarbagatay (47°46'N, 81°36'E), 27 km E of Tarbatatay (47°46'N, 81°36'E), 15 km W of Tarbagatay (47°46'N, 81°37'E), 20 km W of Tarbagatay (47°47'N, 81°42'E), 25 km W of Tarbagatay (47°50'N, 81°49'E) **33** 10 km E of Kyzyl Kesik (47°53'N, 82°06'E) **34** Zhantikei env. (48°04'N, 82°42'E) **35** 20 km NW of Tauke (47°57'N, 83°16'E) **36** 5 km SE of Kabanbay (47°49'N, 83°37'E) **37** 20 km NW of Zaysan (47°34'N, 84°39'E) **38** 12 km S of Zaysan (47°21'N, 84°51'E) **39** two neighbouring localities: 5 km NE of Zaysan (47°30'N, 84°57'E), Aynabulak (47°33'N, 85°03'E) **40** three neighbouring localities: 5 km SE of Kuygan (48°38'N 83°32'E), 8 km NW of Kurshim (48°34'N, 83°36'E), Kurshim env. (48°34'N, 83°36'E) **41** 7 km N of Samarskoje (49°05'N, 83°20'E) **42** Verkhnie Tainty env. (49°24'N, 83°03'E) **43** 10 km S of Bayash Utepov (49°35'N, 82°28'E) **44** Ust-Kamienogorsk (50°00'N, 82°33'E) **45** Putintsevo env. (49°52'N, 84°21'E) **46** Bykovo env. (49°42'N, 84°34'E and 49°39'N, 84°33'E) (OpenStreetMap contributors).

The list of the recorded taxa along with the new localities, general characteristics and remarks on the biology and ecology is presented below. Descriptions of the most common species were omitted. Taxa that are endemic to Kazakhstan are indicated with an asterisk (*).

Prioninae Latreille, 1802

Prionini Latreille, 1802

Psilotarsus brachypterus (Gebler, 1830)

Remarks. This species is widespread in Central Asia from the southern parts of Russia through most of the territory of Kazakhstan to Uzbekistan, Kyrgyzstan and northwestern China (Danilevsky 2000). Specimens of this species reach a length of 20–40 mm in the males and 24–45 mm in the females (up to 65 mm when measured to the end of an abdomen filled with eggs). Twelve-segmented antennae occur in both sexes. The females are flightless. The larvae develop on the roots of desert trees and shrubs (Danilevsky 2014a). Kostin (1973), however, stated that *P. brachypterus* prefers shrub species, e.g. boyalych *Salsola* and teresken *Krascheninnikovia*, in contrast to *Mesoprionus angustatus* (Jakovlev, 1887) larvae, which feed on saxaul *Haloxylon*. Our own observations seem to support this thesis since we did not notice any trees or higher ligneous shrubs at the localities of both of the subspecies that were examined. There were the typical habitats of *Artemisia*- or semi-shrub/dwarf semi-shrub deserts. According to Danilevsky (2014a), the seasonal activity of adults is rather short and only lasts about two weeks; however, based on the data from the labels, it can vary greatly depending on the year – from May to the end of July. On the other hand, the daily activity presumably may differ depending on the particular population or the weather conditions.

Five subspecies are described in this species, four of which are known to occur in Kazakhstan: *Psilotarsus brachypterus aralensis* (Danilevsky, 2000), *P. b. brachypterus* (Gebler, 1830), *P. b. hemipterus* (Motschulsky, 1845) and *P. b. pubiventris* (Semenov, 1900). The fifth subspecies – *P. b. alpherakii* (Semenov, 1900) is distributed exclusively in Xinjiang Province of China (Danilevsky 2018a). A closely related species – *Psilotarsus hirticollis* Motschulsky, 1860, which is very numerous in Kazakhstan, also consists of several subspecies.

This species is highly variable in many morphological features even within the same population, however, our own observations indicated clear differences between the two taxa collected – *P. b. brachypterus* and *P. b. pubiventris*, primarily in the type of pubescence and the sculpture of the pronotum as well as in the size and corpulence of the body. Specimens of the nominotypical subspecies are significantly smaller and slender; even the females are noticeably smaller in size than the males of *P. b. pubiventris*. The pronotum in the males of the nominative subspecies is almost entirely hairless, smoother and lustrous with a sparse and fine punctuation, while it is definitely hairier and matted with coarse and dense, locally wrinkled punctuation in *P. b. pubiventris*.

***Psilotarsus brachypterus brachypterus* (Gebler, 1830)**

Figs 1A–C, 9A–E

Material examined. East Kazakhstan Region: 8 km NW of Kurshim [Қыршым] (48°37'N 83°35'E), 462 m a.s.l., 17 VI 2017, 127♂♂, 6♀♀, leg. MW; 52♂♂, 5♀♀, leg. LK; 114♂♂, 7♀♀, leg. WTS; 31♂♂, 3♀♀, leg. MB.

Remarks. This taxon is distributed in the easternmost part of Kazakhstan (the Irtys River valley – from the environs of Semei to the Zaisan Depression) and north-western China (Xinjiang and possibly the Gansu Provinces) (Danilevsky 2000, 2018a).

The nominotypical subspecies differs mainly due to the shorter lateral process of each middle antennal joint (generally much shorter than the length of joint base) and to its glabrous and shining pronotum, which is situated peripherally, and is rarely covered with a more or less dense pubescence (Danilevsky 2000).

The mass occurrence of this taxon (approx. five hundred specimens) was observed in mid-June during warm (25 °C) weather conditions in the *Artemisia*-desert habitat (Fig. 9F). This period most likely coincided with the beginning of the appearance of females (Fig. 9B) when the males (Fig. 9A, D) were about to reach maximum abundance. The first flying male was spotted immediately after our arrival at this plot (around 9 p.m.), and therefore, it is possible that this taxon begins its activity a little earlier. The number of individuals was increasing after dusk and reached its peak around midnight (Fig. 9D). At the same time, the females were found resting or moving on the ground. They did not seem to react to the light source in any way, even from very close distance. The females were much less numerous (ratio of approx. 1:20) and barely 20 specimens were collected during a few hours of searching within a radius of approx. 800 m from the light source. They appeared to stay active most of the night. Although no mating couples were spotted, a few probably still virgin females were observed resting motionlessly and attracting the males by rising and swinging with their ovipositor exposed in order to shoot out and spray a cloud of pheromones (Fig. 9C). A similar behaviour was observed by Danilevsky (2000) in the case of *Psilotarsus turkestanicus* (Semenov, 1888) in the Samarkand environs in Uzbekistan.

It is worth noting that quite a significant portion of the individuals were found dead or still alive in the webs of the Mediterranean black widow spider *Latrodectus tredecimguttatus* (Rossi, 1790) (Fig. 9E). In some places, the density of these arachnids reached a few individuals per m² and the specimens of *Psilotarsus* (both males and females) were the main victim of this spider species. Therefore, it seems that the hunting activity of *L. tredecimguttatus* is among the most important factors that affect the population of this beetle.

***Psilotarsus brachypterus pubiventris* (Semenov, 1900)**

Figs 1D–F, 9G, H

Material examined. Almaty Region: 28 km N of Kapchagay [Қапшағай] (44°06'N, 77°03'E), 679 m a.s.l., 27 VI 2017, several females and many dead individuals on the road and the roadside, leg. LK, MW & WTS; 26 km N of Kapchagay [Қапшағай]

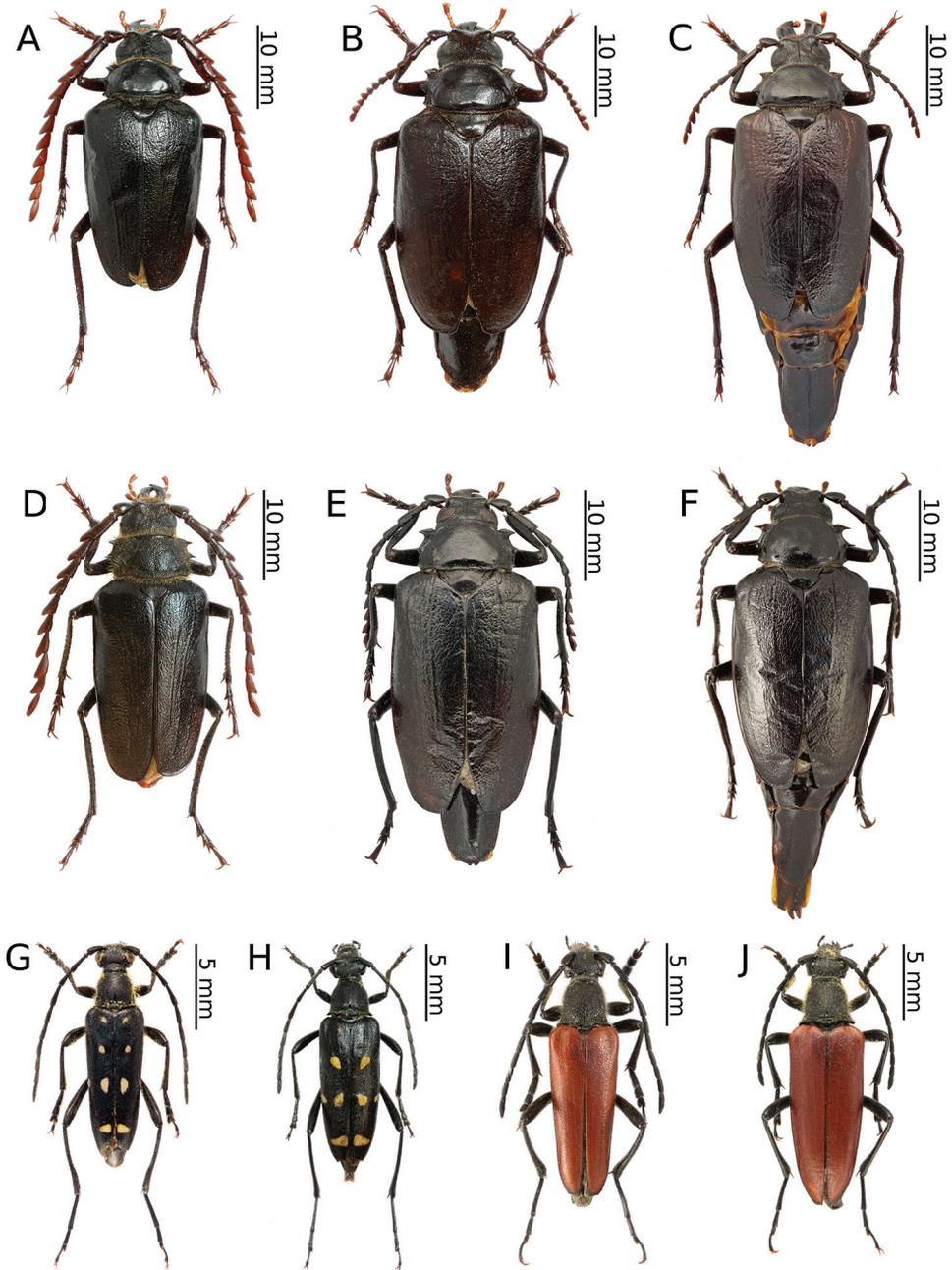


Figure 1. Photos of longhorn beetles specimens collected during the expedition to Kazakhstan in 2017: **A** *Psilotarsus brachypterus brachypterus* (male) **B** *P. brachypterus brachypterus* (female) **C** *P. brachypterus brachypterus* (female, abdomen filled with eggs) **D** *P. brachypterus pubiventris* (male) **E** *P. brachypterus pubiventris* (female) **F** *P. brachypterus pubiventris* (female, abdomen filled with eggs) **G** *Leptura duodecimguttata* (male) **H** *L. duodecimguttata* (female) **I** *Lepturalia nigripes rufipennis* (male) **J** *L. nigripes rufipennis* (female).

(44°06'N, 77°03'E), 648 m a.s.l., 27–28 VI 2017, 6♂♂, 20♀♀ (5♂♂, 7♀♀ – dead specimens), leg. LK; 2♂♂, 26♀♀, leg. MW; 1♂, 14♀♀, leg. WTS; 1♂ (dead specimen), 4♀♀, leg. MB; 22 km N of Kapchagay [Қапшағай] (44°05'N, 77°02'E), 675 m a.s.l., 28 VI 2017, many dead individuals, leg. LK, MW & WTS.

Remarks. This subspecies is distributed in the southeastern region of Kazakhstan (from the Chu-Ili Mountains to about Chilik and the Dzungarian Alatau) and northern Kyrgyzstan (from the environs of Kara-Balta to Bishkek) (Danilevsky 2000).

It is characterised by larger, wider, robust body and relatively shorter antennae with shorter and thicker joint lobes (Danilevsky 2000). The imagines can be active from the first half of May to the end of July (Ishkov and Kadyrbekov 2004).

This taxon was observed at the end of June during warm (approx. 25 °C) weather conditions, after its mating period during which mostly females were still alive and the living males (Fig. 9G) constituted only a small percentage of the whole population. Also, among the females (Fig. 9H), many specimens (approx. 60%) were damaged or already dead including old body remains. Bite traces indicated that most of the specimens were killed or posthumously bitten by small mammals. In this area, any presence of *Latrodectus tredecimguttatus*, which seemed to be the main natural enemy of the aforementioned subspecies, were not observed. Moreover, many specimens that were killed by cars when attempting to pass or fly over the road were also found smashed on the asphalt or in the roadside vegetation strip. All three plots from which the beetles were collected are located within close proximity to each other and represent a temperate semi-shrub/dwarf semi-shrub desert habitat (Fig. 10A). It is worth noting that on 10 June (17 days earlier), insects had been being attracted to the light at a plot located only 2 km away from this location and that not even a single male was observed neither in the night nor in the morning of the next day. This may indeed indicate a rather short, approximately two-week-long, period of the occurrence of this subspecies, which would be in line with Danilevsky's (2014a) findings.

It is also interesting to note that this subspecies seems to stay active for most of the day. Within two different plots, the females of *P. b. pubiventris* were observed from the late evening hours through most of the night (the last active specimens were found around 3–4 a.m.) as well as in the morning of the next day (around 9 a.m.). However, although most of the males were already dead, a few living specimens were caught only in the morning despite several hours of attempting to attract them to the light on the previous evening and night on the same plot. This unusual behaviour might be related to the end of the period of the occurrence and condition of the individuals. On the other hand, according to Danilevsky (2014a), there are contradictory observations concerning the activity of beetles. In 2001, the author collected numerous males only in the morning before the dawn (from 5 to 5:30 a.m) but with no females and no more males were caught earlier or later during the day or while attempting to attract them to a light source at night. A slightly different observation was made by S.V. Murzin in 1989 who noted the maximum activity of both sexes at the sunrise. However, according to Ishkov and Kadyrbekov (2004), there were signs of nocturnal activity.

Lepturinae Latreille, 1802

Lepturini Latreille, 1802

Anastrangalia sequensi (Reitter, 1898)

Fig. 2A

Material examined. East Kazakhstan Region: Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 21–23 VI 2017, 1♂, 2♀♀, leg. WTS; 3♂♂, 4♀♀, leg. MW; Вуково [Быково] env. (49°39'N, 84°33'E), 570 m a.s.l., 24 VI 2017, 2♀♀, leg. WTS; 4♂♂, 3♀♀, leg. LK; 1♂, 1♀, leg. MW; 1♂, leg. MB.

Remarks. This is a typical Siberian species. It has been widely discussed in a previous paper concerning the longhorn beetles of Mongolia (Karpiński et al. 2018). Additionally, we present an interesting melanistic form here (Fig. 2A).

The species was not included in the Kazakh fauna by Kostin (1973), who claimed that all records of this taxon for the country actually belonged to *Anastrangalia sanguinolenta* (Linnaeus, 1761) and that the record of *A. sequensi* from “Burabay” in the Kokchetav region (Kadyrbekov et al. 2003) must represent another species – most probably *Anastrangalia reyi* (Heyden, 1885) (Danilevskaya et al. 2009). The occurrence of *A. sequensi* in Kazakhstan was finally confirmed in the same locality as we present here by Danilevskaya et al. (2009).

Leptura annularis Fabricius, 1801

Material examined. East Kazakhstan Region: 7 km N of Samarskoje [Самарское] (49°05'N, 83°20'E), 626 m a.s.l., 18 VI 2017, 2♂♂, leg. MW; Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 19–23 VI 2017, 1♂, leg. LK; 1♂, leg. MW; Вуково [Быково] env. (49°39'N, 84°33'E), 570 m a.s.l., 24 VI 2017, 1♂, leg. WTS; 2♂♂, leg. LK; 2♂♂, leg. MW; 1♂, leg. MB.

Leptura duodecimguttata Fabricius, 1801

Fig. 1G, H

Material examined. East Kazakhstan Region: Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 20 VI 2017, 1♂, 2♀♀, leg. LK; 1♀, leg. MW.

Remarks. This is a typical Siberian species that is distributed in the Siberian part of Russia and Kazakhstan, Mongolia, China, Japan and the entire Korean peninsula (Cherepanov 1990a, Danilevsky 2014a). The larvae feed on the wood of different deciduous trees. The life cycle usually lasts two years. The adults appear in the late spring and can be found on flowers, mainly from the Apiaceae and Rosaceae families (Cherepanov 1990a).

A few specimens were observed on various Apiaceae flowers in a habitat of a mixed forest in the foothills of the West Altai Mountains.

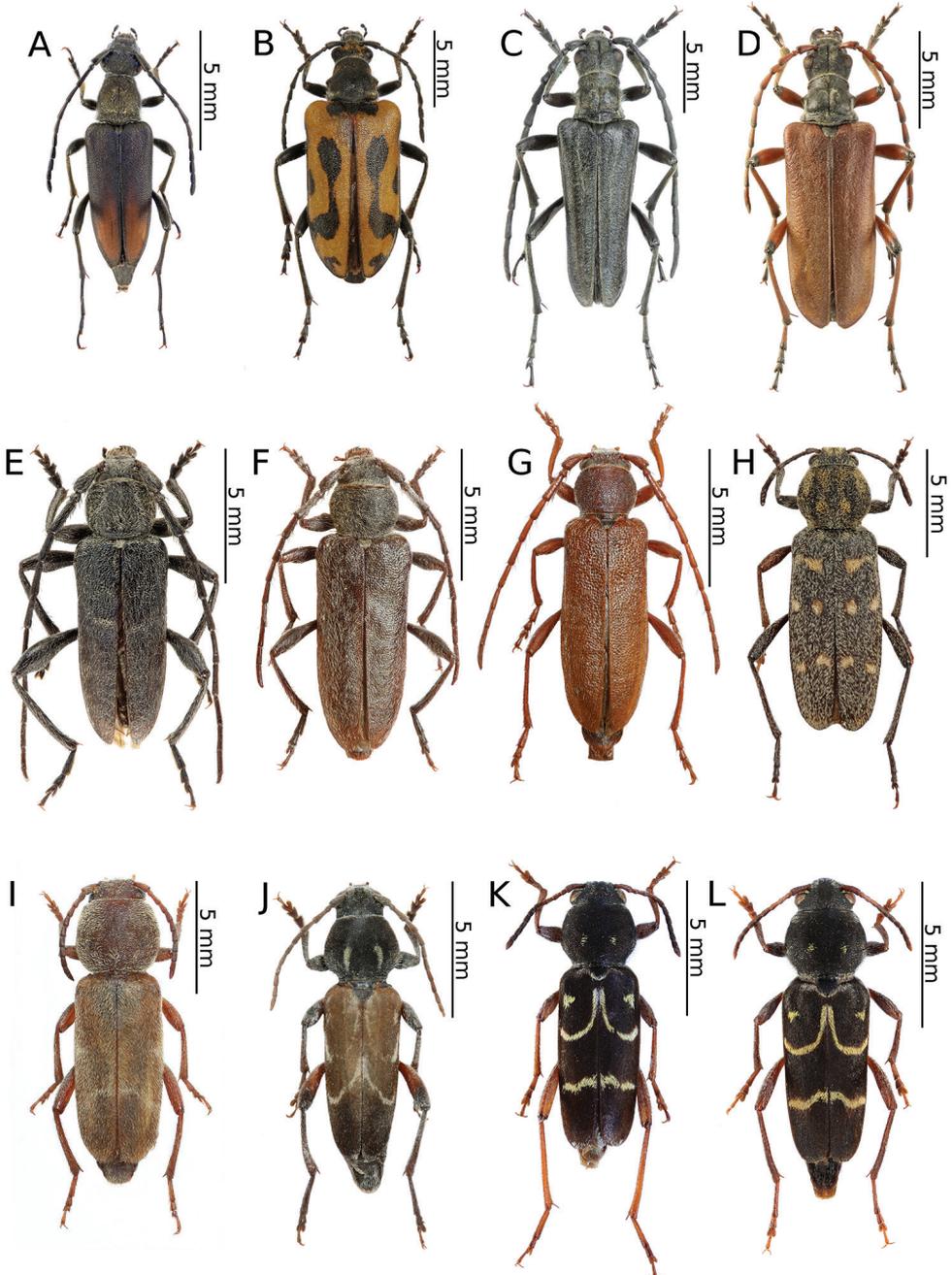


Figure 2. Photos of longhorn beetles specimens collected during the expedition to Kazakhstan in 2017: **A** *Anastrangalia sequensi* (female, melanistic form) **B** *Brachyta interrogationis russica* (female) **C** *Stenocorus minutus* (male) **D** *S. minutus* (female) **E** *Turanium scabrum* (male, dark form) **F** *T. scabrum* (female, dark form) **G** *T. scabrum* (female, light form) **H** *Xylotrechus adpersus* (male) **I** *Xylotrechus alakolensis* (male) **J** *Xylotrechus hircus* (female) **K** *Xylotrechus capricornus* (male) **L** *X. capricornus* (female).

***Leptura quadrifasciata quadrifasciata* Linnaeus, 1758**

Material examined. East Kazakhstan Region: 7 km N of Samarskoje [Самарское] (49°05'N, 83°20'E), 626 m a.s.l., 18 VI 2017, 1♂, leg. WTS; Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 19–23 VI 2017, 1♀, leg. WTS; 1♂, 1♀, leg. LK; 1♂, leg. MW; 1♀, leg. MB; Bykovo [БЫКОВО] env. (49°39'N, 84°33'E), 570 m a.s.l., 24 VI 2017, 1♂, 2♀♀, leg. WTS; 1♂, leg. LK; 1♀, leg. MW.

***Lepturalia nigripes rufipennis* (Blessig, 1873)**

Fig. 1I, J

Material examined. East Kazakhstan Region: 25 km W of Tarbagatay [Тарбагатай] (47°50'N, 81°49'E), 878 m a.s.l., 16 VI 2017, 1♂, leg. MW; Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 19–23 VI 2017, 2♂♂, leg. LK; 3♂♂, 1♀, leg. MW; 1♀, leg. MB; Bykovo [БЫКОВО] env. (49°39'N, 84°33'E), 570 m a.s.l., 24 VI 2017, 5♂♂, 1♀, leg. WTS; 2♂♂, 2♀♀, leg. LK; 2♂♂, 3♀♀, leg. MB; 2♂♂, 1♀, leg. MW.

Remarks. This is a temperate Palaearctic species that is distributed from northeastern Europe to the Far East (Švácha and Danilevsky 1989, Sama 2002). The taxon was discussed in a previous paper concerning the longhorn beetles of Mongolia (Karpiński et al. 2018).

Although the nominotypical subspecies – *Lepturalia nigripes nigripes* (DeGeer, 1873) is distributed in the western part of the range, both taxa can be found in Kazakhstan. A transitional zone between these two forms is situated in the Ural Mountains. According to Danilevskaya et al. (2009), both subspecies occur together in the eastern part of European Russia and in West Siberia, e.g. in the Orenburg region where several populations are known to consist of two different colour forms. However, although specimens with red elytra can be found sporadically in Western Europe, no yellow forms are known from East Siberia or further eastwards.

Our own observations indicate that this taxon is moderately frequent in the mountain and foothill zone in northeastern Kazakhstan, particularly in more afforested areas. About twenty specimens were collected on the flowers of various plants (e.g. Apiaceae, *Rosa* sp.) in habitats such as riverine bushes with *Caragana* shrubs, a mixed forest in the foothills of the West Altai Mountains and at the edge of a mountain deciduous grove that consisted mainly of *Populus*, *Betula* and *Salix* (Fig. 15C). Birches occurred in all of these sites.

***Lepturobosca virens* (Linnaeus, 1758)**

Material examined. East Kazakhstan Region: 7 km N of Samarskoje [Самарское] (49°05'N, 83°20'E), 626 m a.s.l., 18 VI 2017, 1♂, leg. WTS; 1♂, leg. MW; Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 19–23 VI 2017, 1♀, leg. WTS; Bykovo [БЫКОВО] env. (49°39'N, 84°33'E), 570 m a.s.l., 24 VI 2017, 1♀, leg. LK.

***Macroleptura thoracica* (Creutzer, 1799)**

Material examined. Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 24 VI 2017, 1♀, leg. MW; 1♀, leg. WTS.

Remarks. This is a typical Siberian species. It was discussed in a previous paper concerning the longhorn beetles of Mongolia (Karpiński et al. 2018).

Several individuals of *M. thoracica* were collected on dead birch trunks in this locality in June 2005 (Danilevskaya et al. 2009).

In our research, two specimens were collected in the habitat of a rather old *Populus* forest (Fig. 15F) that extends along the Khamir River in the foothills of the West Altai Mountains. The first one was caught in flight, whereas the second was beaten down from a trunk of a dead willow *Salix* sp.

***Oedecnema gebleri* Ganglbauer, 1889**

Material examined. Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 22 VI 2017, 1♀, leg. LK.

Remarks. This is a typical Siberian species that is distributed from Eastern Europe (Ukraine and European Russia) to the Pacific Ocean. *Oedecnema gebleri* is a polyphagous cerambycid that develops in the basal zones and in the stumps of different deciduous and coniferous trees and then pupates in the soil. The imagines can be found on flowers from the end of May to August (Švácha and Danilevsky 1989, Cherepanov 1990a).

Several specimens were collected on flowers in this locality in June 2005 (Danilevskaya et al. 2009).

Only a single female was observed in the habitat of a rather old *Populus* forest that extends along the Khamir River in the foothills of the West Altai Mountains.

***Pachytodes erraticus* (Dalman, 1817)**

Material examined. East Kazakhstan Region: 7 km N of Samarskoje [Самарское] (49°05'N, 83°20'E), 626 m a.s.l., 18 VI 2017, 5♂♂, 3♀♀, leg. WTS; 5♂♂, 4♀♀, leg. LK; 4♂♂, 3♀♀, leg. MW; Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 19 VI 2017, 1♂, leg. WTS; 3♂♂, 1♀, leg. LK; 1♂, leg. MW; Bykovo [Быково] env. (49°39'N, 84°33'E), 570 m a.s.l., 24 VI 2017, 2♂♂, leg. WTS; 10 km S of Bayash Uterov [Баяш Утепов] (49°35'N, 82°28'E), 508 m a.s.l., 25 VI 2017, 1♀, leg. WTS; 1♀, leg. LK.

Remarks. *Pachytodes erraticus* is a typical Palaearctic species that is distributed from Spain to East Siberia. It develops under ground in the rotten roots of different deciduous tree species. The pupation occurs in the soil (Danilevskaya et al. 2009).

This is one of the most common species in the zone of mountains and foothills in northeastern Kazakhstan. We observed this species frequently and rather numer-

ously on the flowers of various Apiaceae species in different habitats from the roadside vegetation strips in the mountain steppe region through river canyons with *Caragana* and *Lonicera* (Fig. 15A) to a riverine and mountain mixed forests mainly with *Betula*, *Populus*, *Salix* and *Picea*.

***Pseudovadonia livida bicarinata* (N. Arnold, 1869)**

Material examined. East Kazakhstan Region: 3 km N of Taskesken [Таскескен] (47°14'N, 80°47'E), 581 m a.s.l., 14 VI 2017, 3♀♀, leg. WTS; 1♂, 2♀♀, leg. LK; 2♂♂, 2♀♀, leg. MW; 15 km W of Tarbagatay [Тарбағатай] (47°46'N, 81°37'E), 1072 m a.s.l., 15 VI 2017, 5♂♂, leg. WTS; Kurshim [Күршім] env. (48°34'N, 83°36'E), 406 m a.s.l., 17 VI 2017, 1♂, 1♀, leg. MB; 5 km SE of Kuygan [Күйған] (48°38'N 83°32'E), 439 m a.s.l., 18 VI 2017, 1♂, 1♀, leg. LK; 7 km N of Samarskoje [Самарское] (49°05'N, 83°20'E), 626 m a.s.l., 18 VI 2017, 1♀, leg. WTS; Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 19 VI 2017, 2♀♀, leg. WTS; 1♂, 1♀, leg. MW; Bykovo [Быково] env. (49°39'N, 84°33'E), 570 m a.s.l., 24 VI 2017, 1♂, 1♀, leg. MW.

Remarks. This is the easternmost subspecies that is distributed from Eastern Europe to East Siberia and China (Danilevsky 2018a).

This taxon was recorded from the Putintsevo environs by Danilevskaya et al. (2009) under an incorrect name, *Pseudovadonia livida pecta* (K. Daniel & J. Daniel, 1891). This subspecies seems to be endemic to Italy (Danilevsky 2018a).

***Stenurella bifasciata bifasciata* (O. F. Müller, 1776)**

Material examined. East Kazakhstan Region: 3 km N of Taskesken [Таскескен] (47°14'N, 80°47'E), 581 m a.s.l., 14 VI 2017, 1♂, leg. WTS; 1♀, leg. LK; 1♂, 1♀, leg. MW; 15 km W of Tarbagatay [Тарбағатай] (47°46'N, 81°37'E), 1072 m a.s.l., 15 VI 2017, 1♂, 1♀ leg. WTS; 2♂♂, 1♀, leg. MW; 7 km N of Samarskoje [Самарское] (49°05'N, 83°20'E), 626 m a.s.l., 18 VI 2017, 1♂, leg. WTS; 3♂♂, 2♀♀, leg. LK; Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 22 VI 2017, 1♀, leg. MW; 10 km S of Bayash Uterov [Баяш Утепов] (49°35'N, 82°28'E), 508 m a.s.l., 25 VI 2017, 1♂, 3♀♀, leg. LK.

Remarks. The nominotypical subspecies is distributed from Central Europe to East Siberia and China (Danilevsky 2018a).

According to some authors (e.g. Bense 1995, Sama 2002), although the biology of *S. bifasciata* is inadequately known, its larvae develop in both deciduous (*Ulmus*, *Quercus*, *Salix*, *Rosa*, *Spartium*, *Ficus*) and coniferous (*Pinus*) trees. Although our own observations from Central Europe indicate its close relationship with pines *Pinus* spp., in Kazakhstan, we also collected this species in completely treeless areas in which the only suitable host plant was the rose *Rosa* sp. We did not observe any morphological differences between the specimens from the semi-steppe habitats, which are apparently associated with *Rosa*, or from the Kazakh mountain forests having a share of *Pinus*, or from Poland.

***Stenurella melanura melanura* (Linnaeus, 1758)**

Material examined. East Kazakhstan Region: 7 km N of Samarskoje [Самарское] (49°05'N, 83°20'E), 626 m a.s.l., 18 VI 2017, 2♂♂, leg. WTS; 2♂♂, 2♀♀, leg. MW; Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 19–23 VI 2017, 2♂♂, 1♀, leg. WTS; 2♀♀, leg. MW; Быково [Быково] env. (49°39'N, 84°33'E), 570 m a.s.l., 24 VI 2017, 1♂, 1♀, leg. WTS; 1♀, leg. LK.

***Strangalia attenuata* (Linnaeus, 1758)**

Material examined. 7 km N of Samarskoje [Самарское] (49°05'N, 83°20'E), 626 m a.s.l., 18 VI 2017, 2♂♂, 2♀♀, leg. WTS; 1♂, 1♀, leg. LK; 1♂, leg. MW; Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 20 VI 2017, 1♂, 1♀, leg. WTS; 1♂, 3♀♀, leg. LK; 1♂, 1♀, leg. MW; Быково [Быково] env. (49°39'N, 84°33'E), 570 m a.s.l., 24 VI 2017, 1♂, leg. LK; 1♂, 1♀, leg. MW; 10 km S of Bayash Утепов [Баяш УТЕПОВ] (49°35'N, 82°28'E), 508 m a.s.l., 25 VI 2017, 1♂, leg. WTS.

Rhagiini Kirby, 1837***Brachyta interrogationis russica* (Herbst, 1784)**

Fig. 2B

Material examined. Быково [Быково] env. (49°39'N, 84°33'E), 571 m a.s.l., 21 VI 2017, 1♀, leg. LK.

Remarks. This is a typical Palaearctic species that is distributed from Spain to the Russian Far East, Korea and China. *Brachyta interrogationis* is a very variable taxon with twelve described subspecies. Each local population is characterised by unique proportions of certain colour forms. The *russica* ssp. is known to occur in European Russia (except for the northern Urals), West Siberia (including Altai) and Kazakhstan, and it is the only subspecies that has been recorded from Kazakhstan (Lazarev 2016, Danilevsky 2018a). In Siberia, the larvae of this species have usually been observed in the roots of living *Paeonia* but also those of *Euphorbia* and *Radiola*, as well as *Trollius* in laboratory conditions (Danilevskaya et al. 2009). Pupation occurs in the soil. The adults can be found on the flowers of various plants from May to the turn of July and August. The species is most numerous in the foothill and mountain regions of the forest and forest-steppe zones (Cherepanov 1990a).

Several individuals of this taxon were collected on *Paeonia* in the area of Putintsevo and on *Ranunculus* in the Sibinka River valley in June 2005 (Danilevskaya et al. 2009), however no subspecies was specified.

A single female was collected on the stem of a herbaceous plant species at the edge of a mountain deciduous grove that consisted mainly of *Populus*, *Betula* and *Salix* (Fig. 15C).

***Dinoptera collaris* (Linnaeus, 1758)**

Material examined. East Kazakhstan Region: 3 km N of Taskesken [Таскескен] (47°14'N, 80°47'E), 581 m a.s.l., 14 VI 2017, 1♂, leg. MW; 7 km N of Samarskoje [Самарское] (49°05'N, 83°20'E), 626 m a.s.l., 18 VI 2017, 1♀, leg. MW; Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 21 VI 2017, 4♀♀, leg. WTS; 3♂♂, 3♀♀, leg. LK; Bykovo [Быково] env. (49°39'N, 84°33'E), 570 m a.s.l., 24 VI 2017, 1♀, leg. MW.

***Stenocorus minutus* (Gebler, 1841)**

Fig. 2C, D

Material examined. East Kazakhstan Region: 10 km S of Bayash Uterov [Баяш Утепов] (49°35'N, 82°28'E), 508 m a.s.l., 25 VI 2017, 4♂♂, 2♀♀, leg. LK; 1♂, 1♀, leg. WTS; 1♂, leg. MW; 1♂, leg. MB.

Remarks. *Stenocorus minutus* is a rare species that is distributed mainly in eastern Kazakhstan and reaches northwestern China and western Mongolia through the Irtysh River valley and the Tarbagatay Mountain range (Danilevsky 2014a, 2018a). While the biology of the preimaginal stages remains unknown, according to Danilevsky (2014a), larvae of this species undoubtedly descend under ground where they feed on the roots of various woody plants. Kadyrbekov and Childebaev (2007) claimed that the larvae develop in dead deciduous trees. The latter authors found adults on the flowers of various plant species, including *Euphorbia lamprocarpa*, in the second half of June. On the other hand, the species was quite numerous observed in treeless xerothermic habitats that had a significant number of shrubs (Danilevsky 2014a).

For a long time, *Stenocorus minutus* was known in Kazakhstan only from the upper ranges of the Saur and Tarbagatay Mountains (Kostin 1973). It was also mentioned as occurring in southeastern Kazakhstan (along Lake Zaysan) by Cherepanov (1990a) under its outdated name *Stenocorus tataricus* (Gebler, 1841); however, the author had never observed this species in nature. Recently, it was found more frequently in the riparian forests of the Tentek River valley (Kadyrbekov and Childebaev 2007).

About ten specimens were collected on the leaves and stems of *Caragana* and *Lonicera* shrubs overgrowing the stony hills in the Sibinka River valley (Fig. 15B). A female was observed feeding on juice leaking from a damaged *Caragana* stem together with a few individuals of *Protaetia* spp. That observation and the fact that most of the specimens (also couples together) were found on *Caragana* may indicate an association of *Stenocorus minutus* with this plant genus, especially since not a single specimen has been recorded by any of the expeditions in a rather well-investigated area of Putintsevo, that is located approx. 120 km eastward, in which many deciduous trees (e.g. *Betula*, *Padus*, *Populus*, *Salix*) and shrubs (e.g. *Lonicera*, *Rosa*, *Spiraea*, *Viburnum*) occur with the exception of *Caragana*. It is also worth noting that this rare but rather large and easily spotted species has not been found in presented locality by M. Danilevsky's research team in mid-June of 2005, which may indicate the beginning of the appearance of beetles in the second half of June when the adults of their sympatric species *Oberea kostini* end their activity.

Cerambycinae Latreille, 1802**Callidiini Kirby, 1837*****Turanium scabrum* (Kraatz, 1882)**

Fig. 2E–G

Material examined. Almaty Region: 1 km E of Tambala [Тамбала] (45°14'N, 78°38'E), 663 m a.s.l., 3 V 2017 (6 V 2017 ex cult.) 2♂♂, 2♀♀, from *Elaeagnus angustifolia*, leg. JH; 13 km W of Szonzy [ШОНЖЫ] (43°32'N, 79°17'E), 731 m a.s.l., 12 V 2017 (I 2018 ex cult.) 1♀, from *Elaeagnus angustifolia*, leg. KL; 5 km N of Karashota [Каражота] (43°41'N, 78°09'E), 492 m a.s.l., 3 VI 2017, 1♂, 2♀♀, leg. WTS; 1♂, 1♀, leg. LK; 5♂♂, 3♀♀, leg. MW.

Remarks. The species is distributed from the southern region of European Russia through the countries of Central Asia to West Siberia and China (Danilevsky 2018a). The polyphagous larvae develop in various deciduous trees and shrubs (e.g. *Elaeagnus*, *Populus*, *Malus*, *Rosa*, *Halimodendron* and *Tamarix*). The adults are active from April to July (Danilevsky 2001b, Ishkov and Kadyrbekov 2004).

Turanium scabrum inhabits almost all of the territory of Kazakhstan (excluding northern and northeastern regions) (Danilevsky 2001b) and it is considered a serious pest, especially of *Elaeagnus angustifolia* and *Populus diversifolia* (Borissova 2018).

The individuals were observed during a hot (30 °C) and sunny afternoon on a flood barrier formed from old branches and boughs primarily of oleasters *Elaeagnus* (Fig. 10B). The beetles were flying to accumulated wood where they were mating. The species was observed sympatrically with *Chlorophorus elaeagni* there. Several specimens were additionally reared from the dry wood of *Elaeagnus angustifolia*.

Clytini Mulsant, 1839***Chlorophorus elaeagni* Plavilstshikov, 1956**

Material examined. Almaty Region: 13 km W of Szonzy [ШОНЖЫ] (43°32'N, 79°17'E), 731 m a.s.l., 12 V 2017 (I 2018 ex cult.) 1♀, from *Elaeagnus angustifolia*, leg. KL; 5 km N of Karashota [Каражота] (43°41'N, 78°09'E), 492 m a.s.l., 3 VI 2017, 3♂♂, leg. LK; 1♂, leg. WTS; Kyzylorda Region: Tartogay env. [Тартогай] (44°25'N, 66°13'E), 135 m a.s.l., 7 VI 2017, 3♂♂, leg. WTS; 2♂♂, leg. LK; 3♂♂, leg. MW.

Remarks. This species is distributed from the Caucasus to Central Asia (Danilevsky 2018a). It was discussed in a previous paper concerning the longhorn beetles of Tajikistan (Kadyrov et al. 2016).

Chlorophorus elaeagni is a rather common species in southern Kazakhstan, where it mainly occurs in tugay habitats. Although the specimens were collected on sites that were located near river banks in rather different habitats, there was always a large share of *Elaeagnus angustifolia*, which seems to be the main host plant for this species. In the

environs of Karashota, during a hot (30 °C) and sunny afternoon, the specimens were observed on a flood barrier formed from old branches and boughs primarily of oleasters *Elaeagnus* (Fig. 10B). Single males were flying to accumulated wood from time to time and started to actively run after landing. This period seemed to be the beginning of the occurrence of this species in nature. On this plot, *Ch. elaeagni* occurred sympatrically with *Turanium scabrum*, which was swarming at that time. Additionally, on a bank of the Syr Darya River in a locality near Tartogay, several males were observed during a scorching (35 °C) day on blossoming tamarisks *Tamarix* (Fig. 10C) in the same habitat as *Anoplistes jacobsoni* (Fig. 11D) at the peak of its occurrence.

Cyrtoclytus capra (Germar, 1824)

Material examined. East Kazakhstan Region: Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 19–23 VI 2017, 6♂♂, 3♀♀, leg. LK; 3♂♂, 2♀♀, leg. WTS; 5♂♂, 3♀♀, leg. MW; 3♂♂, 2♀♀, leg. MB; Выково [Быково] env. (49°39'N, 84°33'E), 570 m a.s.l., 24 VI 2017, 2♂♂, 1♀, leg. LK; 1♂, 1♀, leg. WTS; 1♂, 1♀, leg. MW; 10 km S of Bayash Утепов [Баяш Утепов] (49°35'N, 82°28'E), 508 m a.s.l., 25 VI 2017, 1♂, 1♀, leg. WTS; 1♀, leg. MB.

Remarks. The species is distributed from the northern and central parts of Europe through Siberia, including the northern regions of Kazakhstan, Mongolia and China, to the Far East and the Korean Peninsula (Danilevsky 2018a). While *Cyrtoclytus capra* is a rather rare and sporadic species in West Europe, where the range of its host plants seems to be very narrow (*Acer*, *Alnus*), it is very numerous in Siberia, where it develops in many deciduous trees, e.g. *Betula*, *Quercus* and *Sorbus* but also in *Euonymus*, *Vitis* and *Aralia* (Danilevskaya et al. 2009). It primarily inhabits deciduous and mixed forests. The adults are active from June to August (Švácha and Danilevsky 1988).

Numerous specimens were observed throughout the day on the flowers of various herbaceous plants in rather different habitats, such as a mountain riverine forest dominated by *Salix*, *Populus* and *Betula*, mountain deciduous forests (Fig. 15F) or river canyon hills with *Caragana* and *Lonicera* shrubs (Fig. 15A).

Echinocerus floralis (Pallas, 1773)

Material examined. East Kazakhstan Region: 3 km N of Taskesken [Таскескен] (47°14'N, 80°47'E), 581 m a.s.l., 14 VI 2017, 1♂, leg. WTS; 3♂♂, 1♀, leg. LK; 15 km NW of Taskesken [Таскескен] (47°18'N, 80°36'E), 15 VI 2017, 627 m a.s.l., 2♂♂, leg. WTS; 1♂, 1♀, leg. LK; 2♂♂, 2♀♀, leg. MW; 1♂, leg. MB; 15 km W of Tarbagatay [Тарбағатай] (47°46'N, 81°37'E), 1072 m a.s.l., 15 VI 2017, 1♀, leg. WTS; Tarbagatay [Тарбағатай] env. (47°47'N, 81°17'E), 964 m a.s.l., 15 VI 2017, 1♂, leg. WTS; 25 km W of Tarbagatay [Тарбағатай] (47°50'N, 81°49'E), 878 m a.s.l., 16 VI 2017, 1♀, leg. LK; Kurshim [Күршім] env. (48°34'N, 83°36'E), 406 m a.s.l., 17 VI

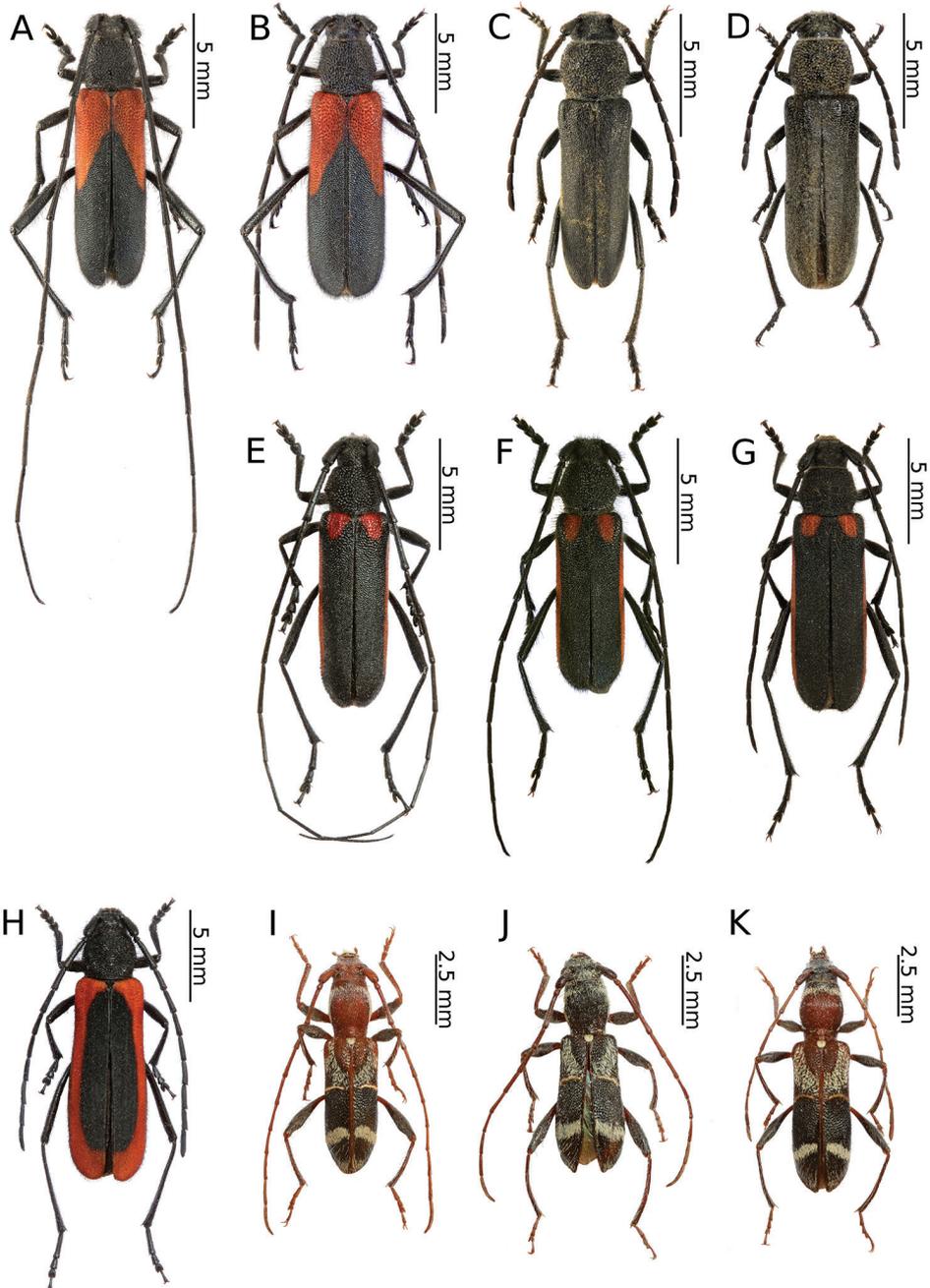


Figure 3. Photos of longhorn beetles specimens collected during the expedition to Kazakhstan in 2017: **A** *Anoplistes jacobsoni* (male) **B** *A. jacobsoni* (female) **C** *Anoplistes galusoi* (male) **D** *A. galusoi* (female) **E** *Anoplistes halodendri halodendri* (male, Sibinka River valley) **F** *A. halodendri halodendri* (male, Tarbagatay environs) **G** *A. halodendri halodendri* (female, Sibinka River valley) **H** *Amarysius duplicatus* (female) **I** *Cleroclytus semirufus collaris* (male, light form) **J** *C. semirufus collaris* (male, dark form) **K** *C. semirufus collaris* (female, light form).

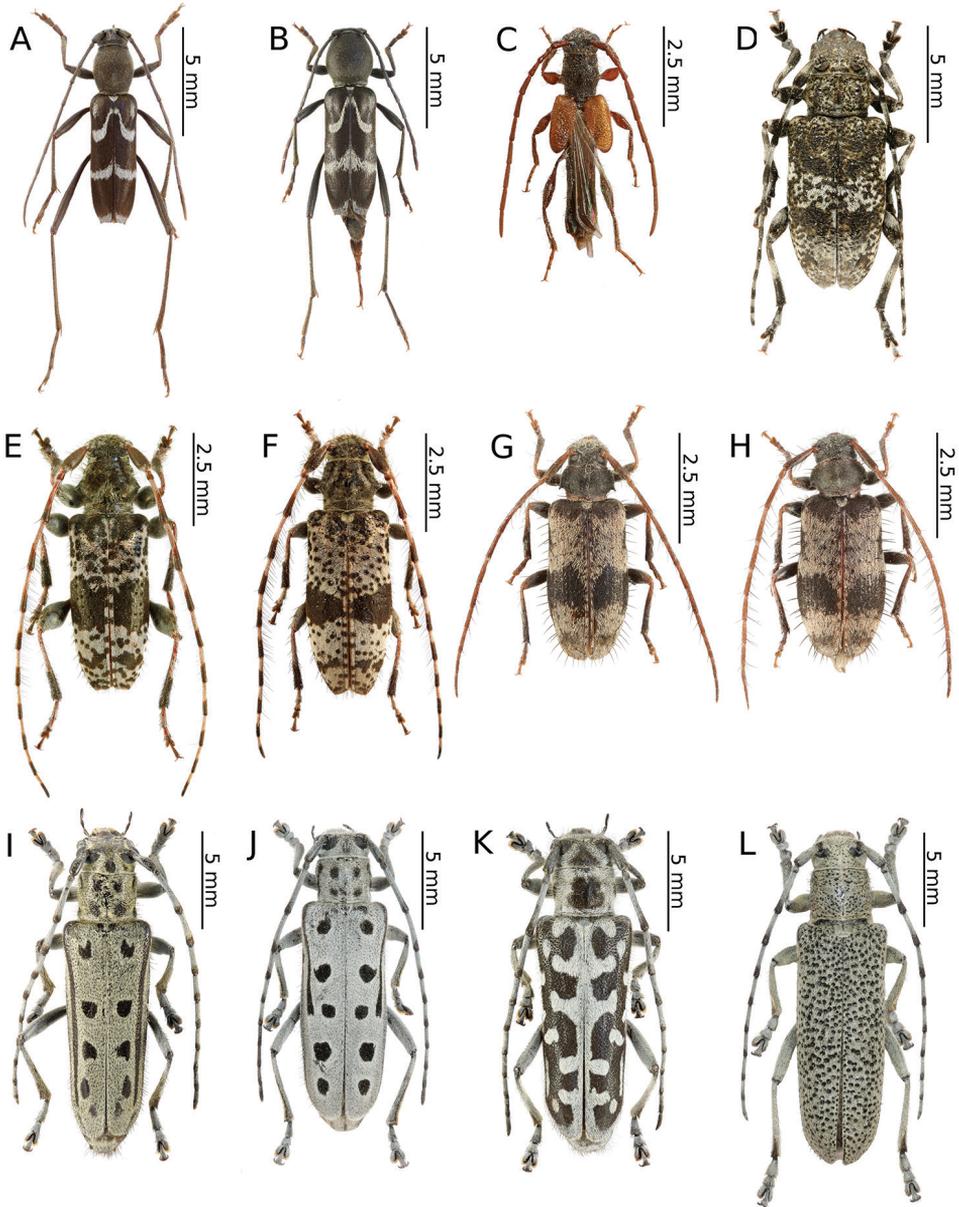


Figure 4. Photos of longhorn beetles specimens collected during the expedition to Kazakhstan in 2017: **A** *Rhaphuma gracilipes* (male) **B** *R. gracilipes* (female) **C** *Molorchus schmidtii* (female) **D** *Aegomorphus obscurior* (female) **E** *Ropaloscelis unifasciatus* (male) **F** *R. unifasciatus* (female) **G** *Exocentrus stierlini* (male) **H** *E. stierlini* (female) **I** *Saperda alberti* (female, whitish form) **J** *Saperda perforata* (female, whitish form) **K** *Saperda scalaris* (female, whitish form) **L** *Saperda similis* (female, whitish form).

2017, 3♂♂, leg. WTS; 10 km S of Bayash Утепов [Баяш Утепов] (49°35'N, 82°28'E), 508 m a.s.l., 25 VI 2017, 3♂♂, leg. WTS; 2♀♀, leg. LK; 1♂, leg. MW.

Remarks. This widespread thermophilous species is distributed from Europe throughout Asia Minor, the Caucasus, Transcaucasia, the Middle East and Central Asia to the Xinjiang region in China (Danilevsky 2018a). The larvae develop in the stems and roots of various herbaceous plants (e.g. *Medicago*, *Onobrychis*, *Amaranthus* and *Cornelia*, *Melilotus*) (Cherepanov 1990b). The adults are active in June and July, when they can be frequently observed visiting flowers of various plant species (Sama 2002).

The imagines were found in many rather dry or ruderal habitats, such as the roadside vegetation strips (Fig. 12C), hills with *Rosa* and canyons at riverbanks with *Caragana* and *Lonicera* (Fig. 15A).

Rhaphuma gracilipes (Faldermann, 1835)

Fig. 4A, B

Material examined. East Kazakhstan Region: Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 19–23 VI 2017, 1♂, 1♀, leg. WTS; 2♂♂, 2♀♀, leg. LK; 1♂, 1♀, leg. MB; 3♂♂ (1♂ – red wine trap), 2♀♀, leg. MW.

Remarks. This is an east-Palaeartic species that is distributed from Eastern Europe, where is rather rare, through Siberia, including the northern regions of Kazakhstan, Mongolia and China, to Sakhalin and Japan (Kurzawa 2012, Danilevsky 2018a). While the larvae usually develop in freshly dead twigs and stems under bark, then in the wood of various deciduous plant species, mainly in *Betula*, *Acer*, *Quercus*, *Tilia* and *Ulmus*, it is also known from *Aralia*, *Vitis*, *Spiraea*, *Syringa*, *Euonymus*, *Daphne* and *Micromeles* (Danilevskaya et al. 2009). The adults are active from June to September (Sama 2002).

The species was recorded from Kazakhstan for the first time by Kostin (1973). Some specimens were also collected in the Putintsevo environs in June 2005 by Danilevskaya et al. (2009).

Several imagines were collected on the flowers of Apiaceae in a mountain deciduous forest dominated by *Populus* and *Betula* (Fig. 15F). A single male was additionally lured into a red wine trap.

Xylotrechus adpersus (Gebler, 1830)

Fig. 2H

Material examined. East Kazakhstan Region: Буково [БЫКОВО] env. (49°42'N 84°34'E), 477 m a.s.l., 21 VI 2017, 1♀, leg. LK.

Remarks. *Xylotrechus adpersus* is distributed from Altai to Sakhalin and Japan and from Yakutia to northern China and the northern part of the Korean Peninsula (Cherepanov 1990b, Danilevsky 2018a). The species is ecologically associated with willows and *Chosenia arbutifolia*. After mating, the females lay their eggs in living twigs. The larvae initially

live under the bark and then in wood where they pupate after about two years. The imagines usually emerge from June to July (Cherepanov 1990b, Danilevskaya et al. 2009).

Several specimens were collected in the Putintsevo environs in June 2005 by Danilevskaya et al. (2009).

A single, probably freshly emerged, female was observed sitting motionlessly on a willow branch next to its emergence hole in an enclave of willows located next to a river (Fig. 12A). Moreover, several fresh larval feeding galleries of this species (Fig. 12B) were found in willow branches that were still alive, together with a single early instar larva under bark. Additionally, a few imagines of an unidentified parasitic Hymenoptera species were found in tunnels.

Xylotrechus alakolensis Karpiński & Szczepański, 2018 *

Fig. 2I

Material examined. East Kazakhstan Region: 15 km NW of Taskesken [Таскескен] (47°18'N, 80°36'E), 15 VI 2017, 627 m a.s.l., 1♂, leg. WTS.

Remarks. This newly described species was identified based on the specimen presented herein (Fig. 2I). Although only the holotype is known as yet, the range of this taxon is most likely limited to the eastern part of Kazakhstan. More information is provided in Karpiński and Szczepański (2018).

A single male was collected within a very rich roadside vegetation strip in a steppe-like habitat (Fig. 12C) using the sweep-netting method.

Xylotrechus capricornus (Gebler, 1830)

Fig. 2K, L

Material examined. East Kazakhstan Region: Bykovo [Быково] env. (49°39'N, 84°33'E), 570 m a.s.l., 21 VI 2017, 1♂, 1♀, leg. LK.

Remarks. *Xylotrechus capricornus* is a rare species that is distributed from Central Europe (Austria and the Czech Republic) to West Siberia (Sláma and Gutowski 1997, Danilevsky 2018a). It is probably monophagous on birch *Betula* spp. The females are very exacting in regard to the required health condition of a host plant. Although trees are occupied infrequently, many of them, especially those that are completely exposed, can be totally inhabited by numerous specimens on almost the entire surface of a trunk. The larvae first feed under the bark and then in the wood of trunks that have recently died. Pupation occurs deep in the wood. The life cycle of this species usually lasts two years, but can be extended up to three years. A situation in which two generations develop in the same host is very unusual. While the adults are active from the end of June to mid-August, imagines are rarely observed in nature – the beetles appear only on the hottest days and they usually disappear immediately after the sun sets behind the clouds or when the weather becomes windy or cold. Only a small part of a whole population can be spotted outside of the wood (Sláma and Gutowski 1997).

Until recently, the species was known from Kazakhstan only based on a single specimen that was found near Karkaralinsk (Kostin 1973). Then, in June 2005, several specimens were collected on birch bark in the Putintsevo environs by Danilevskaya et al. (2009). That was the first record in NE Kazakhstan.

In our research, a pair of *X. capricornus* was collected at the edge of a mountain deciduous grove that consisted mainly of *Populus*, *Betula* and *Salix* (Fig. 15C). Around noon, during hot weather, the beetles were copulating on birch trunks that were lying on a sun-exposed site. Our finding confirms the presence of this species in Kazakhstan.

Xylotrechus hircus (Gebler, 1825)

Fig. 2J

Material examined. East Kazakhstan Region: 20 km NW of Tauke [Тайке] (47°57'N, 83°16'E), 407 m a.s.l., 6 V 2017 (VI 2017 ex cult.) 4♂♂, 2♀♀, from *Betula* sp., leg. JH.

Remarks. Although the species originally occurred exclusively in Northern Asia from Altai to Japan (Cherepanov 1990b, Danilevsky 2018a), it was recently accidentally introduced into North America (e.g. LaBonte et al. 2005), where it is considered an invasive species. It was widely discussed in a previous paper concerning the longhorn beetles of Mongolia (Karpiński et al. 2018).

Several specimens were reared from birch wood *Betula* sp. collected in the hilly grove (Fig. 12D).

Xylotrechus rusticus (Linnaeus, 1758)

Material examined. East Kazakhstan Region: Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 19–23 VI 2017, 2♂♂, 1♀, leg. WTS; 1♂, leg. LK; 1♂, leg. MW; Bykovo [Быково] env. (49°39'N, 84°33'E), 570 m a.s.l., 24 VI 2017, 1♂, 1♀, leg. WTS; 2♀♀, leg. LK; 1♂, 2♀♀, leg. MW.

Hesperophanini Mulsant, 1839

Trichoferus campestris (Faldermann, 1835)

Material examined. Almaty Region: 2 km E of Saryozek [Сарыөзек] (44°22'N, 78°01'E), 875 m a.s.l., 02 VI 2017 (23 VI 2017, ex cult.) 1♂, 1♀, from *Ulmus* sp., leg. MW & LK; East Kazakhstan Region: Ust-Kamienogorsk [Өскемен] (50°00'N, 82°33'E), 302 m a.s.l., 19 VI 2017, 2♂♂, 1♀, leg. MW.

Remarks. *Trichoferus campestris* is originally native to the southeastern Palaearctic region; however, it is now considered an invasive species that has rapidly increased its

range in recent years (e.g. Grebennikov et al. 2010, Dascălu et al. 2013). It was discussed in a previous paper concerning the longhorn beetles of Tajikistan (Kadyrov et al. 2016).

Two specimens were reared from thick elm branches *Ulmus* sp. Additionally, a few imagines were attracted to artificial light sources during a warm night in a habitat of a city park.

Molorchini Gistel, 1848

Molorchus schmidti Ganglbauer, 1883

Fig. 4C

Material examined. East Kazakhstan Region: Aynabulak [Аынабулак] ad Zaysan [Зайсан] (47°33'N, 85°03'E), 508 m a.s.l., 7 V 2017 (25 V 2017, ex cult.) 2♂♂, 2♀♀, from *Elaeagnus angustifolia*, leg. RP; Almaty Region: 13 km W of Szonzy [Шонжы] (43°32'N, 79°17'E), 731 m a.s.l., 12 V 2017 (XI 2017, ex cult.) 1♀, from *E. angustifolia*, leg. KL.

Remarks. This species is distributed from Eastern Europe to Central Asia (Sama 2002, Danilevsky 2018a). The larvae develop in various deciduous trees and shrubs, e.g. *Salix*, *Elaeagnus*, *Cerasus*, *Populus*, *Malus*, *Prunus* (Sama 2002). In Kazakhstan, it also develops in wood of plants such as *Halimodendron*, *Hippophae* and *Rosa* (Ishkov and Kadyrbekov 2004). The imagines are active from the second half of April to the end of June and can be found on their host plants (Sama 2002).

Several specimens were reared from the twigs of *Elaeagnus angustifolia*.

Obriini Mulsant, 1839

Obrium cantharinum cantharinum (Linnaeus, 1767)

Material examined. East Kazakhstan Region: Bykovo [Быково] env. (49°39'N, 84°33'E), 570 m a.s.l., 21 VI 2017, 1♀, leg. MW.

Remarks. This is a widespread species that is distributed from western Europe through the Caucasus and Siberia to the Far East (Sama 2002, Danilevsky 2018a). The species is ecologically associated with *Populus tremula* but it can also develop in the wood of other tree species such as *Salix*, *Betula*, *Quercus*, *Malus*, *Sorbus*, *Robinia pseudoacacia*, *Fraxinus* and *Rosa* (Starzyk and Partyka 1993). According to Sama (2002), adults are active from April to August and can be found on their host plants or on the flowers of various plant species.

Only a single female was attracted to the artificial light source (Fig. 15H) at the edge of a mountain deciduous grove that consisted mainly of *Populus*, *Betula* and *Salix* (Fig. 15C).

Purpuricenini J. Thomson, 1861***Amarysius duplicatus* Tsherepanov, 1980**

Fig. 3H

Material examined. East Kazakhstan Region: Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 20 VI 2017, 1♀, leg. MW; 1♀, leg. MB, coll. LK.

Remarks. *Amarysius duplicatus* is a rather infrequent Siberian species that is distributed from West Siberia and eastern Kazakhstan to the Far East (Danilevsky 2018a). The species is ecologically associated with *Spiraea*, which is the only known host plant to date. The larvae feed and pupate in the wood of thin twigs. The adults are active from June to July and can be found on *Spiraea* flowers in large quantities (Cherepanov 1990b, Danilevskaya et al. 2009).

The first record for Kazakhstan was provided by Danilevskaya et al. (2009) based on several hundreds of specimens that were collected in the Putintsevo environs in June 2005. According to these authors, the species had been collected earlier near Ust-Kamenogorsk by I. Kostin in 1960 – misidentified as *Amarysius altajensis* (Laxmann, 1770) – and also by A. Napolov in 1994, but the record was not published.

Only two rather old females (one specimen lacked several segments of both antennae) were collected on the leaves of faded *Spiraea* shrubs in a mixed forest that covers the foothills of the West Altai Mountains. Taking into account the condition of host plants and specimens, as well as the number of individuals that had been collected here in June 2005, it must have been the end of the appearance of this species.

***Anoplistes galusoi* (Kostin, 1974) ***

Figs 3C, D, 10E, F

Material examined. Almaty Region: 25 km SW of Kalinino [Басши], 691 m a.s.l., 13 VI 2017, 1♂, leg. LK; 2♂♂, 1♀, leg. WTS.

Remarks. This is an endemic Kazakh species with its known distribution limited to the area of Mt. Ulkunkalkan at the Ili River in the southeastern part of the country (Kostin 1974, Danilevsky 2018a). According to Kostin (1974), the larvae develop in the roots and basal parts of the stems of living *Ephedra strobilacea*. The irregular feeding ground is widened with the increasing of larva and although it is initially oriented downwards, it turns back to the top. Its length usually does not exceed 20 cm. Most of the emergence holes of the adults are located at the base of the root neck, approx. a few centimetres above ground level. The damaged shoots dry up before the autumn, and sometimes this may cause the whole bush to die. Adults that are rather immobile can be found from the end of May to mid-June. They copulate on host plants shortly after they hatch and supplementary feeding does not seem to be important in this species.

The imagines (Fig. 10E, F) were observed during windy and hot weather sitting on tufts of *E. strobilacea* (Fig. 10G) that were growing on the steep mountain slopes on the western side at a higher altitude in the habitat of a stony semi-desert that was sparsely covered with vegetation (Fig. 10H). Only four inactive specimens (three males and one female) were found despite checking nearly a thousand *Ephedra* shrubs. They did not seem to react to either the strong gusts of wind or the presence of observers. The beetles were found throughout most of the day from about 11 a.m. to 6 p.m. This strongly limited, endemic species seems to be in decline recently. In order to protect the exact locality of this vulnerable cerambycid, even approximate geographical coordinates have not been given. The species may somehow be related to the extremely rare *Anoplistes diabolicus* Reitter, 1915.

Anoplistes halodendri halodendri (Pallas, 1773)

Fig. 3E–G

Material examined. East Kazakhstan Region: 15 km W of Tarbagatay [Тарбағатай] (47°46'N, 81°37'E), 1072 m a.s.l., 15 VI 2017, 1♂, leg. LK; 20 km W of Tarbagatay [Тарбағатай] (47°47'N, 81°42'E), 1000 m a.s.l., 16 VI 2017, 1♀, leg. MW; Zhantikei [Жәңгікей] env. (48°04'N, 82°42'E), 455 m a.s.l., 16 VI 2017, 1♂, leg. MW; 10 km S of Bayash Uterov [Баяш Утепов] (49°35'N, 82°28'E), 508 m a.s.l., 25 VI 2017, 11♂♂, 5♀♀, leg. MW.

Remarks. *Anoplistes halodendri* is an east-Palaeartic species that is distributed from the Balkans to the Russian Far East, China, Korea and Japan (Danilevskaya et al. 2009). Within its range, it was divided into seven subspecies: *A. h. balcanicus* Sláma, 2010, *A. h. ephippium* (Steven & Dalman, 1817), *A. h. halodendri*, *A. h. heptapotamicus* (Semenov, 1926), *A. h. kasatkini* Lazarev, 2014, *A. h. minutus* Hammarström, 1892 and *A. h. pirus* (Arakawa, 1932). Apart from its nominotypical form, two other subspecies are known to occur in Kazakhstan: *A. h. ephippium* and *A. h. heptapotamicus* (Danilevsky 2018a). According to Cherepanov (1990b), the larvae of this species are ecologically associated with deciduous trees and shrubs (e.g. *Acacia*, *Daphne mezereum*, *Quercus* and *Salix*) in steppe and forest-steppe habitats. The adults are active from July.

In the Sibinka River valley, the species was collected numerously in 2002 and as a single specimen in 2005 under the same conditions (Danilevskaya et al. 2009). According to these authors, this population can be considered typical.

All of the individuals were collected on the pea shrub *Caragana* spp. (Fig. 11H). Only three rather fresh specimens were found in mid-June in the area of Tarbagatay (Fig. 11G) (each at a different locality and on two different species of *Caragana*) despite a long and attentive investigation of several suitable plots with numerous pea shrub bushes, which might suggest the beginning of the appearance of this species. On the other hand, nine days later in the Sibinka River valley (Fig. 15B), about a dozen very damaged specimens were observed gathered on a single pea shrub while no additional specimens were found on the neighbouring shrubs. Since the two pairs were observed

in copula, it is probable that the males that still survived were attracted by the last females. This, in turn, clearly indicated the end of appearance; however, it may be related to the difference in the altitude of these localities (Tarbagatay approx. 1000 m and Sibinka 455 m a.s.l.). It is worth noting that neither during the presented expedition, nor in Mongolia (2015), were any imagines or immature stages of this species found on any different host or in any different habitat without *Caragana*, despite the thorough investigations of many plots and plant species using various methods. A similar observation concerning the occurrence of this species solely on *Caragana* spp. was made by Danilevsky (2018c) in Kazakhstan and Mongolia. It is possible that all of the records that are connected to other host plants may refer to related taxa, e.g. *A. b. ephippium*, or that some sibling species exist in this group, similar to the genus *Amarysius*. Furthermore, regarding the subspecies *heptapotamicus*, which was described from SE Kazakhstan (Lake Balkhash and Tarbagatay env.) based on several rather strange specimens, no significant morphological differences have been found between the specimens from the Sibinka River valley (Fig. 3E) and the Tarbagatay environs (Fig. 3F). However, some individuals from the area of Lake Balkhash should also be studied.

***Anoplistes jacobsoni* Baeckmann, 1904 ***

Figs 3A, B, 11A–C

Material examined. Kyzylorda Region: Tartogay env. [Тартора́й] (44°25'N, 66°13'E), 135 m a.s.l., 7 VI 2017, 22♂♂, 11♀♀, leg. LK; 38♂♂, 16♀♀, leg. WTS; 20♂♂, 5♀♀, leg. MB; 40♂♂, 17♀♀, leg. MW.

Remarks. This is an endemic Kazakh species that is only known from several localities along the lower and middle course of the Syr Darya River in the southern part of the country. According to Plavilstshikov (1940), *A. jacobsoni* is ecologically associated with *Tamarix* and *Elaeagnus*. However, Kostin (1974) and Kadyrbekov et al. (1996) barely mentioned the larval development in *Halimodendron*. Many aspects of the species biology including the duration of its life cycle remain unknown. The adults appear from the end of May to June and can be found on host plants (Kadyrbekov et al. 1996).

Our own observations clearly indicate that Plavilstshikov's data (1940) regarding the host plants are wrong. The species was observed in large numbers in a tugay habitat with *Halimodendron*, *Tamarix* and *Elaeagnus* (Fig. 11D). *Anoplistes jacobsoni* is ecologically associated with the common salt tree *Halimodendron halodendron* (Fig. 11E) and none of the individuals were observed on blossoming tamarisks or on oleasters despite the significant share of these plants in the habitat. Additionally, no emergence holes matching this longhorn beetle were found on the two last plant species mentioned, unlike the common salt tree on which many of them were observed. Therefore, Plavilstshikov probably recorded the main woody plants that formed the tugays in the habitat on which the species was found. According to our observations and based on the distribution of certain plant species, *A. jacobsoni* seems monophagous on *Halimodendron halodendron*. The larvae and feeding galleries (Fig. 11F) of this species were found in the stems and branches 2 to 5

cm in diameter. The adult emergence holes were located at heights that ranged from approx. 10 cm to 1 m above ground level. Although they were not usually concentrated, sometimes a few of them were situated about a dozen cm from each other. The larvae initially feed on living shoots, which died afterwards. The imagines were observed during a scorching (35 °C) day from around 10:30 a.m., when the males (Fig. 11A) were already actively but rather slowly flying in the upper parts of the most impressive shrubs (Fig. 11E). Most of females (Fig. 11B) that were collected were sitting on the shady leaves of the lower branches. However, some copulating pairs (Fig. 11C) were spotted before noon as well. The highest activity of the beetles occurred around noon and although the flight of the adults began to end after that, some individuals were still found sitting on the leaves and branches. At around 1 p.m., the number of visible individuals quickly started to decrease until about 1:30 p.m. when most of the beetles were already hidden from the heat. No adults were observed again until late in the afternoon (about 4 p.m.) and as time passed, their numbers began to gradually increase. Most of the specimens were collected around 5–6 p.m. while they sitting or copulating in different parts of shrubs, mostly in exposed places but sometimes also in the shade. At that time, most of the mating couples were observed; however, despite the largest number of individuals, not many were actively flying. In the evening hours, the beetles started to hide again so the last specimens were observed before 8 p.m. This was clearly the climax of the appearance of this species despite the fact that the *Halimodendron* shrubs were already faded at that time. The males prevailed in the population (ratio of approx. 2:1). Nevertheless, freshly emerged individuals were also found. *Anoplistes jacobsoni* was observed sympatrically with *Chlorophorus elaeagni*, which visited the blossoming tamarisks exclusively.

Tillomorphini Lacordaire, 1868

Cleroclytus semirufus collaris Jakovlev, 1885

Fig. 3I–K

Material examined. Almaty Region: Kabanbay [Қабанбай] (45°50'N, 80°37'E), 661 m a.s.l., 8 V 2017, 1♂ (at light), leg. GT, coll. RP; 7 km W of Kabanbay [Қабанбай] (45°48'N, 80°31'E), 720 m a.s.l., 9 V 2017, 3♂♂, 2♀♀, leg. RP; 12♂♂, 29♀♀, leg. JH; 2♂♂, 4♀♀, leg. KL; 13 km W of Szonzy [Шонжы] (43°32'N, 79°17'E), 730 m a.s.l., 12 V 2017 (9–30 XI 2017, ex cult.) 2♂♂, 6♀♀, from *Berberis vulgaris*, leg. RP; (I 2018, ex cult.) 1♀, from *Fraxinus sogdiana*, leg. JH; (XII 2017, ex cult.) 1♂, 1♀, from *Elaeagnus angustifolia*, leg. KL; Kapchagay [Қапшағай] (43°52'N, 77°03'E), 610 m a.s.l., 1 V 2017 (IX–X 2017, ex cult.) 1♂, 4♀♀, from *Acer* sp., leg. JH; East Kazakhstan Region: 20 km NW of Zaysan [Зайсан] (47°34'N, 84°39'E), 453 m a.s.l., 6 V 2017, 1♀, leg. JH; Aynabulak [Айнабулак] ad Zaysan [Зайсан] (47°33'N, 85°03'E), 508 m a.s.l., 7 V 2017 (26 IX–17 X 2017, ex cult.) 13♂♂, 9♀♀, from *E. angustifolia*, leg. RP.

Remarks. *Cleroclytus semirufus* is distributed from Central Asia and Afghanistan to Mongolia and northwestern China. Three subspecies have been described to date: *C.*

s. semirufus Kraatz, 1884, *C. s. collaris* Jakovlev, 1885 and *C. s. savitsky* Lazarev, 2014. The subspecies discussed here is known to occur in Afghanistan, Kirgizia, Kazakhstan and the Xinjiang region in China (Danilevsky 2001a, 2018a). According to the literature, it inhabits various habitats such as mountain and submountain forests (Plavilstshikov 1940), steppes (Kadyrbekov and Tleppaeva 1997) and tugay forests (Borissova 2018). The species is strongly polyphagous; its larvae develop in the twigs, *inter alia*, of *Salix*, *Populus* and *Rosa* (Kadyrbekov and Tleppaeva 1997, Ishkov and Kadyrbekov 2004). The imagines are active from May to July and can be found on their host plants as well as on various blossoming plant species (Plavilstshikov 1940).

Numerous individuals were collected on the flowers of the hoary cress *Lepidium draba* (Fig. 12E). Additionally, many specimens were reared from the inhabited material of various plant species: *Berberis vulgaris* (Fig. 12F), *Fraxinus sogdiana*, *Elaeagnus angustifolia* and *Acer* sp. The wood collected in Aynabulak turned out to be sympatrically infested with the larvae of two rather rare Bostrichidae species (det. et coll. J. Borowski): *Enneadesmus scopini* (Fursov, 1936) (> 30 exx.) and *Lyctus turkestanicus* (Lesne, 1935) (2 exx.).

Lamiinae Latreille, 1825

Acanthoderini J. Thomson, 1860

Aegomorphus clavipes (Schrank, 1781)

Material examined. East Kazakhstan Region: Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 19–23 VI 2017, 18♂♂, 7♀♀, leg. WTS; 4♂♂, 2♀♀, leg. LK; 16♂♂, 20♀♀, leg. MW; 3♂♂, 2♀♀, leg. MB; Вукovo [Быково] env. (49°39'N, 84°33'E), 570 m a.s.l., 24 VI 2017, 2♂♂, 1♀, leg. WTS; 5♂♂, 7♀♀, leg. LK; 3♂♂, 2♀♀, leg. MW.

Aegomorphus obscurior (Pic, 1904)

Fig. 4D

Material examined. East Kazakhstan Region: Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 21–24 VI 2017, 1♂, leg. WTS; 3♀♀, leg. LK; 1♂, leg. MW.

Remarks. This species is currently known to be broadly distributed in Russia and in the Siberian part of Kazakhstan (Danilevsky and Shapovalov 2007) as well as in Mongolia (Hilszczański 2008). In Europe, it reaches Latvia (Telnov 2016) and eastern Poland (Hilszczański 2008). *A. obscurior* was discussed in a previous paper concerning the longhorn beetles of Mongolia (Karpiński et al. 2018).

Several specimens were beaten down from the branches and thin shoots of birches on an exposed site next to a river in a mountain deciduous forest dominated by *Populus* and *Salix* with an admixture of *Betula* (Fig. 15D). In this region, the species is ecological-

ly associated with birch, in contrast to its western boundary of occurrence (e.g. Poland), where all records are related to oak. We observed this species together with *A. clavipes*, which was definitely more numerous and was mainly found on poplars and willows.

Agapanthiini Mulsant, 1839

***Agapanthia alternans alternans* Fischer von Waldheim, 1842**

Fig. 5D, E

Material examined. East Kazakhstan Region: 5 km SE of Kuygan [Құйған] (48°38'N 83°32'E), 439 m a.s.l., 18 VI 2017, 1♂, 1♀, leg. MB; 1♂, leg. WTS; 7 km N of Samarskoje [Самарское] (49°05'N, 83°20'E), 626 m a.s.l., 18 VI 2017, 3♂♂, 1♀, leg. WTS; 1♂, leg. LK; Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 22 VI 2017, 1♂, leg. WTS; 1♂, leg. MW; Bykovo [Быково] env. (49°39'N, 84°33'E), 570 m a.s.l., 24 VI 2017, 2♂♂, leg. WTS; 1♂, 4♀♀, leg. LK; 2♂♂, 2♀♀, leg. MW.

Remarks. This is a rather widespread species that is distributed from the central part of Kazakhstan to East Siberia. Five subspecies have been described, four of which are known to occur in Kazakhstan: *A. a. alternans* Fischer von Waldheim, 1842, *A. a. paralternans* (Danilevsky, 2017), *A. a. songarica* Kostin, 1973 and *A. a. tarbagataica* Kostin, 1978 (Danilevsky 2018a). Its nominotypical form occupies the northern part of the species range from about NE Kazakhstan to Transbaikalia and Mongolia. The species is ecologically associated with *Prangos* and *Ferula* (Danilevsky 2017).

Several specimens of this taxon were collected in the Putintsevo environs in June 2005 by Danilevskaya et al. (2009), however the subspecies was not specified.

The specimens were collected in rather different habitats, such as the roadside strip with herbaceous vegetation at the edge of a coniferous forest (Fig. 12H), in the entire area of Putintsevo and Bykovo. It was observed sympatrically with *Agapanthia dabli calculensis*, similar to Danilevskaya et al. (2009); however, according to these authors, both of these species have different host plants.

***Agapanthia dabli calculensis* Lazarev, 2013 ***

Fig. 5A–C

Material examined. Almaty Region: 5 km N of Karashota [Каражота] (43°41'N, 78°09'E), 492 m a.s.l., 3 VI 2017, 1♀, leg. WTS; East Kazakhstan Region: Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 22 VI 2017, 1♂, leg. WTS; 1♂, leg. MW; Bykovo [Быково] env. (49°39'N, 84°33'E), 570 m a.s.l., 24 VI 2017, 3♂♂, leg. WTS; 1♀, leg. LK; 6♂♂, 5♀♀, leg. MW; 10 km S of Bayash Uterov [Баяш Утепов] (49°35'N, 82°28'E), 508 m a.s.l., 25 VI 2017, 2♂♂, 1♀, leg. MW.

Remarks. This is an extremely polymorphic and widespread species that is distributed from Central and Southern Europe through Asia Minor, the Caucasus and

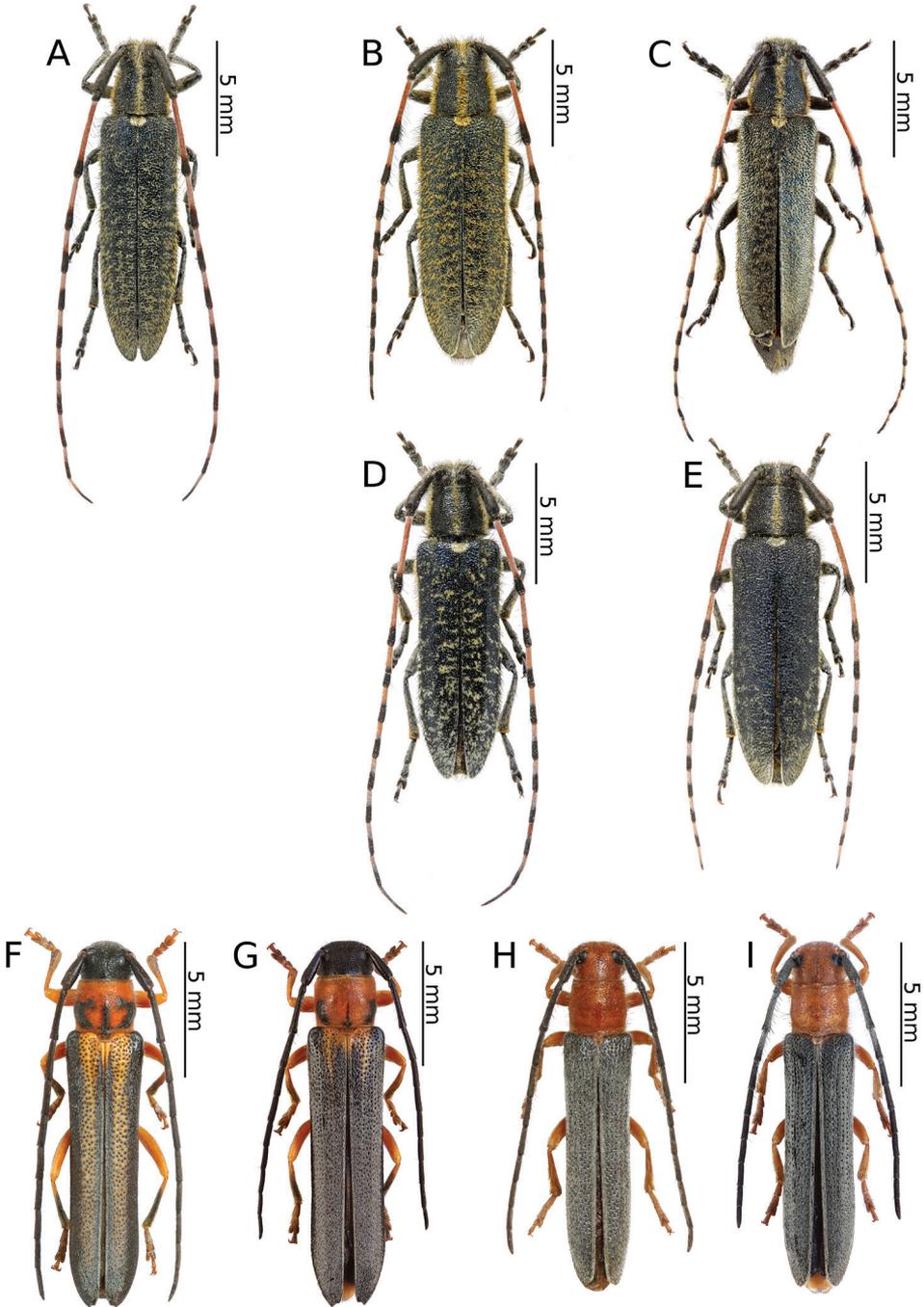


Figure 5. Photos of longhorn beetles specimens collected during the expedition to Kazakhstan in 2017: **A** *Agapanthia dabli calculensis* (male) **B** *A. dabli calculensis* (female) **C** *A. dabli* spp. (female, Karashota environs) **D** *Agapanthia alternans alternans* (male) **E** *A. alternans alternans* (female) **F** *Oberea kostini* (male) **G** *O. kostini* (female) **H** *Oberea ruficeps ruficeps* (male) **I** *O. ruficeps ruficeps* (female).

Central Asia to almost entire region of Siberia (Danilevsky 2018a). Within its range, it is represented by many distinct local forms. To date, as many as 15 subspecies have been designated. Most of them were described or moved from the species level very recently (Lazarev 2013a,c, Lazarev et al. 2016). *Agapanthia dabli calculensis* is endemic to northeastern Kazakhstan (Lazarev 2013a). According to this author, the subspecies primarily differs in the poorly developed setae tufts of its antennal joints, which are very long and dense in all of the other geographical forms as well as in the poorly pubescent elytra. Although *Agapanthia dabli* is ecologically associated with various herbaceous plants species, the larvae prefer to feed in the inner tissues of stems of *Cirsium*, *Melilotus*, *Cannabis* and *Ferula*. On the other hand, the series of type specimens of *A. d. calculensis* were collected on *Malva* sp. and *Dictamnus* sp. (Lazarev 2013a). The life cycle of this species usually lasts one year but sometimes can be extended to two years (Cherepanov 1991a).

Several specimens of this taxon were collected in the Putintsevo and the Sibinka River valley environs in June 2005 before *A. d. calculensis* was described; hence, it was recorded as a nominotypical subspecies by Danilevskaya et al. (2009).

According to M. Danilevsky (2018, pers. comm.), the single female (Fig. 5C) that was collected on *Carduus* sp. in the area of Karashota may represent a new subspecies. However, more specimens, including males, need to be gathered to support this hypothesis.

Agapanthia villosoviridescens DeGeer, 1775

Material examined. East Kazakhstan Region: Буково [Быково] env. (49°39'N, 84°33'E), 570 m a.s.l., 24 VI 2017, 1♀, leg. LK; 1♂, leg. MW.

Remarks. This is a typical Palaearctic species that is distributed from Southern Europe to East Siberia and Mongolia (Danilevsky 2018a). The larvae feed in the inner tissues of the stems of various herbaceous plants, mainly on *Carduus*, *Cirsium* and *Urtica*, and less frequently on *Angelica*, *Chaerophyllum*, *Eupatorium*, *Heracleum*, *Senecio*, *Scrophularia* and *Anthriscus* (Cherepanov 1991a). The adults can be found on their host plants from May to August.

One of the collected specimens represented a very rare and interesting form with red coloured antennae. Such forms are also known to occur in Europe.

Agapanthia violacea Fabricius, 1775

Material examined. Almaty Region: 7 km W of Kabanbay [Қабанбай] (45°48'N, 80°31'E), 720 m a.s.l., 9 V 2017, 9♂♂, 4♀♀, leg. RP & TJ; 9♂♂, 6♀♀, leg. JH; 3♀♀, leg. KL; 1♂, leg. GT; 6 km E of Коулик [Қойлық] (45°38'N, 80°19'E), 737 m a.s.l., 9 V 2017, 1♂, leg. RP; 2♂♂, leg. KL; East Kazakhstan Region: Буково [Быково] env. (49°39'N, 84°33'E), 570 m a.s.l., 24 VI 2017, 3♂♂, leg. WTS.

Remarks. *Agapanthia violacea* is distributed from Southern and Central Europe through Asia Minor and the Caucasus to Lake Baikal in Siberia. It is a thermophilic species that mainly inhabits xerothermic sites. It is ecologically associated with various plant species, mainly of Apiaceae and Asteraceae. The adults can be found on their host plants from mid-May to July (Paulus 1974, Cherepanov 1991a).

The specimens were mainly collected on *Astragalus sieversianus* (Fig. 12G).

Agapanthiola leucaspis (Steven, 1817)

Material examined. Almaty Region: 2 km E of Saryozek [Сарыөзек], (44°22'N, 78°01'E), 875 m a.s.l., 2 VI 2017, 1♂, 1♀, leg. WTS; 1♀, leg. MW; East Kazakhstan Region: 15 km NW of Taskesken [Таскескен] (47°18'N, 80°36'E), 15 VI 2017, 627 m a.s.l., 3♂♂, 2♀♀, leg. WTS; 1♂, 1♀, leg. LK; 1♂, leg. MW; Вукovo [Быково] env. (49°39'N, 84°33'E), 571 m a.s.l., 21 VI 2017, 1♀, leg. WTS.

Remarks. *Agapanthiola leucaspis* is a west-Palaearctic species that is distributed from Southern Europe through the southern regions of Eastern Europe and Russia, Turkey, Central Asia to Lake Baikal in Siberia, Mongolia and China (Sama 2002, Danilevsky 2018a). It is a polyphagous species whose larvae develop in various herbaceous plants, e.g. *Melilotus officinalis*, *Campanula sibirica*, *Salvia stepposa* and *Erigeron* sp. (Cherepanov 1991a).

Several specimens were collected in rather different habitats (e.g. roadside vegetation strip, mountain forest) using the sweep-netting method.

Desmiphorini J. Thomson, 1860

Rhopaloscelis unifasciatus Blessig, 1873

Fig. 4E, F

Material examined. East Kazakhstan Region: Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 22–23 VI 2017, 2♀♀, leg. WTS; 1♂, leg. MB, coll. LK; 1♂, 1♀, leg. MW.

Remarks. This is an east-Palaearctic species that is distributed from Altai to Sakhalin and Japanese islands, including China and the Korean peninsula (Cherepanov 1991a, Danilevsky 2018a). It is a highly polyphagous species whose larvae develop in the twigs or thin shoots of various deciduous trees and shrubs; however, they prefer *Salix*, *Morus*, *Acer*, *Aralia* and *Ulmus*. The larvae feed very intensely in the upper layers of wood and create longitudinal, often densely arranged, larval feeding galleries that are filled with fine sawdust. The life cycle lasts about two years. The imagines are active from May to July. The adults conduct their supplementary feeding on the young and thin twigs or branches of various deciduous species (Cherepanov 1991a).

Rhopaloscelis unifasciatus was recently reported from Kazakhstan for the first time by Danilevskaya et al. (2009) based on a single specimen that had accidentally been collected on a stem of *Artemisia* in the Putintsevo environs.

In our research, several specimens were beaten down from the dead parts of young willows in a mountain deciduous forest dominated by *Populus* and *Salix*. These findings confirm the presence of this species in Kazakhstan. *Rhopaloscelis unifasciatus* shares the same habitat with other Lamiinae species, *inter alia*, *Exocentrus stierlini* and *Saperda similis* as well as with other saproxylic beetles, e.g. *Kolibacia squamulata* (Gebler, 1830) (Trogossitidae) (Szczepeński et al. 2018).

Dorcadionini Swainson, 1840

Dorcadion abakumovi sarkandicum Danilevsky, 2004 *

Fig. 6A, B

Material examined. Almaty Region: 10 km SW of Sarkan [Сарқан] (45°21'N, 79°48'E), 990 m a.s.l., 4 V 2017, 2♂♂, leg. RP; 1♂, 1♀, leg. KL; 1♂, leg. GT.

Remarks. This taxon is endemic to eastern Kazakhstan and is known to occur only in one locality near the city of Sarkan in the foothills of the Dzungarian Alatau (Toropov and Milko 2013). This species includes four subspecies: *D. a. abakumovi* Thomson, 1865, *D. a. laterale* Jakovlev, 1895, *D. a. lepsyense* Danilevsky, 2004 and *D. a. sarkandicum*, which are represented only by small populations that occur in a limited area in the northern part of the Dzungarian Alatau in eastern Kazakhstan (Danilevsky 2004). The biology of the species is poorly known. The beetles occur at altitudes of approx. 800–1300 m a.s.l. where they feed on various species of Poaceae (Toropov and Milko 2013).

Dorcadion absinthium ishkovi Kadyrbekov, 2004 *

Fig. 7A, B

Material examined. Almaty Region: 2 km E of Arkhaly [Арқалы] (44°10'N, 77°56'E), 1005 m a.s.l., 2 V 2017, 6♂♂, 2♀♀, leg. RP; 11♂♂, 3♀♀, leg. KL.

Remarks. *Dorcadion absinthium ishkovi* is an endemic Kazakh taxon with its known distribution limited to an area situated approx. 50 km north of Kapchagay in the environs of Kerbulak (Kadyrbekov 2004, Toropov and Milko 2013). The biology of this species is poorly known. According to Kadyrbekov (2004), it inhabits the sandy desert above a canyon of the Ili River. Based on the known collection data, the imagines are active at the turn of April and May.

The population, which was dominated by males, was found in a steppe habitat (Fig. 13A) in the environs of Arkhaly. Our finding extends the known range of this taxon about 50 km to the east.

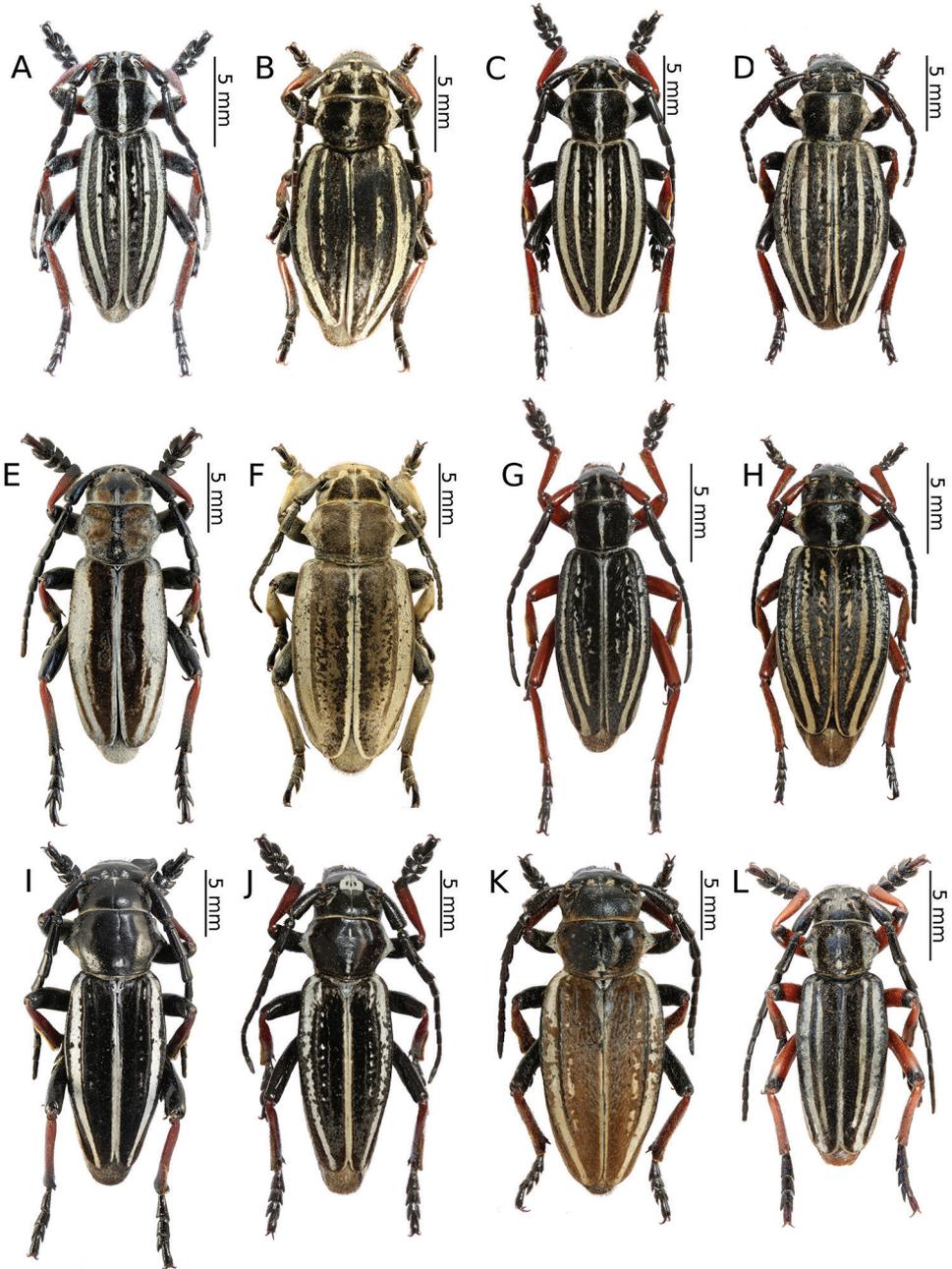


Figure 6. Photos of longhorn beetles specimens collected during the expedition to Kazakhstan in 2017: **A** *Dorcadion abakumovi sarkandicum* (male) **B** *D. abakumovi sarkandicum* (female) **C** *Dorcadion tenuelineatum* (male) **D** *D. tenuelineatum* (female) **E** *Dorcadion crassipes crassipes* (male) **F** *D. crassipes crassipes* (female) **G** *Dorcadion acutispinum* (male) **H** *D. acutispinum* (female) **I** *Dorcadion gebleri gebleri* (male, Zaysan environs) **J** *D. gebleri gebleri* (male, Kabanbay environs) **K** *D. gebleri gebleri* (female) **L** *Dorcadion arietinum arietinum* (male).

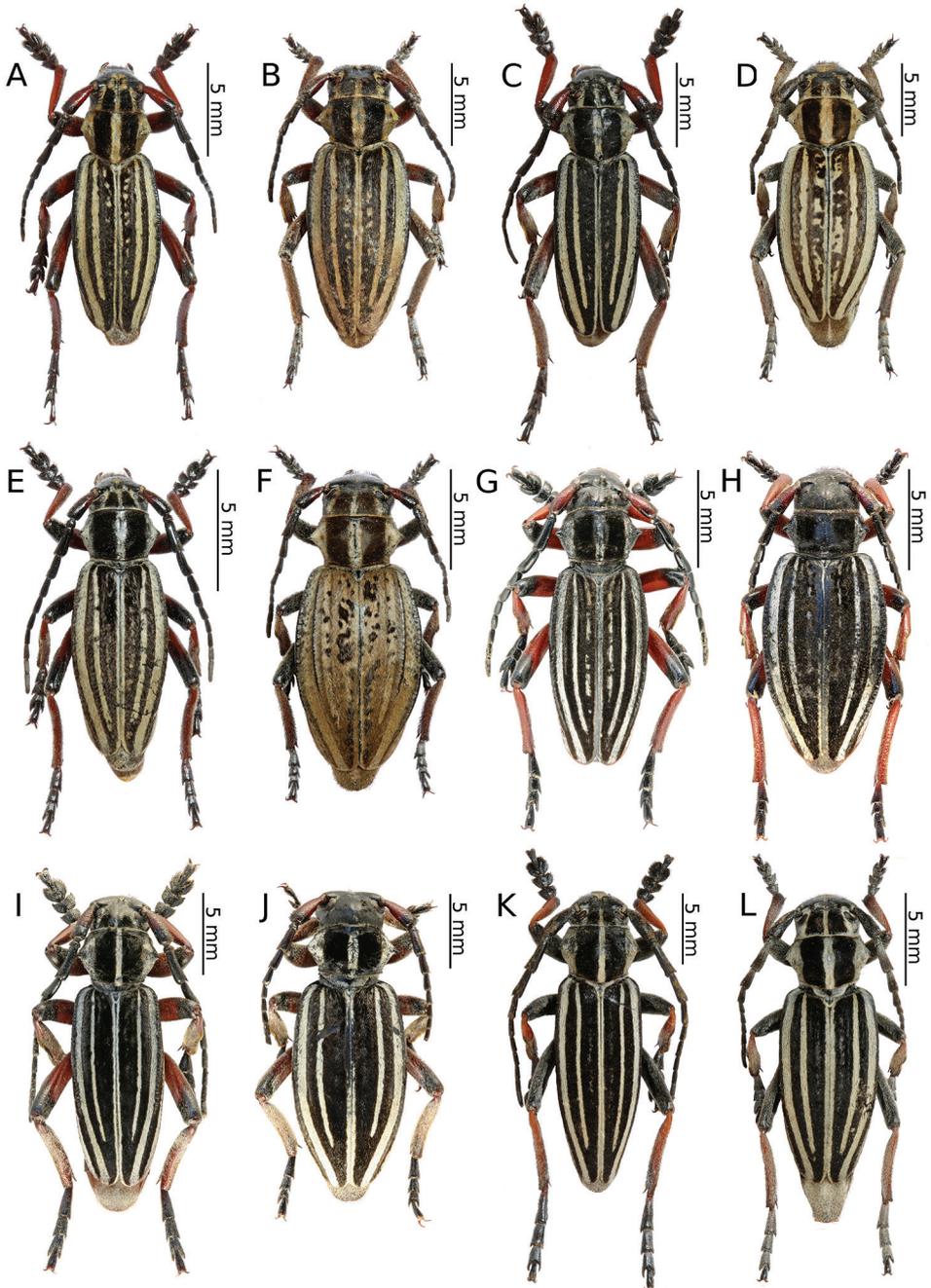


Figure 7. Photos of longhorn beetles specimens collected during the expedition to Kazakhstan in 2017: **A** *Dorsadion absinthium ishkovi* (male) **B** *D. absinthium ishkovi* (female) **C** *Dorsadion kapchagaicum* (male) **D** *D. kapchagaicum* (female) **E** *Dorsadion nikolaevi* (male) **F** *D. nikolaevi* (female) **G** *Dorsadion suvorovi konyolenum* (male) **H** *D. suvorovi konyolenum* (female) **I** *Dorsadion tianshanskii radkevitschi* (male) **J** *D. tianshanskii radkevitschi* (female) **K** *Dorsadion unidiscale* (male) **L** *D. unidiscale* (female).

***Dorcadion acutispinum* Motschulsky, 1860 ***

Figs 6G, H, 13B

Material examined. Almaty Region: 16 km NE of Kapal [Қапал] (45°12'N, 79°14'E), 1275 m a.s.l., 3 V 2017, 14♂♂, 5♀♀, leg. RP; 6♂♂, 2♀♀, leg. JH; 3♂♂, leg. GT; 22 km E of Kapal [Қапал] (45°13'N, 79°16'E), 1201 m a.s.l., 3 V 2017, 4♂♂, 1♀, leg. KL; 15 km E of Kapal [Қапал] (45°11'N, 79°12'E), 1320 m a.s.l., 3 V 2017, 2♂♂, leg. KL; 34 km W of Kapal [Қапал] (45°14'N, 78°39'E), 665 m a.s.l., 3 V 2017, 1♂, leg. KL.

Remarks. *Dorcadion acutispinum* is endemic to eastern Kazakhstan where it is known to occur in a few localities in the valley of the Kapal River and its surroundings in the northern range of Dzungarian Alatau (Danilevsky 1996c). The species inhabits sparse grasslands with sandy plots in a river valley. The imagines are active at the turn of April and May (Toropov and Milko 2013).

Numerous individuals were collected in steppe-like habitat in the Kapal canyon. The population was dominated by males (Fig. 13B) (ratio of approx. 3:1).

***Dorcadion arietinum arietinum* Jakovlev, 1898 ***

Figs 6L, 13C

Material examined. Almaty Region: 2 km N of Kegen [Кеген] (43°02'N, 79°13'E), 1809 m a.s.l., 12 VI 2017, 7♂♂, leg. WTS; 3♂♂, leg. LK; 4♂♂, leg. MW.

Remarks. *Dorcadion arietinum* includes seven described subspecies that are distributed in southern and southeastern Kazakhstan and northwestern China. The nominotypical subspecies is known to occur only in the area of SE Kazakhstan (Danilevsky 2018a). It inhabits mountain valleys and semi-arid areas at altitudes of approx. 600–2000 m a.s.l. The larvae feed on the roots of various grass Poaceae (e.g. *Stipa* spp.) and sedges of the Cyperaceae species. The adults feed on the aboveground parts of their host plants (Toropov and Milko 2013).

The males (Fig. 13C) were collected in a mountain steppe habitat sympatrically with *Dorcadion crassipes crassipes* Ballion, 1878 and *Dorcadion semenovi semenovi* Ganglbauer, 1884. Although the plot (Fig. 13D) was mainly covered with high tufts of grass, there were also large, bare sandy spots where reddish and rather active beetles were clearly visible.

***Dorcadion arietinum charynense* Danilevsky, 1996 ***

Material examined. 38 km SW of Szonzy [Шонжы] (43°21'N, 79°03'E), 1077 m a.s.l., 11 V 2017, 1♂, leg. GT.

Remarks. The taxon is endemic to southeastern Kazakhstan. The only known population is distributed along the northern foot of the east part of the Turaigyr Mountains (Danilevsky 1996d). The biology is similar to the nominotypical subspecies.

Only a single, rather old male specimen was found in the Sharyn Canyon.

***Dorcadion crassipes crassipes* Ballion, 1878 ***

Fig. 6E, F

Material examined. Almaty Region: 40 km SE of Sary-Ozek [Сары-Озек] (44°13'N, 78°30'E), 1534 m a.s.l., 10 V 2017, 1♂, leg. GT, coll. RP; 2 km N of Kegen [Кеген] (43°02'N, 79°13'E), 1809 m a.s.l., 12 VI 2017, 2♂♂, leg. MB, coll. LK & WTS.

Remarks. *Dorcadion crassipes* is distributed in southeastern Kazakhstan, northwestern China and Kyrgyzstan. Three subspecies have been described to date: *D. c. crassipes*, *D. c. glazunovi* Suvorov, 1910 and *D. c. validipes* Jakovlev, 1906. The nominotypical form is endemic to SE Kazakhstan and is known to occur eastwards from about the Chu-Ili Mountains to the Dzungarian Alatau (Danilevsky 1996b, 2018a). This is the most variable species of the *Compsodorcadion* group, which also includes *Dorcadion ganglbaueri* Jakovlev, 1898, *Dorcadion cephalotes* Jakovlev, 1889 and *Dorcadion gebleri* Kraatz, 1873. According to Toropov and Milko (2013), both adults and larvae are ecologically associated with the needle grass of the genus *Achnatherum*, especially with *Achnatherum splendens* (= *Stipa splendens* = *Lasiagrostis splendens*). Additionally, Danilevsky (1996b) claims that all of the taxa of the former *Compsodorcadion* subgenus are related to the grasses of the genus *Lasiagrostis*.

Despite several hours of searching at the locality near Kegen, only two males were collected in a mountain steppe habitat sympatrically with *Dorcadion arietinum arietinum* and *Dorcadion semenovi semenovi* Ganglbauer, 1884. This seems to confirm the interesting observations of Danilevsky (1996b) that although two or three *Dorcadion* species often occur together in the same locality, they are never two species of the same subgenus. Similarly, in our study three species represented three different subgenera: *Acutodorcadion* Danilevsky, Kasatkin & Rubenyan, 2005, *Cribridorcadion* Pic, 1901 and *Dorcadion* s. str. Dalman, 1817. This new locality in the environs of Kegen is the southeasternmost known location of this species, which is situated more than 100 km from the nearest sites that are already known. The plot (Fig. 13D) was mainly covered with high tufts of grass.

***Dorcadion gebleri gebleri* Kraatz, 1873**

Figs 6I–K, 13E

Material examined. East Kazakhstan Region: 5 km SE of Kabanbay [Қабанбай] (47°49'N, 83°37'E), 461 m a.s.l., 6 V 2017, 2♂♂, leg. RP; 2♂♂, leg. JH; 1♂, 3♀♀, leg. KL; 1♀, leg. GT; 20 km NW of Zaysan [Зайсан] (47°34'N, 84°39'E), 453 m a.s.l., 6 V 2017, 2♂♂, leg. RP; 1♀, leg. JH; 1♀, leg. KL; 5 km NE of Zaysan [Зайсан] (47°30'N, 84°57'E), 509 m a.s.l., 17 VI 2017, 1♂ (dead specimen), leg. WTS; 1♂ (body remains), leg. MB, coll. LK; 1♂, 1♀ (body remains), leg. MW.

Remarks. *Dorcadion gebleri* is distributed in eastern Kazakhstan and northwestern China. The species includes four subspecies: *A. g. demimetrum* Danilevsky, 1996, *A. g. gebleri*, *A. g. lukhtanovi* Danilevsky, 1996 and *A. g. taylori* Danilevsky, 1996. Most of

them are endemic to E Kazakhstan; only the nominotypical form extends its range into China (Danilevsky 2018a). This taxon mainly occurs on a small area around Lake Zaysan. The imagines are active rather early from the end of April to May, and sometimes even in June (Danilevsky 1996a). According to Danilevsky (1996b), this is the largest representative of the entire *Dorcadion* genus. The larvae feed on the roots of *Achnatherium* spp., especially on *A. splendens*. The adults feed on the above-ground parts of their host plants on which they also copulate (Toropov and Milko 2013).

Several males and females (Fig. 13E) that were collected in May were observed in pasture habitats overgrown by high tufts of *Festuca* sp. (Fig. 13F). The specimens that were found in mid-June consisted of rather old body remains, which confirms the very early period of the occurrence of this species. The plot was also overgrown by high tufts of *Festuca* sp. The two males that were depicted (Fig. 6I, J) were collected in two different plots located approx. 100 km from each other.

Dorcadion gebleri lukhtanovi Danilevsky, 1996 *

Material examined. East Kazakhstan Region: Kurshim [Құршім] env. (48°34'N, 83°36'E), 406 m a.s.l., 17 VI 2017, 1♂ (body remains), leg. WTS.

Remarks. *Dorcadion gebleri lukhtanovi* is known from several localities eastwards from Lake Zaysan in northeastern Kazakhstan (Toropov and Milko 2013). It occurs in the Kurchum Mountain ridge and in the surrounding foothill area (Danilevsky 1996a). The larvae probably feed on the roots of *Achnatherium* spp. The imagines are active from the end of April to May and only sometimes can be observed in June (Toropov and Milko 2013). According to Danilevsky (1996a), this taxon seems to be a transitional form between *D. g. gebleri* and *Dorcadion cephalotes* Jakovlev, 1890.

Only the remains of a single male were found in a grassy, semi-ruderal habitat in the Kurchum River valley.

Dorcadion kapchagaicum Danilevsky, 1996 *

Fig. 7C, D

Material examined. Almaty Region: 8 km N of Kapchagay [Қапшағай] (43°56'N, 77°02'E), 610 m a.s.l., 1 V 2017, 7♂♂, 7♀♀, leg. RP; 9♂♂, 6♀♀, leg. JH; 10♂♂, 6♀♀, leg. KL; 1♂, leg. GT; 50 km N of Kapchagay [Қапшағай] (44°18'N, 76°56'E), 587 m a.s.l., 1 V 2017, 4♂♂, 3♀♀, leg. RP; 4♂♂, 2♀♀, leg. JH; 2♂♂, 6♀♀, leg. KL; 3♂♂, leg. GT.

Remarks. *Dorcadion kapchagaicum* is endemic to southeastern Kazakhstan. The species is distributed in the area located to the north and west of the Kapchagay Reservoir, where it prefers clayey, semi-desert habitats in plains and foothills. The larvae feed on roots of various species of Poaceae. The beetles occur at altitudes of approx. 700 m a.s.l. where they feed on their host plants. The adults are active from the end of April to

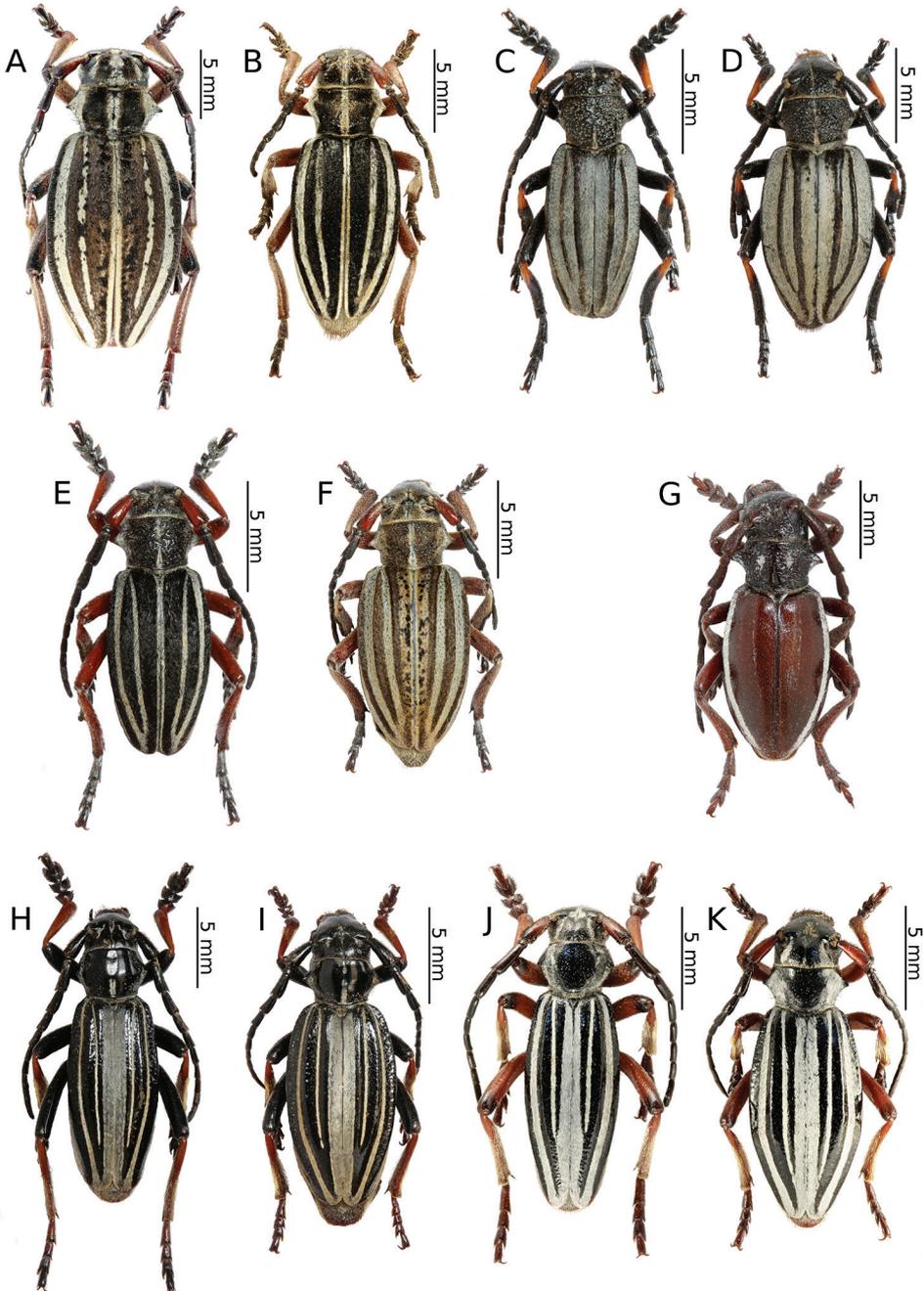


Figure 8. Photos of longhorn beetles specimens collected during the expedition to Kazakhstan in 2017: **A** *Dorcadion songaricum* (female) **B** *Dorcadion morozovi* (female) **C** *Dorcadion semenovi semenovi* (male) **D** *D. semenovi semenovi* (female) **E** *Dorcadion sokolowi* (male) **F** *D. sokolowi* (female) **G** *Eodorcadion carinatum carinatum* (male) **H** *Politodorcadion politum politum* (male) **I** *P. politum politum* (female) **J** *Politodorcadion ribbei bobrovi* (male) **K** *P. ribbei bobrovi* (female).

the beginning of June (Toropov and Milko 2013). According to Danilevsky (1996b), the most related taxon is *Dorcadion tschitscherini* Jakovlev, 1900, which is distributed slightly more to the south between the cities of Kapchagay and Almaty.

Numerous individuals were collected in steppe habitats in the area north of Kapchagay. At that time, the gender ratio of the observed population was rather equal.

Dorcadion morozovi Danilevsky, 1992

Fig. 8B

Material examined. Almaty Region: 10 km N of Kegen [Кеген] (43°09'N, 79°12'E), 1840 m a.s.l., 12 V 2017, 1♀, leg. JH, det. M. Danilevsky.

Remarks. The species is endemic to southeastern Kazakhstan and Xinjiang province in China (Danilevsky 2018a). In Kazakhstan, it occurs locally in the environs of Kegen and Narynkol (Danilevsky 1992, Toropov and Milko 2013), where it inhabits valleys with steppe and meadow vegetation up to 2500 m a.s.l. The larvae feed on roots of various grass species (e.g. *Festuca spp.*). The imagines are active from mid-April to the end of May (Toropov and Milko 2013).

Dorcadion mystacinum rufidens Jakovlev, 1906 *

Material examined. Zhambyl Region: 10 km NW of Akkol [Акколь] (43°27'N, 70°35'E), 382 m a.s.l., 5 VI 2017, 1♀ (body remains), leg. MB, coll. LK.

Remarks. The species is distributed in south Kazakhstan and northwestern Kyrgyzstan (Toropov and Milko 2013). Three subspecies have been described to date: *D. mystacinum mystacinum* Ballion, 1878, *D. mystacinum rufidens* and *D. mystacinum pumilio* Plavilstshikov, 1951 (Danilevsky 2018a). This subspecies seems to be endemic to the southeastern slopes of the Syr-Dar Karatau Mountains, where it mainly inhabits sparse grasslands and fixed sands in clayey and stony piedmonts between 320 and 1150 m a.s.l. The larvae feed on the roots of various grass species, mainly on *Festuca* and *Stipa*. The imagines are active from the end of April to the end of May (Toropov and Milko 2013).

Only the remains of a single female were found in a habitat with *Caragana* shrubs near the shore of a salt lake.

Dorcadion nikolaevi Danilevsky, 2005 *

Fig. 7E, F

Material examined. Almaty Region: 6 km E of Koylik [Койлык] (45°38'N, 80°19'E), 737 m a.s.l., 4 V 2017, 15♂♂, 3♀♀, leg. RP; 6♂♂, 1♀, leg. JH; 1♂, 1♀, leg. GT; 9 V 2017, 9♂♂, leg. RP; 9♂♂, leg. JH; 7♂♂, 1♀, leg. KL.

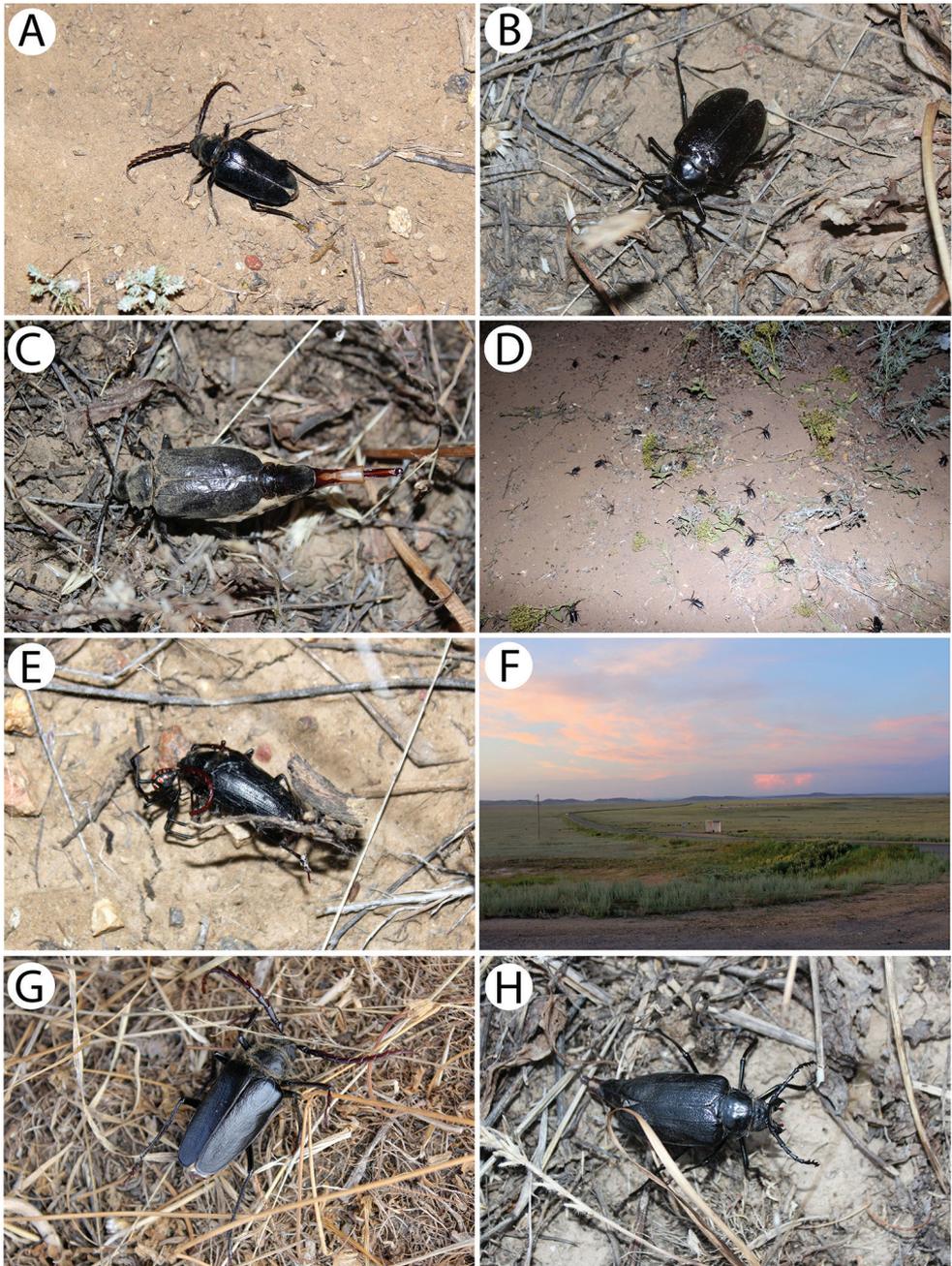


Figure 9. Field photos of imagines in nature and habitats of typical Kazakh cerambycid species: **A** male of *Psilotarsus brachypterus brachypterus* **B** female of *P. brachypterus brachypterus* **C** female of *P. brachypterus brachypterus* while spraying pheromones with raised ovipositor **D** massive occurrence of the males of *P. brachypterus brachypterus* attracted to an artificial light source **E** male of *P. brachypterus brachypterus* hunted by *Latrodectus tredecimguttatus* **F** *Artemisia*-desert in Kurshim environs, the habitat of *P. brachypterus brachypterus* **G** male of *Psilotarsus brachypterus pubiventris* **H** female of *P. brachypterus pubiventris*.

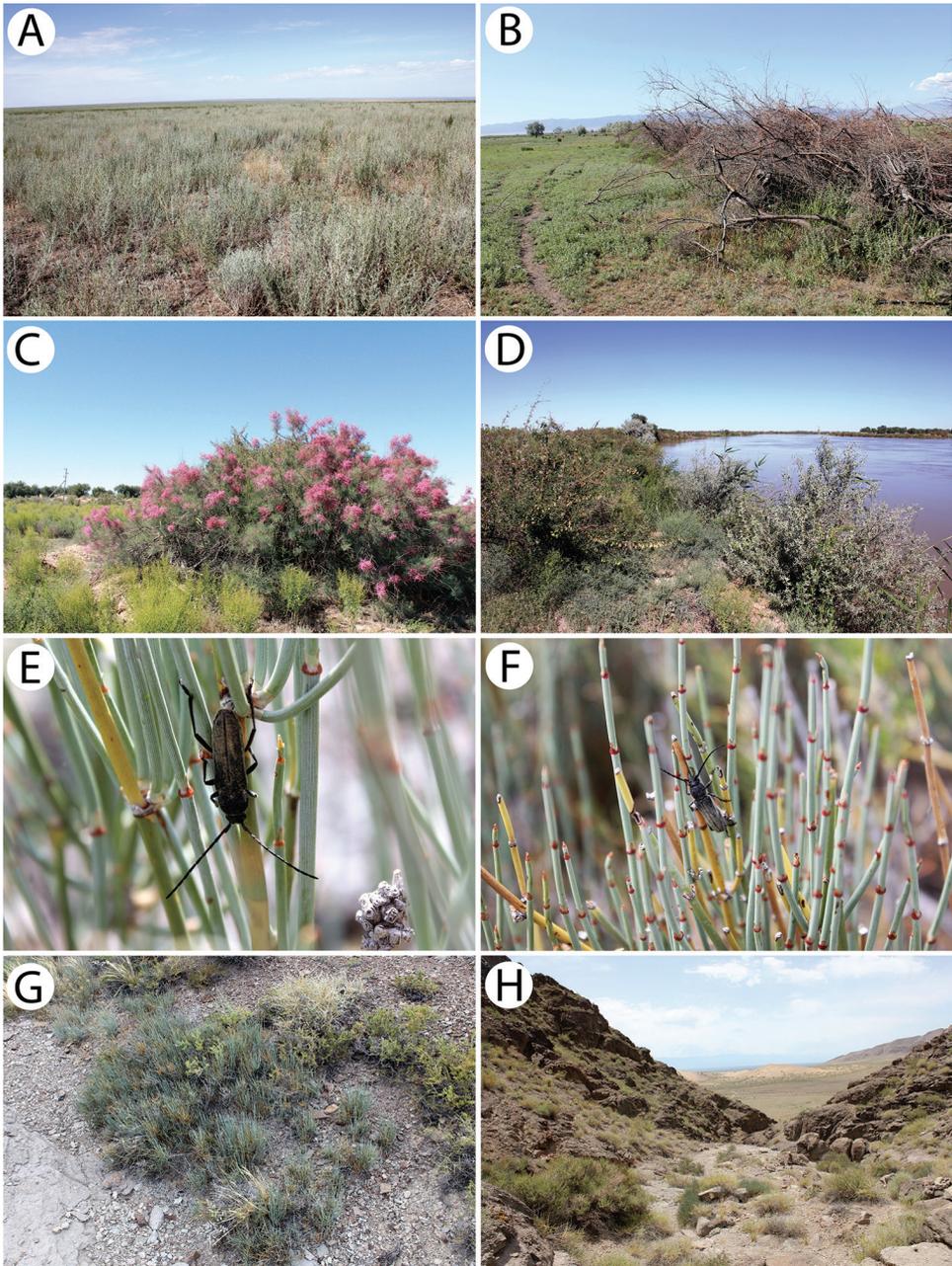


Figure 10. Field photos of imagines in nature, host plants and habitats of typical Kazakh cerambycid species: **A** semi-shrub desert in Kapchagay environs, the habitat of *Psilotarsus brachypterus pubiventris* **B** flood barrier formed with oleasters branches, the habitat of *Turanium scabrum* and *Chlorophorus elaeagni* **C** blossoming tamarisks in the habitat of *Ch. elaeagni* and *Anoplistes jacobsoni* **D** bank of the Syr Darya River in Tartogay environs, the habitat of *Oberea ruficeps ruficeps* **E** male of *Anoplistes galusoi* **F** *A. galusoi* on *Ephedra strobilacea* **G** shrubs of *E. strobilacea*, the host plant of *A. galusoi* **H** mountain slopes in Altyn-Emel National Park, the habitat of *A. galusoi*.

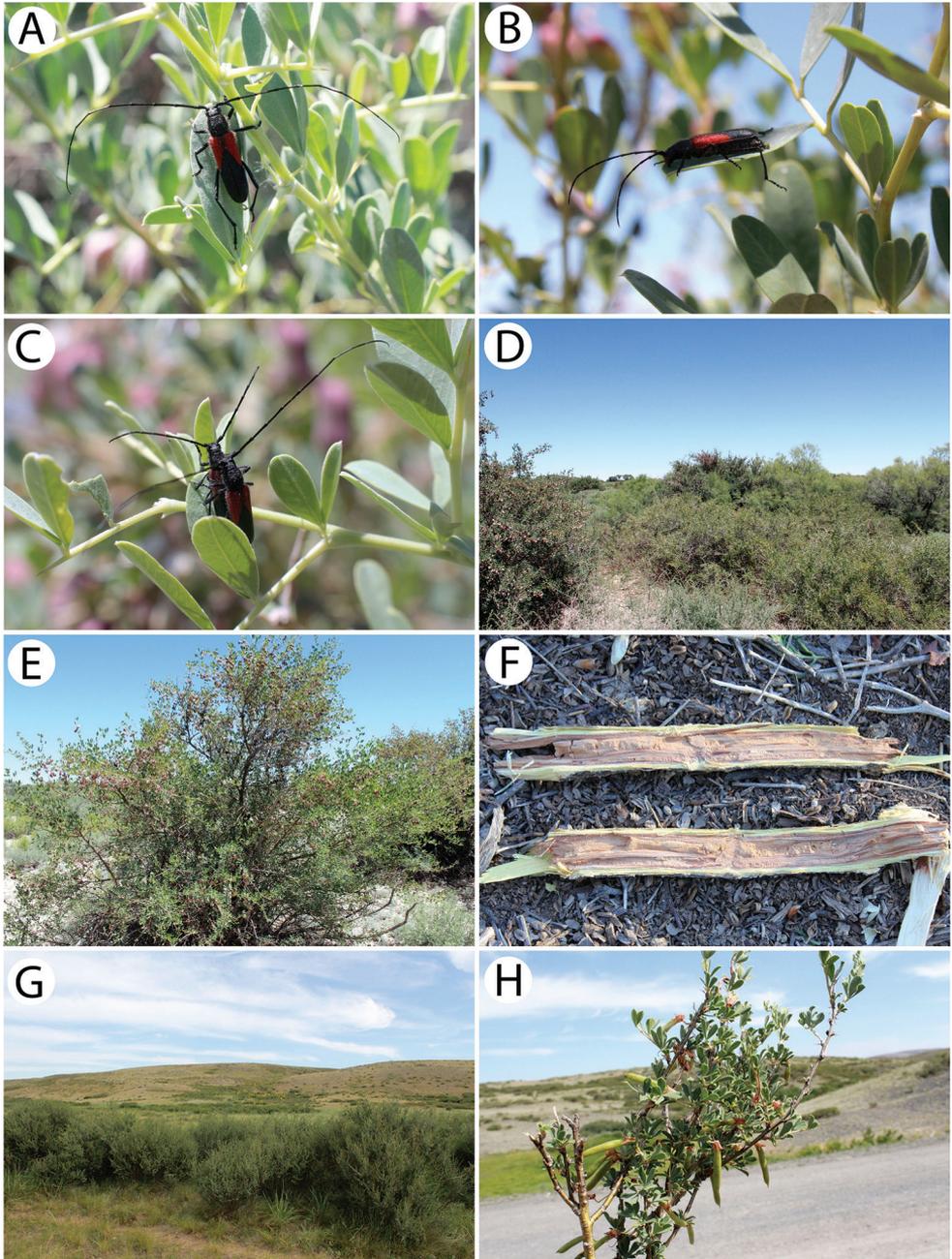


Figure 11. Field photos of imagines in nature, host plants and habitats of typical Kazakh cerambycid species: **A** male of *Anoplistes jacobsoni* **B** female of *A. jacobsoni* **C** pair of *A. jacobsoni* in copula on *Halimodendron halodendron* **D** tugays with *Halimodendron*, *Tamarix* and *Eleagnus* in Tartogay environs, the habitat of *A. jacobsoni* and *Chlorophorus elaeagni* **E** shrub of *H. halodendron*, the host plant of *A. jacobsoni* **F** larval feeding gallery of *A. jacobsoni* in a stem of *H. halodendron* **G** *Caragana* shrubs in Tarbagatay environs, the habitat of *Anoplistes halodendri halodendri* **H** *Caragana* sp., the host plant of *A. halodendri halodendri*.

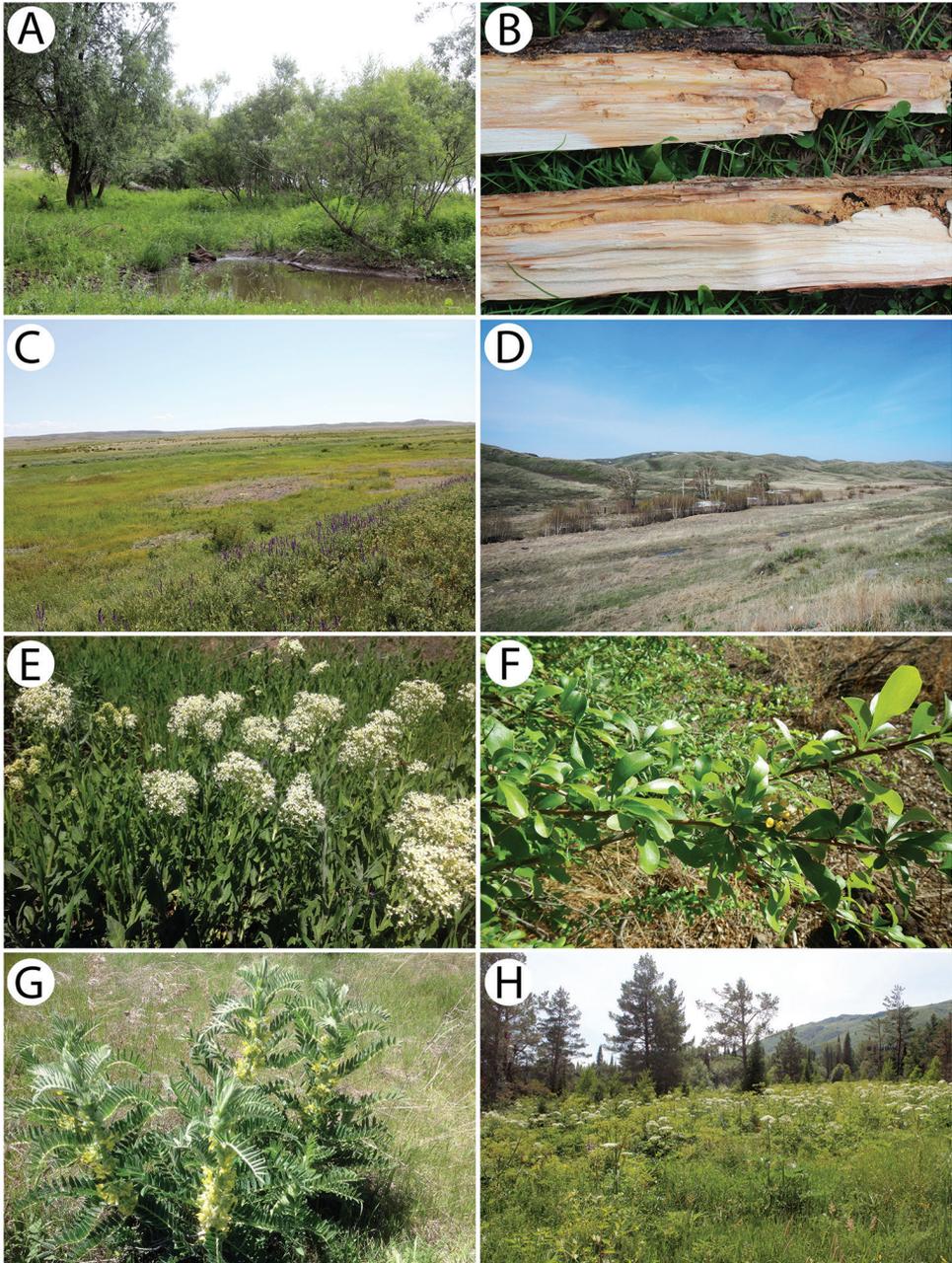


Figure 12. Field photos of host plants, larval feeding galleries and habitats of typical Kazakh cerambycid species: **A** river bank overgrown by willows, the habitat of *Xylotrechus adpersus* **B** larval feeding gallery of *X. adpersus* in a branch of *Salix* sp. **C** roadside vegetation strip in Taskesken environs, the habitat of *Xylotrechus alakolensis* **D** hilly grove with birches, the habitat of *Xylotrechus hircus* **E** inflorescences of *Lepidium draba*, the food plant of *Cleroclytus semirufus collaris* **F** *Berberis vulgaris*, the host plant of *C. semirufus collaris* **G** *Astragalus sieversianus*, possible host plant of *Agapanthia violacea* **H** roadside strip with herbaceous vegetation, the habitat of *Agapanthia alternans alternans*.

Remarks. The species is endemic to eastern Kazakhstan. It occurs only in the central part of the northern slopes of Dzungarian Alatau where it inhabits piedmont areas between 600–700 m a.s.l. The larvae feed on the roots of various grass species. The imagines are active mostly from the end of April to the second half of May (Toropov and Milko 2013).

***Dorcadion semenovi semenovi* Ganglbauer, 1884**

Figs 8C, D, 13G

Material examined. Almaty Region: 10 km N of Kegen [Қеғен] (43°07'N, 79°11'E), 1922 m a.s.l., 12 V 2017, 5♂♂, 8♀♀, leg. RP; 2♂♂, 2♀♀, leg. JH; 2♂♂, leg. KL; 17 km SE of Kegen [Қеғен] (42°55'N, 79°25'E), 2078 m a.s.l., 12 V 2017, 5♂♂; leg. KL; 15 km N of Kegen [Қеғен] (43°09'N, 79°12'E), 1844 m a.s.l., 11 V 2017, 3♀♀, leg. KL; 2♂♂, leg. GT; 5 km E of Saryzhaz [Сарыжаз] (42°55'N, 79°40'E), 1900 m a.s.l., 12 VI 2017, 2♂♂, 9♀♀, leg. WTS; 9♂♂, 6♀♀ (1♂, 4♀♀ – body remains), leg. LK; 5♂♂, 8♀♀, leg. MW; 2 km N of Kegen [Қеғен] (43°02'N, 79°13'E), 1809 m a.s.l., 12 VI 2017, 7♂♂, leg. WTS; 3♂♂, 1♀, leg. LK; 2♂♂, 2♀♀, leg. MW.

Remarks. *Dorcadion semenovi* is a very variable species, which includes ten subspecies that are distributed in the area of northern Kyrgyzstan, southeastern Kazakhstan and western China (Danilevsky 2002, 2018a). Its nominotypical subspecies is distributed to the northeast of Lake Issyk-Kul, mainly in the environs of the villages of Kegen and Narynkol (Danilevsky 2002, Toropov and Milko 2013). It inhabits foothills and river valleys at altitudes of 1600–3200 m a.s.l. The larvae feed on the roots of various grass species. The imagines are active from the end of April to the end of June, depending on the altitude on which they occur (Toropov and Milko 2013).

Most of the specimens were collected from a few different localities in the environs of Kegen. At a plot located 2 km N of Kegen, this species was observed in a mountain steppe habitat sympatrically with *D. crassipes crassipes* and *D. arietinum arietinum*. Although the plot (Fig. 13D) was mainly covered with high tufts of grass, there were also large, bare sandy spots. This species seems to have a long period of its occurrence. In May of the same year, numerous specimens were found in very good condition; however, over a month later, some live (although damaged) males (Fig. 13G) and females were still found.

***Dorcadion sokolowi* Jakovlev, 1899**

Fig. 8E, F

Material examined. Almaty Region: 7 km N of Sarymbel [Сарымбель] (44°29'N, 80°04'E), 1725 m a.s.l., 11 V 2017, 13♂♂, 6♀♀, leg. RP; 2♂♂, 2♀♀, leg. JH; 4♂♂, 4♀♀, leg. KL.

Remarks. *Dorcadion sokolowi* is distributed in southeastern Kazakhstan and the Xinjiang province in China (Danilevsky 2018a). In Kazakhstan, it mainly occurs in the

southeastern piedmonts of Dzungarian Alatau in environs of the town of Zharkent. It is also known from one locality in the valleys of the Ili and Charyn Rivers. The species inhabits stony foothills with a low-herb grassy vegetation at altitudes of approx. 600–700 m a.s.l. The larvae feed on the roots of various grass species. The adults are active from the end of April to the second half of May (Toropov and Milko 2013).

A rather unusual observation regarding the genus *Dorcadion* of a few specimens of both genders that were gathering on a single female probably in an attempt to copulate (Fig. 13H) was made in the area of Sarymbel.

Dorcadion songaricum Ganglbauer, 1884

Fig. 8A

Material examined. East Kazakhstan Region: 10 km E of Kyzyl Kesik [ҚЫЗЫЛ ҚЕСИК] (47°53'N, 82°06'E), 808 m a.s.l., 8 V 2017, 1♀, leg. RP, det. M. Lazarev.

Remarks. *Dorcadion songaricum* is distributed in east Kazakhstan and the Xinjiang province in China (Danilevsky 2018a). In Kazakhstan, the species is known from the northern slopes of the Tarbagatay and Saur Mountain ranges as well as the southern slopes of the Manrak Mountains. It inhabits sparse grasslands in piedmont regions. The larvae feed on the roots of various grass species. This is one of the latest occurring species; the adults are active from the second half of May to the end of June (Toropov and Milko 2013).

Only a single female was collected in a mountain-steppe habitat in the area of rocky hills (Fig. 14F).

Dorcadion suvorovi konyrolenum Danilevsky, 1996 *

Figs 7G, H, 14A

Material examined. Almaty Region: Karlygash [Қарлығаш] env. (44°16'N, 78°28'E), 1398 m a.s.l., 2 VI 2017, 1♂, leg. WTS; 1♀, leg. MB, coll. LK.

Remarks. The species includes five subspecies, which are mainly distributed within the area from the Kapchagay Reservoir to the Dzungarian Alatau (Toropov and Milko 2013). *Dorcadion suvorovi konyrolenum* is an endemic taxon whose known localities are limited to the environs of Konyrolen in southeastern Kazakhstan (Danilevsky 1996c, Toropov and Milko 2013). The biology of the species is poorly understood. According to Toropov and Milko (2013), the larvae feed on the roots of various grass species. The beetles occur at altitudes between 600–1,800 m a.s.l. The adults are active from the end of April to the beginning of June.

Only a single male (Fig. 14A) and female were collected in a mountain steppe habitat. The plot (Fig. 14B) was mainly covered with medium-high grass. Such a small number of observed individuals may indicate the end of the appearance of this species.

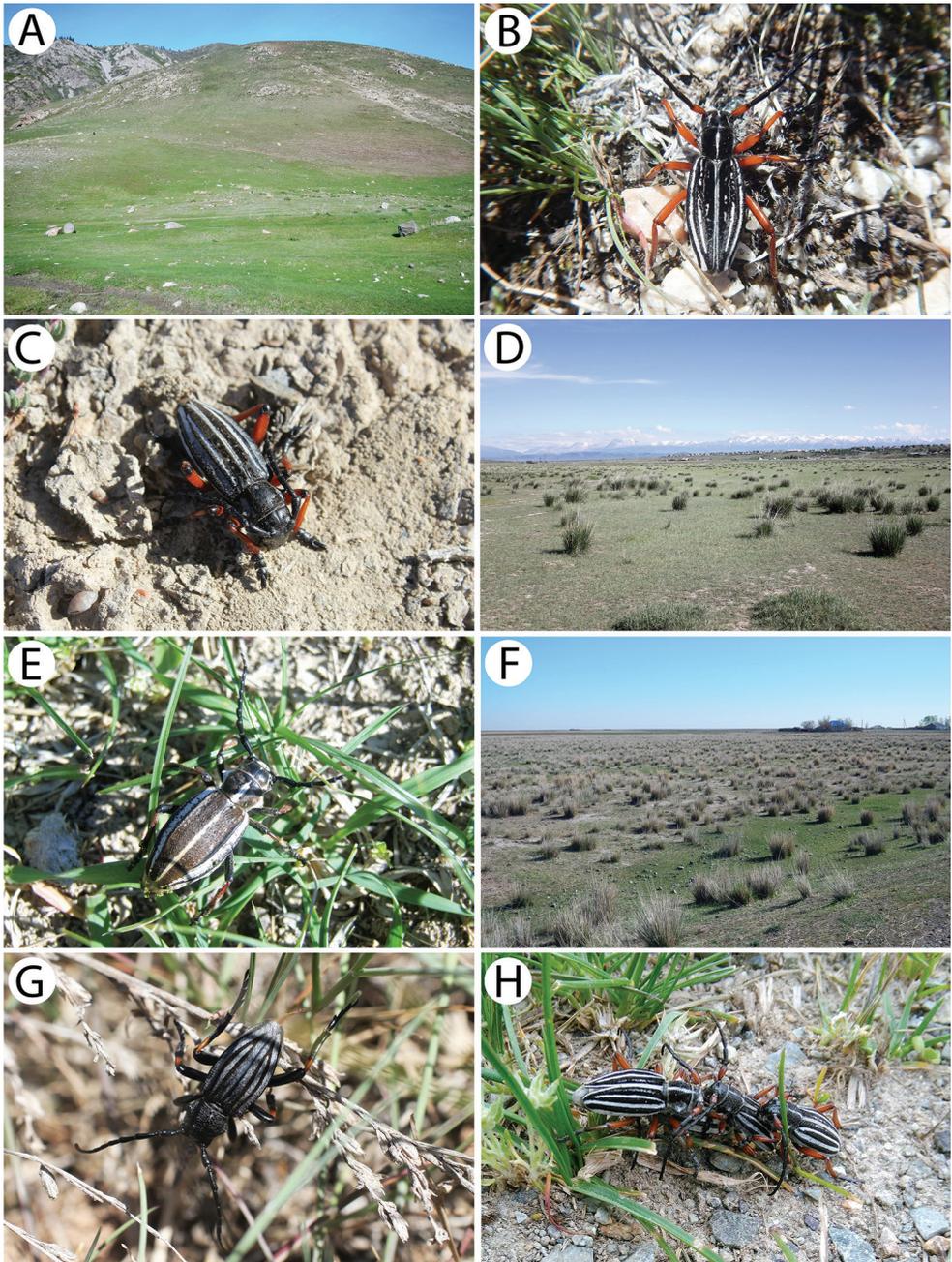


Figure 13. Field photos of imagines in nature and habitats of typical Kazakh cerambycid species: **A** steppe area in Arkhaly environs, the habitat of *Dorcadion absinthium ishkovi* **B** male of *Dorcadion acutispinum* **C** male of *Dorcadion arietinum arietinum* **D** mountain steppe area in Kegen environs, the habitat of *D. arietinum arietinum*, *Dorcadion crassipes crassipes* and *Dorcadion semenovi semenovi* **E** female of *Dorcadion gebleri gebleri* **F** mountain steppe area in Zaysan environs, the habitat of *D. gebleri gebleri* **G** male of *D. semenovi semenovi* **H** particular behavior of a few individuals of *Dorcadion sokolowi*.

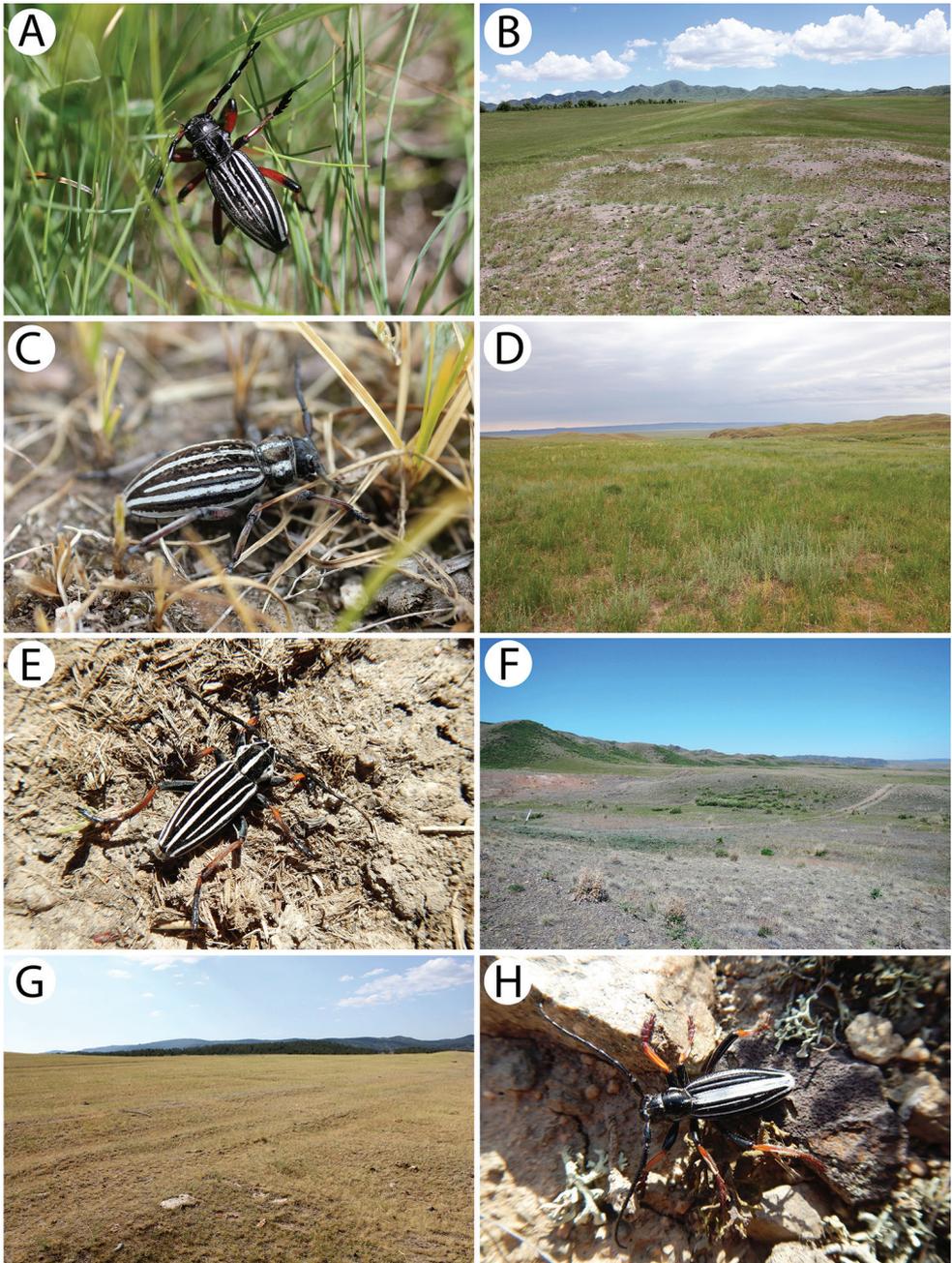


Figure 14. Field photos of imagines in nature and habitats of typical Kazakh cerambycid species: **A** female of *Dorcadion suvorovi konyrolenum* **B** steppe area in Karlygash environs, the habitat of *D. suvorovi konyrolenum* **C** female of *Dorcadion tianshanskii radkevitschi* **D** pasture in Kenen environs, the habitat of *D. tianshanskii radkevitschi* **E** male of *Dorcadion unidiscale* **F** mountain steppe area in Kyzyl Kesik environs, the habitat of *Dorcadion songaricum* **G** pasture in Verkhnie Tainty environs, the habitat of *Eodorcadion carinatum carinatum* **H** male of *Politodorcadion politum politum*.

***Dorcadion tenuelineatum* Jakovlev, 1895 ***

Fig. 6C, D

Material examined. Almaty Region: 10 km E of Gerasimovka [Герасимовка] (45°48'N, 80°59'E), 844 m a.s.l., 4 V 2017, 1♂, leg. RP; 1♂, leg. JH; 1♂, leg. KL; 9 V 2017, 12♂♂, 1♀, leg. RP; 3♂♂, 1♀, leg. KL.

Remarks. *Dorcadion tenuelineatum* is a species that is endemic to Kazakhstan (Danilevsky 2018a), where it occurs only in the area between Lake Alakol and the northeastern range of the Dzungarian Alatau (Toropov and Milko 2013). The species inhabits grasslands on the slopes in piedmont areas at an altitude of approx. 1000 m a.s.l. The larvae feed on the roots of various species of Poaceae. The adults are active from the end of April to the second half of May (Toropov and Milko 2013).

***Dorcadion tianshanskii radkevitschi* Suvorov, 1910 ***

Figs 7I, J, 14C

Material examined. Zhambyl Region: 5 km W of Kenen [Кенен] (43°25'N, 74°58'E), 928 m a.s.l., 4 VI 2017, 9♂♂, 3♀♀ (5♂♂ – body remains), leg. LK; 3♂♂, 2♀♀, leg. WTS; 18♂♂, 11♀♀ (3♂♂, 2♀♀ – body remains), leg. MW; 1♂ (dead specimen), 1♀, leg. MB.

Remarks. *Dorcadion tianshanskii* is a species that is endemic to Kazakhstan (Danilevsky 2018a). It includes eight subspecies, which are distributed in the area to the north of the Chu River, mainly in the environs of Kenen (Danilevsky 2012, Toropov and Milko 2013). The biology of this taxon is poorly known. According to Toropov and Milko (2013), it inhabits various habitats depending on the subspecies. The larvae feed on the roots of various grass species. The imagines are active from the end of April to the end of May.

The individuals of *D. t. radkevitschi* were collected during relatively cold (approx. 20 °C) and cloudy weather in a grassland habitat (Fig. 14D). Despite the rather late period for the species, a few copulating pairs as well as some males, which were actively moving between tufts of grass, were still found. The females (Fig. 14C) were found in rather better condition. Nevertheless, many specimens were already dead. The individuals that were still alive occurred more frequently in a shallow depression near a small stream, usually no further than 1.5 m from the stream.

***Dorcadion unidiscate* Danilevsky, 1996 ***

Figs 7K, L, 14E

Material examined. Almaty Region: 10 km S of Kaskelen [Каскелен] (43°05'N, 76°35'E), 1735 m a.s.l., 13 V 2017, 15♂♂, 4♀♀, leg. RP; 10♂♂, 4♀♀, leg. JH; 14♂♂, 1♀, leg. KL.

Remarks. *Dorcadion unidiscate* is endemic to southeastern Kazakhstan and it is known based on only a single population that is distributed in the area of Kaskelen

on the northern slopes of the Trans-Ili Mountains (Danilevsky 1999). According to Toropov and Milko (2013), this species inhabits midmontane meadows at altitudes of 1500–2000 m a.s.l. The larvae feed on the roots of various grass species. The imagines (Fig. 14E) are active from the beginning of May to the first half of June.

***Eodorcadion carinatum carinatum* (Fabricius, 1781)**

Fig. 8G

Material examined. East Kazakhstan Region: Verkhnie Tainty [Верхние Таинты] env., (49°24'N, 83°03'E), 879 m a.s.l., 18 VI 2017, 1♂, leg. WTS.

Remarks. *Eodorcadion carinatum* is distributed from the South Urals through South Siberia, northern Kazakhstan and Mongolia to the territory of northeastern China. Five subspecies have been described to date and a nominotypical form occupies the western part of the species range (up to Krasnoyarsk). The species inhabits steppe and semi-desert habitats up to an altitude of 1900 m a.s.l. (Toporov and Milko 2013). The populations of all subspecies are usually characterised by a large number of individuals that occur on numerous plots. It seems to be primarily ecologically associated with *Agropyron* spp. and *Elmynus* spp. (Danilevsky 2007c). In the western part of its range, the larvae often feed on the roots of cereals and forage plant species (Plavilstshikov 1958). The adults start to appear in June and can be found until September (Danilevsky 2007c).

Only a single male that was hidden under a cow dung in a pasture habitat was collected (Fig. 14G).

***Politodorcadion eurygyne eurygyne* (Suvorov, 1911)**

Material examined. East Kazakhstan Region: 20 km NW of Tauke [Тайке] (47°57'N, 83°16'E), 407 m a.s.l., 6 V 2017, 1♀, leg. RP.

Remarks. *Politodorcadion eurygyne* is distributed in eastern Kazakhstan and West Siberia. This species includes two subspecies: *P. e. eurygyne* and *P. e. lailanum* Danilevsky, 2007 (Danilevsky 2018a). The nominotypical subspecies occurs in two separate regions in E Kazakhstan: north of Lake Zaysan and to the south of the Tarbagatay Mountains. Its range in the latter area is limited only to southern foothills of the Kalbinsky Ridge (Danilevsky 2007b). The beetles inhabit clayey deserts and semi-deserts (at an altitude of approx. 500 m a.s.l.) with sparse grass vegetation where they feed on various species of Poaceae (Toropov and Milko 2013).

***Politodorcadion politum politum* (Dalman, 1823)**

Figs 8H, I, 14H

Material examined. East Kazakhstan Region: 120 km NE of Ajagöz [Аягөз] (48°57'N, 80°55'E), 586 m a.s.l., 5 V 2017, 4♂♂, 1♀, leg. RP; 3♂♂, 1♀, leg. JH; 1♂, leg. GT;

125 km NE of Ajagöz [Аягөз] (48°57'N 80°54'E), 592 m a.s.l., 5 V 2017, 2♂♂, 1♀, leg. KL; 50 km S of Ajagöz [Аягөз] (47°37'N, 80°38'E), 747 m a.s.l., 8 V 2017, 1♂, leg. KL; 48 km N of Ajagöz [Аягөз] (48°22'N, 80°29'E), 727 m a.s.l., 5 V 2017, 2♂♂, leg. KL; 25 km E of Tarbagatay [Тарбағатай] (47°46'N, 81°36'E), 1128 m a.s.l., 8 V 2017, 1♂, 1♀, leg. RP; 3♂♂, leg. JH; 27 km E of Tarbagatay [Тарбағатай] (47°46'N, 81°36'E), 1119 m a.s.l., 8 V 2017, 7♂♂, 1♀, leg. KL.

Remarks. *Politodorcadion politum* is distributed in northeastern Kazakhstan and southwestern Russia. The species includes three subspecies: *P. p. politum*, *P. p. akmolense* (Suvorov, 1911) and *P. p. shapovalovi* Danilevsky, 2006 (Danilevsky 2018a). The nominotypical subspecies is distributed west of Lake Zaysan and in West Siberia (Toropov and Milko 2013, Danilevsky 2018a, b). It inhabits grassy steppes that were mainly formed by *Stipa* spp. and sparse grasslands in hilly plains. The larvae feed on various species of Poaceae. The adults (Fig. 14H) are active from the end of April to mid-June (Toropov and Milko 2013).

Politodorcadion ribbei bobrovi (Danilevsky, 2001) *

Fig. 8J, K

Material examined. East Kazakhstan Region: 12 km S of Zaysan [Зайсан] (47°21'N, 84°51'E), 965 m a.s.l., 7 V 2017, 1♂, 1♀, leg. RP; 1♂, 1♀, leg. KL.

Remarks. This species is distributed in northeastern Kazakhstan and the Xinjiang region in China. The species includes two subspecies: *P. r. ribbei* (Kraatz, 1878) and *P. r. bobrovi*, whose populations are separated by the Manrak and Saur Mountain ranges (Toropov and Milko 2013, Danilevsky 2018a). *Politodorcadion ribbei bobrovi* is endemic to Kazakhstan and occurs exclusively on the northern slopes of these mountains in the border zone with China. It inhabits clayey and stony semi-deserts in piedmont valleys with sparse grass vegetation. The larvae feed on various species of Poaceae. The adults are active from the end of April to the end of May (Toropov and Milko 2013).

Acanthocinini Blanchard, 1845

Exocentrus stierlini Ganglbauer, 1883

Fig. 4G, H

Material examined. East Kazakhstan Region: Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 19–23 VI 2017, 3♂♂, 2♀♀, leg. WTS; 1♂, leg. LK; 1♂, 1♀, (VI 2018 ex cult.) 2♂♂, from *Salix* sp., leg. MW; 2 exx., red wine trap, coll. LK & MB.

Remarks. *Exocentrus stierlini* is an extremely rare but widespread species that is distributed from Central Europe to the Far East including northern Mongolia (Danilevsky 2014b, 2018a). Its occurrence in Mongolia was proven only very recently (Mül-

ler et al. 2013), similar to that of the Ulyanovsk region of Russia (Isaev and Ishutov 2001). According to Danilevsky (2014b), it is known to be monophagous on *Salix* within its entire range and there are no differences between specimens from Europe, Siberia and the Far East. The larvae develop in thin (6–22 mm diameter) willow shoots of both trees that are still alive or that are decaying. Pupation begins in May and continues until July. The adults occur in nature from June to August. Newly emerged imagines require supplementary feeding, which is conducted on the bark of young willow shoots. They lead a cryptic mode of life and can be found almost exclusively on their host plants (Cherepanov 1991a).

Although this species has already been mentioned as occurring in Kazakhstan (Danilevsky 2018a), this record was based only on the assumption concerning a single specimen from Staroaleyskoye (Altai Region of Russia, approx. 25 km from the Kazakh border) that is preserved in the collection of P. Svacha (Danilevsky 2014b, 2018, pers. comm.). However, until now, no specimens have been known directly from the borders of this country. Therefore, the presented locality in the area of Putintsevo is the first record for Kazakhstan.

Several specimens were beaten down from both live and dead willows of different ages, during hot and sultry weather in a deciduous forest that extends along the Khamir River in the foothills of the West Altai Mountains (Fig. 15D). The imagines of *E. stierlini* were collected in a few different habitats within one area in the Putintsevo environs. In addition to the rather shady and humid forest dominated by *Populus* and *Salix* where most of the specimens were found, beetles were also observed on an exposed site next to a river that had an admixture of *Betula* as well as in a more open habitat of a rather old *Populus* forest (Fig. 15F). At the last plot, two specimens were found in red wine traps. This is a rather peculiar observation concerning the representatives of the subfamily Lamiinae; however, the traps were hung in an air corridor, hence, they might have served as a mechanical barrier. Nevertheless, both individuals were caught on different days. Two mating couples were also observed. Only ten specimens were collected despite conducting many hours of targeted investigation over a few days during a rather optimal period, which underlines the rarity of this species. Attempting to attract them to an artificial light source, even at the site where the imagines were collected, did not provide the expected results. *Exocentrus stierlini* occurred sympatrically with other Lamiinae species, such as *Saperda similis*, *Lamia textor* and *Rhopaloscelis unifasciatus*.

Mesosini Mulsant, 1839

Mesosa myops (Dalman, 1817)

Material examined. East Kazakhstan Region: Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 21–22 VI 2017, 1♂, 1♀, leg. WTS; 1♂, 2♀♀, (IV 2018 ex cult.) 1♂, from *Salix* sp., leg. LK; 1♀, leg. MW; Вукovo [Быково] env. (49°39'N, 84°33'E), 570 m a.s.l., 24 VI 2017, 1♂, 3 larvae, (24 VII 2017 ex larva) 1♂, from *Populus* sp., leg. MW.

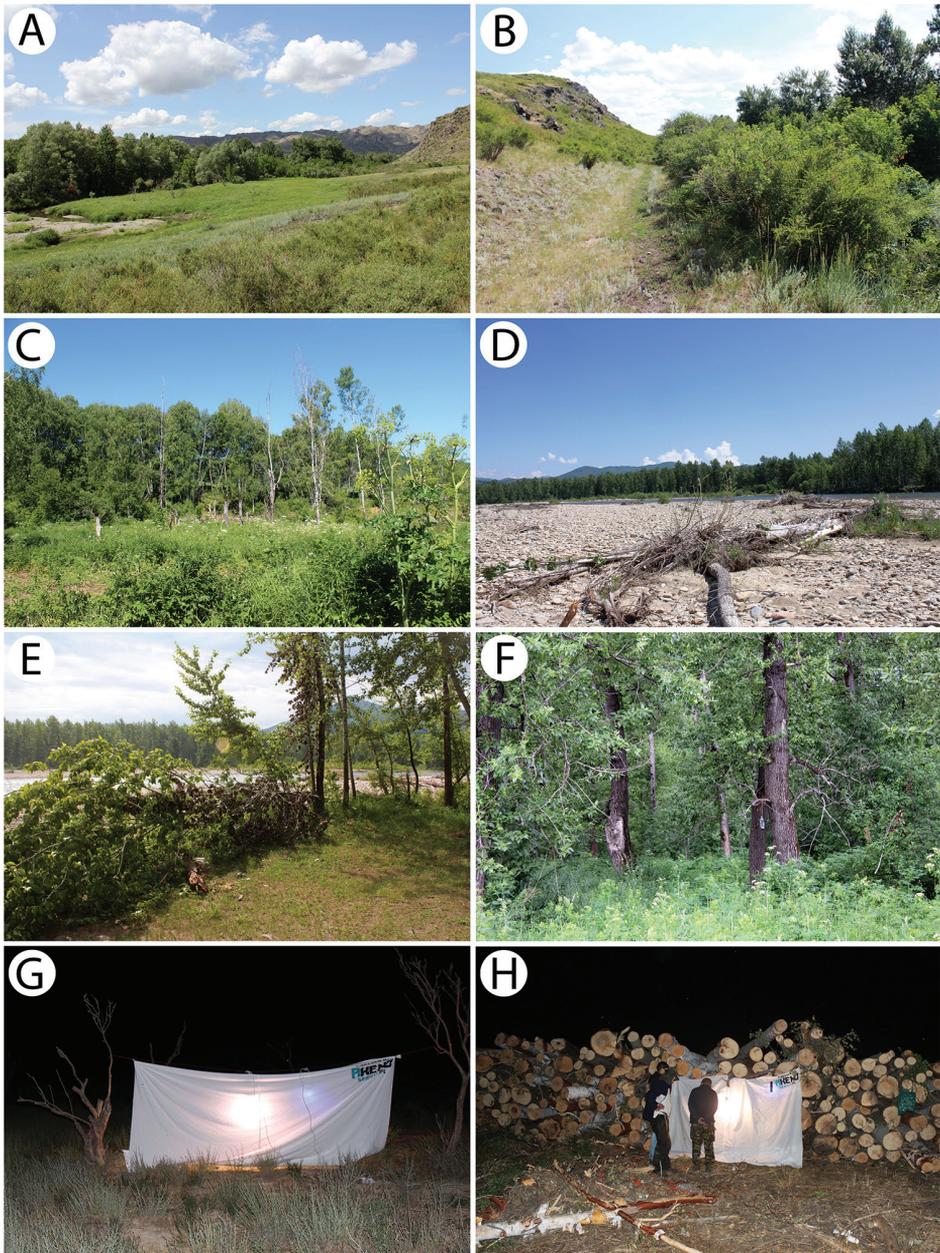


Figure 15. Field photos of habitats of typical Kazakh cerambycid species and some methods used: **A** general view on Sibinka River valley, the habitat of several collected species **B** pea shrubs on stony hills in Sibinka River valley, the habitat of *Stenocorus minutus* and *Anoplistes halodendri halodendri* **C** mountain deciduous grove in Bykovo environs, the habitat of numerous collected species **D** general view on mountain deciduous forest along the Khamir River in Putinsevo environs, the habitat of numerous collected species **E** river bank with poplar windfalls, the habitat of *Saperda alberti* **F** wine trap in poplars forest, the habitat of *inter alia* *Macroleptura thoracica*, *Rhaphuma gracilipes* and *Exocentrus stierlini* **G** attracting insects to artificial light source in *Artemisia*-desert habitat **H** attracting insects to artificial light source at the edge of a mountain deciduous forest.

Remarks. This species is distributed from Eastern Europe through Siberia, including northern Kazakhstan, Mongolia and China, to the Far East and Sakhalin (Cherepanov 1990c, Danilevsky 2018a). It was widely discussed in a previous paper concerning the longhorn beetles of Mongolia (Karpiński et al. 2018).

The imagines were collected on the bark or beaten down from the dead branches and boughs of a few deciduous tree species (mostly of middle-aged birches *Betula*). Two specimens were additionally reared from the collected wood material of a fallen poplar *Populus* trunk and a thin willow *Salix* trunk.

Lamiini Latreille, 1825

Lamia textor (Linnaeus, 1758)

Material examined. East Kazakhstan Region: Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 22 VI 2017, 1 ♀, leg. MB, coll. MW.

Remarks. *Lamia textor* is a typical Palaearctic species that is distributed from Spain to Japan, including the Caucasus, Iran and Turkey (Danilevskaya et al. 2009). The larvae develop at the basal part of trunks and in the roots of various deciduous tree species, mainly of the poplars *Populus* and willows *Salix*.

A single female was beaten down from a young willow trunk in the habitat of a mountain deciduous forest.

Monochamus sartor urusovii (Fischer von Waldheim, 1805)

Material examined. East Kazakhstan Region: Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 21 VI 2017, 1 ♂, leg. WTS.

Remarks. This taxon is widespread in Siberia and is distributed from Scandinavia and Eastern Europe (NE Poland) to the Far East and Japan (Plewa et al. 2018). It was discussed in a previous paper concerning the longhorn beetles of Mongolia (Karpiński et al. 2018). The taxonomic status of this species was uncertain. Wallin et al. (2013) considered *M. urusovii* to be a subspecies of *Monochamus sartor* (Fabricius, 1787). This status was recently confirmed also by Plewa et al. (2018) by using different sets of data, such as morphology, genetics and ecology.

Saperdini Mulsant, 1839

Oberea kostini Danilevsky, 1988

Fig. 5F, G

Material examined. East Kazakhstan Region: Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 22 VI 2017, 1 ex., obs. WTS; 10 km S of Bayash Uterov [Баяш

Утепов] (49°35'N, 82°28'E), 508 m a.s.l., 25 VI 2017, 1♂, 3♀♀, leg. WTS; 1♀, leg. MW; 1♀, leg. MB, coll. LK.

Remarks. This is a locally occurring species that is distributed from the eastern part of European Russia to West Siberia and eastern Kazakhstan. The species is ecologically associated with the genus *Lonicera*. The larvae probably develop in the wood of living twigs and thin stems (Danilevskaya et al. 2009). According to Danilevsky (1988) and Yanovsky (2003), the adults are active in June and July.

Numerous specimens were collected in these two localities (Putintsevo and Sibinka River valley) in June 2005 (Danilevskaya et al. 2009).

In our research, only several rather old and damaged specimens were collected with a predominance of females, which may indicate the end of the appearance of this species. On the other hand, the imagines were rather active, flying around the host plants and sitting on the leaves only from time to time. On the first plot, this species inhabits *Lonicera* shrubs that border a river and a forest stand dominated by *Betula*, *Populus* and *Salix*. In the Sibinka River valley, the population of *O. kostini* develops in the shrubs that are growing on river banks as well as on stony areas around the valley (Fig. 15A).

***Oberea ruficeps ruficeps* Fischer von Waldheim, 1842**

Fig. 5H, I

Material examined. Kyzylorda Region: Tartogay env. [Тартогай] (44°25'N, 66°13'E), 135 m a.s.l., 7 VI 2017, 1♂, leg. WTS; Almaty Region: 25 km SW of Kalinino [Басши] (43°53'N, 78°34'E), 691 m a.s.l., 13 VI 2017, 1♀, leg. MB, coll. LK.

Remarks. The nominotypical subspecies is distributed in Kyrgyzstan, Kazakhstan, Uzbekistan, western Siberia and northwestern China. The second subspecies – *O. ruficeps muchei* Breuning, 1981 – is only known from Tajikistan (Danilevsky 2018a). The larvae probably develop in the stems and roots of plants of the genus *Euphorbia*.

This is a rarely collected species in Kazakhstan, where it is usually observed in tugay habitats. Ishkov and Kadyrbekov (2004) recorded this taxon, *inter alia*, in the Karatal and Ili River valleys.

In the environs of Tartogay, *O. ruficeps* was observed on a rather dry and salty bank of the Syr Darya River, which was mostly overgrown by *Elaeagnus*, *Tamarix* and *Hali-modendron* (Fig. 10D). In the second locality, the species was found in a rather humid habitat near a small stream. The imagines were observed in flight in both cases; however, any *Euphorbia* species were not noticed on these plots.

***Phytoecia coerulea* (Scopoli, 1763)**

Material examined. Almaty Region: 7 km W of Kabanbay [Қабанбай] (45°48'N, 80°31'E), 720 m a.s.l., 9 V 2017, 1♂, leg. RP; East Kazakhstan Region: Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 21 VI 2017, 1♂, leg. WTS.

***Phytoecia rufipes rufipes* (Olivier, 1795)**

Material examined. Almaty Region: Kaskeleng [Каскелен] (43°12'N, 76°38'E), 825 m a.s.l., 13 V 2017, 1♀, leg. TJ, coll. RP.

Remarks. This taxon is distributed from Southern Europe through North Africa, Asia Minor, the Caucasus and the Near East to Central Asia and South Siberia. The second subspecies – *P. rufipes latior* Pic, 1895 – is only known from some regions in Syria and Turkey (Danilevsky 2018a). *Phytoecia rufipes* is an oligophagous species whose larvae develop in the roots of various herbaceous plants, particularly in *Foeniculum vulgare*, *Ferula galbanifera* and other Apiaceae. The adults can be found on their host plants from May to July (Bense 1995).

***Phytoecia nigricornis* (Fabricius, 1782)**

Material examined. East Kazakhstan Region: Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 23 VI 2017, 1♂, leg. MW.

***Menesia sulphurata* (Gebler, 1825)**

Material examined. East Kazakhstan Region: Буково [Быково] env. (49°39'N, 84°33'E), 571 m a.s.l., 21 VI 2017, 1 ex., obs. WTS.

Remarks. This species is distributed from the eastern part of European Russia to the Far East and the Korean peninsula (Danilevsky 2018a). The larvae develop in the small diameter shoots and twigs of various deciduous trees. Its life cycle lasts from one to two years. The imagines fly from June to August (Cherepanov 1991b).

A single specimen was observed on a leaf of a harvested poplar at the edge of mountain deciduous grove consisted mainly of *Populus*, *Betula* and *Salix* (Fig. 15C).

***Saperda alberti* Plavilstshikov, 1915**

Fig. 4I

Material examined. East Kazakhstan Region: Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 21 VI 2017, 2♀♀, leg. WTS.

Remarks. *Saperda alberti* is distributed from western Siberia to Japan, reaching the maximum of abundance in the Russian Far East (Danilevskaya et al. 2009). It was discussed in a previous paper concerning the longhorn beetles of Mongolia (Karpiński et al. 2018).

This species was recently published as a new for the Kazakh fauna by Danilevskaya et al. (2009) based on numerous specimens collected on *Populus* bark in the Putintsevo environs.

Two females were collected on the bark of a fresh poplar windfall on a river bank (Fig. 15E).

***Saperda perforata* (Pallas, 1773)**

Fig. 4J

Material examined. East Kazakhstan Region: Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 20–21 VI 2017, 2♀♀, leg. WTS; 1♂, 1♀, leg. LK; Bykovo [БЫКОВО] env. (49°39'N, 84°33'E), 571 m a.s.l., 21 VI 2017, 4♂♂, 4♀♀, leg. WTS; 2♂♂, 4♀♀, leg. LK; 4♂♂, 5♀♀, leg. MW; 1♀, leg. MB.

Remarks. This is a widespread species that is distributed from western Europe to the Far East, including North Africa and the Near East (Danilevsky 2018a). The larvae develop under the bark of deciduous trees, but they usually choose the poplar *Populus* and the willow *Salix* (Danilevskaya et al. 2009).

Numerous specimens were collected on the bark of harvested poplars, while some of them were attracted to artificial light sources (Fig. 15H).

***Saperda scalaris* (Linnaeus, 1758)**

Fig. 4K

Material examined. East Kazakhstan Region: Bykovo [БЫКОВО] env. (49°39'N, 84°33'E), 571 m a.s.l., 21 VI 2017, 1♀, leg. WTS.

Remarks. This species is widespread in the Palaearctic region and is distributed from Western Europe to the Far East, while *S. s. hieroglyphica* (Pallas, 1773) ranges from European Russia through Kazakhstan, Mongolia and China to the Far East (Danilevsky 2018a).

In contrast to the nominotypical subspecies whose pubescence is intensively yellowish, this taxon is characterised by a constant bluish colour of its pale pubescence (Danilevsky 2018c). However, distinguishing a subspecies based only on a colour difference is rather doubtful, and therefore, it is considered by some authors (e.g. Sama 2002) to be a synonym of a nominotypical subspecies. According to Bussler (2013), both forms can be found in the Southern Carpathians. In this case, the colour variation may be caused by its association with a different host plant. In Siberia, this polyphagous species is mainly associated with the birch *Betula platyphylla* (Cherepanov 1991b), thus a rather whitish colouration may facilitate its camouflage on birch bark. Such a hypothesis seems to be confirmed by Hoskovec et al. (2016) in the case of *S. perforata*. The authors explained this phenomenon as a *prototypical mimicry* and claimed that the colour of imagines is determined by the host plant, and thus adults whose larvae developed in the Eurasian aspen *Populus tremula* usually have a yellow-green or yellow-grey colour integument, whereas the beetles that developed in the white poplar *Populus alba* are usually grey. In Kazakhstan, we also observed similar white pubescence forms in the case of other related, though not associated with birches, species – *S. alberti*, *S. perforata* and *S. similis* (Fig. 4I, J, L). Therefore, a new synonymy is proposed: *Cerambyx scalaris* Linnaeus, 1758 = *Cerambyx hieroglyphicus* Pallas, 1773, syn. n.

A single female was found on the bark of a harvested birch log at the edge of mountain deciduous grove consisted mainly of *Populus*, *Betula* and *Salix* (Fig. 15C).

***Saperda similis* Laicharting, 1784**

Fig. 4L

Material examined. East Kazakhstan Region: Putintsevo [Путинцево] env. (49°52'N, 84°21'E), 472 m a.s.l., 22 VI 2017, 1 ♀, leg. MB, coll. MW.

Remarks. This is a rather rare but widespread species that is distributed from eastern Europe to the Far East (Danilevsky 2018a). It was discussed in a previous paper concerning the longhorn beetles of Mongolia (Karpiński et al. 2018).

A single female was beaten down from a dead willow in a mountain deciduous forest dominated by *Populus* and *Salix*.

The collected specimen represents the white pubescence form (var. *albopubescentis* Pic, 1925), which is characteristic for central-east Asia but rather rare in Europe (e.g. the Czech Republic, France). Very similar specimens are deposited in Abdysalom Kadyrov's collection (Dushanbe) that represents cerambycid material from Tajikistan.

Discussion

The flora of Kazakhstan amounts to more than 13 000 species, including approx. 5750 representatives of gymnosperms. As many as 14% of the total plant species are endemics in various degrees, many of them are additionally relicts. Moreover, Kazakhstan, due to its unique combination of natural complexes of steppes, deserts and mountain ranges, which are connected with major inland water and river systems, provides a wide variety of habitats and relevant types of flora that are connected with the arid regions of Central Asia. Apart from two centres of the endemism of the flora (the Karatau Mountains and the Western Tien Shan), there are many unique natural ecosystems, such as desert communities in Betpak-Dala, xylium, shrub and steppe communities of the Southern Altai, spruce and apple forests in the foothills and mountains of Dzungarian Alatau and Tien Shan and floodplain (riparian) forests in the Syr Darya and Ili River valleys (MEWR 2014).

This huge variety of habitats as well as the presence of many endemic plant species creates a unique diversity of invertebrates, also among the representatives of Coleoptera. According to the records of the State Forest Fund of the Republic of Kazakhstan, afforested areas cover only 4.61% of the total territory, and they consist of more than 20 tree and 40 shrub species. The forests in Kazakhstan can be divided into several types including pine forests in the Kazakh uplands, mountain forests in the Altai, Saura, Dzungarian Alatau and the Tien Shan Mountains, saxaul forests and riparian intrazonal forests (MEWR 2014). Special attention should be paid to the unique forest enclave on the western slopes of the Altai Mountains in the northeastern part of the country. According to Danilevskaya et al. (2009), northeastern Kazakhstan is generally a very interesting area from a zoogeographical point of view. In this place, the easternmost localities of European species are situated next to the westernmost sites of East Asian taxa, which creates the high-level biodiversity of the region. That was also confirmed in the case of representatives of the family Cerambycidae.

A total of 78 species belonging to the subfamilies of Prioninae, Lepturinae, Cerambycinae and Lamiinae was recorded as a result of the field research conducted during our two expeditions. They represent approx. 30% of the cerambycid fauna that is known from the entire country's area. Three species – *Psilotarsus brachypterus* (Gebler, 1830), *Dorcadion arietinum* Jakovlev, 1898 and *D. gebleri* Kraatz, 1873 – were represented by two different subspecies. Among 81 taxa that were collected, as many as 19 (approx. 23%), mainly in the genera of *Anoplistes* and *Dorcadion*, are endemic to Kazakhstan. The next 14 (approx. 18%) are endemic in regard to either the neighbouring region of Xinjiang (e.g. *Dorcadion morozovi* Danilevsky, 1992, *D. sokolowi* Jakovlev, 1899), to the region of Central Asia – e.g. *Turanium scabrum* (Kraatz, 1882), *Oberea ruficeps ruficeps* Fischer von Waldheim, 1842 – or to western Mongolia and West Siberia, e.g. *Stenocorus minutus* (Gebler, 1841). Some little-known species, such as *Anoplistes forticornis* Reitter, 1901, *A. diabolicus* Reitter, 1915 and *Turkaromia pruinosa* (Reitter, 1903), were not found despite conducting many hours of targeted investigation during a rather optimal period in suitable habitats or even on the exact plots that had been recorded by other authors. Although it may be related to phenological changes in different years, it also may indicate the declining of the particular populations of these species. According to Kadyrbekov et al. (1996), some cerambycids, such as *Hesperophanes heydeni* Baeckmann, 1923 and *Dorcadion balchashense* (Suvorov, 1911), have reduced their ranges in last 30–40 years, while other, e.g. *Anoplistes galusoi* Kostin, 1974, *T. pruinosa* and *Dorcadion grande* Jakovlev, 1906, survived in small areas due to anthropogenic transformation of their habitats. The part of our research that was focused mainly on the saproxylic representatives of the family Cerambycidae was carried out in the area of Putintsevo from 19 to 23 June and resulted in finding 40 species. Another scientific expedition, which was also devoted to longhorn beetles, was conducted in this region in 2005 by M. Danilevsky's research team (Danilevskaya et al. 2009). The authors recorded 59 species from 8 to 30 June. Since both surveys took place in the similar period the results can be compared to some extent. As many as 33 species, which constitute approx. 83% of taxa collected by us, were common in both studies. Most of the common species (in genera such as *Asemum*, *Euracmaeops*, *Gnathacmaeops*, *Pachyta*, *Molorchus* and *Pogonocherus*) that were not collected are ecologically associated with conifers and their lack in our research was caused by insufficient investigation of the areas with main share of *Abies*, *Picea*, *Larix* and *Pinus*. However, the lack or a very small number of individuals of some species that live on deciduous trees (e.g. *Amarysius duplicatus* Tsherepanov, 1980 on *Spiraea* and *Oberea kostini* Danilevsky, 1988 on *Lonicera*) is clearly connected to phenological changes. Some other species, *inter alia*, *Amarysius sanguinipennis* Blessing, 1872, *Xylotrechus ibex* (Gebler, 1825) and *Necydalis major* Linnaeus, 1758, are in turn very rare or lead the cryptic mode of life. On the other hand, a few interesting species, such as *Exocentrus stierlini* (Ganglbaur, 1883) and *Saperda similis* Laicharting, 1784, were not found in 2005. A similar comparison can be made for the locality in the Sibinka River valley. In 2005, the research team of M. Danilevsky found there 22 species including *Xylotrechus adspersus* (Gebler, 1830) and *Politodorcadion eurygyne eurygyne* (Suvorov, 1911), while only 8 taxa were collected by our group. However, an interesting and infrequent species – *Stenocorus minutus* – was found there only in 2017.

The greatest contributions to the knowledge of longhorn beetles from the area of Kazakhstan – particularly to the regions of the South and East – have been made by Kostin (1968a,b, 1973, 1974, 1978) and Kadyrbekov (1999, 2004), as well as in collaborations with other authors: Kadyrbekov, Childebaev and Yashchenko (1996), Kadyrbekov and Tleppaeva (1997, 2004a,b, 2016), Kadyrbekov, Ishkov and Tleppaeva (1998), Kadyrbekov, Tleppaeva and Childebaev (2003), Ishkov and Kadyrbekov (2004), Kadyrbekov and Childebaev (2007), Kadyrbekov, Tleppaeva and Mansurova (2010). However, the outstanding input concerning Cerambycidae of Central and Northern Asia, which comprises the region discussed here, has also been made by Plavilstshikov (1936, 1940, 1958), Cherepanov (1990a,b,c, 1991a,b), Danilevsky (e.g. 1996a,b,c, 1999, 2000, 2001a,b,c, 2002, 2004, 2007a,b,c, 2009, 2012, 2014a, 2017, 2018d), Lazarev (2011, 2013a,b, 2014) and Shapovalov (2014). Moreover, an interesting expedition to northeastern Kazakhstan was also conducted by M. Danilevsky's research team in mid-June of 2005 (Danilevskaya et al. 2009). It was R. Kadyrbekov and related scientists who recorded and observed numerous rare and endemic taxa in the territory of South and East Kazakhstan. Among many others, *Microarthron komaroffi* Dohrn, 1885, *Dokhtouroffia nebulosa* Gebler, 1845, *Tetropium staudingeri* Pic, 1901, *Apatophysis serricornis* Gebler, 1843, *A. baekmanniana* Semenov, 1907, *Phymatodes hauseri* Pic, 1907, *Hesperophanes heydeni*, *Molorchus pallidipennis* Heyden, 1887, *Xylotrechus zaisanicus* Plavilstshikov, 1940, *Anoplistes diabolicus*, *A. galusoii* and *Dorcadion profanifuga* Plavilstshikov, 1951 are particularly interesting.

Despite all of the aforementioned studies, the cerambycid fauna of Kazakhstan is still not sufficiently recognised. This is evidenced by the many new taxa that have been described from the southern and eastern parts of the country in the last several years. The new endemic genus *Murzinia* Lazarev, 2011, which is additionally represented by a rather large species – *M. karatauensis* Lazarev, 2011 – deserves special attention. Among the recently published species from the region are *Cortodera kokpektensis* Danilevsky, 2007, *Xylotrechus alakolensis* Karpiński & Szczepański, 2018, *X. katerinae* Shapovalov, 2014, *Agapanthia danilevskyi* Lazarev, 2013 and *A. parauliensis* Danilevsky, 2017. Furthermore, many new subspecies, i.e. *Psilotarsus heydeni alatauensis* Danilevsky, 2014, *Brachyta variabilis shapovalovi* Lazarev, 2014, *Stenocorus validicornis mediocris* Danilevsky, 2012, *Xylotrechus arnoldii tenebrosus* Shapovalov, 2014, *Dorcadion pantherinum ludmilae* Abramov, 2018, *Agapanthia alternans paralternans* Danilevsky, 2017 and *Tetrops elaeagni shapovalovi* Danilevsky, 2018, were discovered in this region only in the last few years. Additionally, some taxa that were already known may still be found here as new to the country. One example is *Exocentrus stierlini* recorded here for the first time from the area of Putintsevo. Five other cerambycid species, recently found in the same area, are new for Kazakhstan: *Euracmaeops smaragdulus* Fabricius, 1793, *Amarysius sanguinipennis*, *A. duplicatus*, *Rhopaloscelis unifasciatus* Blessig, 1873 and *Saperda alberti* Plavilstshikov, 1916. Although *A. duplicatus* was collected earlier by I. Kostin near Ust-Kamenogorsk in 1960, it was identified as *A. altajensis* Blessig, 1872, and the another finding in the same locality by A. Napolov in 1994 has not been published (Danilevskaya et al. 2009).

In addition to the taxonomic studies, the biology and ecology of the longhorn beetles that are distributed in this region should also be thoroughly investigated. More and more of the vulnerable Kazakh endemics are particularly interesting. The bionomy of many local species, for example in the genera of *Psilotarsus*, *Apatophysis*, *Anoplistes* and *Xylotrechus* (*Kostinichlytus*), requires further research. Herein we report on *Halimodendron halodendron* as a host plant of *Anoplistes jacobsoni* Baeckmann, 1904, at the same time questioning its association with *Tamarix* and *Elaeagnus*, or on *Caragana* spp. as probably the sole plant genus of hosts for *A. halodendri halodendri* (Pallas, 1773). Moreover, since the territory of this country is located between Eastern Europe and China, it may constitute a transit zone for the establishment of some quarantine pests from southern Asia. Therefore, it is extremely important to constantly examine and monitor, but also to preserve, these shrinking habitats.

The main threat to the unique habitats of Kazakhstan is the agricultural economy because approx. 81% of the total area of the country's land is suitable for agriculture. Crucial changes in many ecosystems in Kazakhstan that are harmful to biodiversity occurred more than 50 years ago as a result of the extensive plowing of the steppe and forest-steppe zones. Together with the growth of livestock, a strong increase in overgrazing occurred in the region. As a result, there was a significant loss of biodiversity in the steppe areas. There are also several threats to the biodiversity of the desert habitats. Among them, the most important comprise the haphazard road network, the regulation of rivers and the illegal logging of saksaul. As a result of the urbanisation and intensive agricultural development in the foothills in the south and east of the country, the natural vegetation is still severely damaged. In the river valleys in the desert zone (e.g. the Syr Darya, Shu, Talas), due to the limitations of river flow, highly productive floodplain communities are almost completely degraded. Furthermore, the increasing pace of the construction of infrastructures such as roads, pipelines and power lines, creates a great negative impact on the fauna, even if only due to the fragmentation of habitats. In the last five years, the fields of oil and gas production and uranium mines have drastically been extended. The area occupied by mining enterprises is also expanding steadily. However, although many ecosystems, especially in the grasslands and abandoned pastures, began to be restored after the collapse of the USSR and the economic collapse in the 1990s and they have recently continued their natural recovery, previously abandoned areas are now being restored for the economic use. Unfortunately, the use of the current resource model of economic development leads not only to inefficient economic development but also to increasing pressure on ecosystems (MEWR 2014).

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New tribal placement and review of *Parapucaya* Prell and *Pucaya* Ohaus (Coleoptera, Scarabaeidae, Dynastinae)

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Abstract

The dynastine scarab genera *Parapucaya* Prell and *Pucaya* Ohaus have been historically classified in Pentodontini; however, that tribal classification is not supported under the current tribal circumscriptions. A discussion justifying the transfer of the genera *Parapucaya* and *Pucaya* from Pentodontini into Cyclocephalini is presented. This research is based on morphological observations (mandible shape and wing characters among others) and molecular data (genes 28S, COI, and 16S/ND1). A review of both genera is included, providing descriptions, diagnoses, distribution data, illustrations, and keys to species. A revised key to the world genera of Cyclocephalini is also included.

Resumen

Los escarabajos de los géneros *Parapucaya* Prell y *Pucaya* Ohaus, de la subfamilia Dynastinae, han sido históricamente clasificados en la tribu Pentodontini; sin embargo, esa clasificación no se ajusta a la circunscripción actual de la tribu. Se presenta una discusión justificando la transferencia de los géneros *Parapucaya* y *Pucaya* de Pentodontini a Cyclocephalini. Esta investigación se basa en observaciones morfológicas (forma de la mandíbula y caracteres del ala membranosa entre otras) y en datos moleculares (genes 28S, COI y 16S/ND1). Se incluye una revisión general de ambos géneros, con descripciones, diagnosis, datos de distribución, ilustraciones, y claves para especies. También se incluye una clave revisada para todos los géneros de Cyclocephalini.

Keywords

Cyclocephalini, molecular analysis, morphology, Neotropical scarabs, Pentodontini, taxonomy

Introduction

Dynastinae is classified in the scarab beetle family Scarabaeidae, a large coleopteran family that comprises about 30,000 species (Ratcliffe and Cave 2015). Though Scarabaeidae is well-studied, almost 200 new species are described each year (Ratcliffe and Cave 2015). Some adults of Scarabaeidae stand out due to their relatively large size, bright colors, elaborate ornamentation, unique life histories, and many interesting adaptations (Jameson 1998). These exaggerated features are common in the subfamily Dynastinae, which includes about 1,500 species distributed worldwide (Ratcliffe and Cave 2017). More dynastine species are found in the Neotropics than in any other biogeographic realm (Ratcliffe and Cave 2015). In the Neotropics, six of the eight recognized dynastine tribes are represented: Cyclocephalini, Pentodontini, Oryctini, Philaurini, Agaocephalini, and Dynastini. The Neotropical genera *Parapucaya* and *Pucaya* have long been classified in the tribe Pentodontini based on morphological characters, but some recent authors have questioned their tribal placement (Clark 2011, López-García et al. 2015). In this study, we address the classification of *Parapucaya* and *Pucaya* within Pentodontini and redefine the tribe Cyclocephalini.

Cyclocephalini

Cyclocephalini is the second most species-rich tribe of Dynastinae after Pentodontini, and it contains 14 genera and over 500 species and subspecies (Smith 2006, Moore et al. 2015, 2018b, Ratcliffe and Cave 2017). Historically, the tribe Cyclocephalini was characterized by the absence of characters found in other dynastines. These characters included: 1) lack of horns, tubercles, carinae, or foveae on the head and prothorax; 2) absence of a stridulatory area (*pars stridens*) on the propygidium; 3) simple mandibles that lack dentition distal to the molar region; 4) metatibial apex truncate and without produced teeth or a crenulated margin; and 5) metatarsus with basal joint simple and not triangular (Ratcliffe and Cave 2017). The sexual dimorphism found in cyclocephalines is not as pronounced as it is in the horned dynastines. However, most cyclocephaline species display sexual dimorphism of the protarsus (enlarged in males; simple in females) and elytral epipleural margin (simple in males; expanded and modified in females of some species). Moore (2012) hypothesized that during mating, there was an interaction between the enlarged male protarsal claw and the female epipleural expansion, making it easier for the male to clasp the female during copulation and for mate guarding. Moreover, as in all dynastines, the apex of the last abdominal sternite is emarginate in males and entire or rounded in females (Figs 1, 2).

Cyclocephalini, while relatively morphologically uniform, is not well defined, and monophyly of the tribe still needs to be evaluated (Ratcliffe and Cave 2017). In that endeavor, some generic-level taxa have been removed from the tribe while others have been

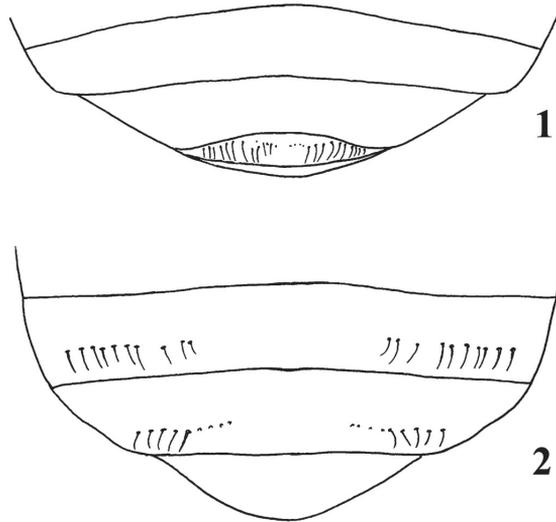
transferred into Cyclocephalini. *Coscinocephalus* Prell was transferred from Cyclocephalini to Pentodontini and is considered to be most similar to *Orizabus* Fairmaire (Morón and Ratcliffe 1996). The bizarre, monotypic genus *Acrobolbia* Ohaus was transferred from Rutelinae to Cyclocephalini by Jameson et al. (2002), and those authors compared the genus to *Ancognatha* Erichson. *Peltonotus* Burmeister, with 25 species, was transferred from Rutelinae to Dynastinae (Jameson 1998) and specifically to Cyclocephalini (Jameson and Jakl 2010). Additionally, the monophyly of several cyclocephaline genera is in doubt. Ratcliffe (2003) stressed that further research is needed on the genera *Cyclocephala* Dejean, *Mimeoma* Casey, *Aspidolea* Bates, and *Ancognatha* to ascertain if they should be maintained as valid genera or some should be folded into others. Moore et al. (2015) evaluated the monophyly of *Mimeoma* and its relationship with *Cyclocephala* by using a combined molecular and morphological analysis. These data showed that the five species of *Mimeoma* clustered within an apical clade of other *Cyclocephala* species, rendering *Cyclocephala* paraphyletic. As a result, *Mimeoma* was synonymized with *Cyclocephala*.

Pentodontini

Pentodontini is the largest tribe of dynastines, comprising about 100 genera and over 550 species distributed worldwide (Ratcliffe and Morón 1997, Ratcliffe and Cave 2017). Adult pentodontines are distinguished by: 1) the presence of tubercles, a carina, or a fovea on the head and pronotum; 2) broad mandibles with or without teeth on the scissorial region; 3) propygidium with or without a *pars stridens*; 4) lateral margin of the protibia usually tridentate; 5) apex of the metatibia usually truncate and margined with short, spine-like setae; 6) protarsus occasionally enlarged in males (Ratcliffe and Morón 1997, Ratcliffe and Cave 2017).

Dimorphism between males and females is slight in most species (Ratcliffe and Morón 1997), although males sometimes have larger protarsi and tubercles on the head and pronotum (López-García et al. 2015), and the pronotal fovea is more pronounced. Pentodontines, along with all dynastines, display sexual dimorphism of the last abdominal sternite, which is emarginate in males and entire or rounded in females (Figs 1, 2).

López-García et al. (2015) reported that for over 100 years, there was no consensus whether Pentodontini should be treated as a family, subfamily, or tribe. Historical workers prioritized different criteria: Mulsant (1842) considered the categories Pentodonaires and Oryctésaires as separate groups; followed by Bates (1888) who designated Pentodontinae as a subfamily (Ratcliffe and Morón 1997, López-García et al. 2015); Casey (1915) established Pentodontini as a tribe and later Leng (1920), Arrow (1937), Blackwelder (1944), and Arnett (1973) did not recognize any of these former designations and included pentodontine genera within Oryctini (Ratcliffe and Morón 1997). Endrődi (1969) re-established the tribes Pentodontini and Oryctini as they are currently used, but he considered that transitional characters blurred the distinction between the tribes. Consequently, the monophyly of Pentodontini is in doubt (Ratcliffe 2003, Gasca-Álvarez et al. 2008, López-García et al. 2015, Sanabria et al. 2012).



Figures 1–2. Last sternite in Dynastinae. **1** male with apex emarginate **2** female with apex entire.

Materials and methods

Morphological methods

Morphological descriptions and temporal and distributional data were based on the study of 425 specimens from three sources: (1) field collecting expeditions by the authors and colleagues; (2) data recorded from the literature; and (3) specimens from the following museums and private collections: Canadian Museum of Nature (Ottawa, Canada), Canadian National Collection of Insects (Ottawa, Canada), Florida State Collection of Arthropods (Gainesville, Florida, United States), Museo Ecuatoriano de Ciencias Naturales (Quito, Ecuador), Museo de la Escuela Politécnica Nacional (Quito, Ecuador), National Museum of Natural History (Prague, Czech Republic), Museo QCAZ-Invertebrados de la Pontificia Universidad Católica del Ecuador (Quito, Ecuador), Stephane Le Tirant Collection (Terrabonne, Québec, Canada), University of Nebraska State Museum (Lincoln, Nebraska, United States), and United States National Museum (Washington, DC, currently on long-term loan to University of Nebraska State Museum, Lincoln, Nebraska, United States).

This study was developed as part of the broader project “The Dynastine Scarab Beetles of Ecuador”. For this reason, we provide only generalized, province-level distribution data for *Pucaya* and *Parapucaya* species in Ecuador. More detailed distribution data for these genera will be released as part of that forthcoming monograph. Collecting methods utilized were: 1) light traps using mercury vapor and ultraviolet bulbs; 2) foliage gleaning; 3) excavating rotting logs and stumps; and 4) manual collecting around public lights. Ecuadorian collecting, mobilization, and export permits were obtained with the support of QCAZ in Quito, Ecuador.

The species descriptions encompass the range of variation observed in the specimens at hand. They were based on the following characteristics (from Ratcliffe and Cave 2017): 1) length from apex of the clypeus to the apex of the elytra; 2) width across elytral humeri; 3) coloration and markings; 4) interocular width (number of transverse eye diameters across the frons between the eyes); 5) form and sculpturing of the head, pronotum, elytra, and pygidium; 6) form of the prosternal process; and 7) form of the parameres. Punctures were considered simple unless otherwise noted. Minute punctures were generally not visible with 12.5× magnification but were easily seen with 50× magnification. Small punctures were clearly visible with 12.5× magnification and can be seen with the naked eye. Large punctures are easily seen without magnification. Sparse punctures were characterized by greater than 5 puncture diameters between them. Punctures moderate in density had 3–5 puncture diameters between them. Dense punctures had only 2 or fewer puncture diameters between them.

DNA extraction, PCR, and data-mining

Previous studies by Gunter et al. (2016) and Ahrens et al. (2011, 2014) generated DNA sequence data that served as a phylogenetic scaffold for testing the classification of *Pucaya* and *Parapucaya* within Pentodontini (Tab. 1). GenBank was datamined for 28S, CO1, and 16S/ND1 sequences from diverse tribal-level exemplars for higher Scarabaeidae (Tab. 1). Among Dynastinae, there were tribal-level exemplars with at least partial data for all three gene regions from six of the eight commonly recognized tribes (minus Hexodontini and Agaocephalini). 16S and 28S data were generated from exemplar specimens of *Pucaya pulchra* Arrow and *Parapucaya amazonica* Prell to incorporate into this phylogenetic framework. Based on shared morphological characters with *Pucaya* species, *Cyclocephala freyi* Endrödi exemplars were also targeted for DNA extraction and PCR.

DNA extractions of metafemoral tissue from specimens of *C. freyi*, *P. amazonica*, and *P. pulchra* were performed using guanidinium thiocyanate following the QCAZ Molecular Biology Laboratory protocol (unpublished). 28S sequence data was gathered using the primers Bulbasaur/28SR (Moore et al. 2015, Whiting et al. 1997, Whiting 2001) and thermocycles from Moore et al. (2015). 16S sequence data was generated using the universal primer LRJ-12864 and 16Sar-L (Palumbi et al. 1991) with the following thermocycle: 1) 94 °C for 2 minutes; 2) 94 °C for 40 seconds; 3) 54 °C for 40 seconds; 4) 68 °C for 1 minute and 30 seconds (34 cycles of steps 2–4); and a final extension of 68 °C for 1 minute. Forward and reverse sequence traces were trimmed and assembled into contigs in Geneious 5.6.2 (Kearse et al. 2012).

Alignments and phylogenetic analyses

Based on the results of Gunter et al. (2016), a species of *Isonychus* Mannerheim (Scarabaeidae: Melolonthinae: Macroductylini) was used as an outgroup for all phylogenetic

Table 1. GenBank accession numbers of the taxa analyzed in this study. Molecular sequences of *Cyclocephala freyi* Endrődi, *Parapucaya amazonica* Prell, and *Pucaya pulchra* Arrow included in this study were obtained from the Museo de Zoología QCAZ, at the Pontificia Universidad Católica del Ecuador in Quito.

Taxa	28S accessions	CO1 accessions	16S/ND1 accessions
Melolonthinae: Macroductylini			
<i>Isonychus</i> sp.	HQ599181	HQ599132	HQ711606
Cetoniinae: Cetoniini			
<i>Chiloloba acuta</i> (Wiedemann)	DQ524778	DQ524540	DQ680981
<i>Glycyphana</i> sp.	KF802022	KF801859	KF801691
<i>Heterocnemis graeca</i> Brulle	EU084147	EU084042	EF487942
<i>Protaetia</i> sp.	KF802102	KF801937	KF801775
Cetoniinae: Goliathini			
<i>Heterorrhina micans</i> (Guérin Méneville)	DQ524738	DQ524507	DQ681041
Cetoniinae: Schizorhinini			
<i>Bisallardiana</i> sp.	KF802033	KF801870	KF801702
<i>Chlorobapta</i> sp.	KF802101	KF801935	KF801773
<i>Chondropyga</i> sp.	KF802038	KF801875	KF801707
<i>Dilochrosis</i> sp.	KF802056	KF801891	KF801727
<i>Eupoecila</i> sp.	KF802032	KF801869	KF801701
<i>Hemipharis</i> sp.	KF802088	KF801924	KF801760
<i>Lomaptera</i> sp.	KF802099	KF801933	KF801771
<i>Lyraphora</i> sp.	KF802058	KF801893	KF801729
<i>Mycterophallus</i> sp.	KF802134	KF801970	KF801806
<i>Pseudoclitiria</i> sp.	KF802100	KF801934	KF801772
<i>Trichaulax</i> sp.	KF802053	KF801888	KF801724
Dynastinae: Cyclocephalini			
<i>Cyclocephala freyi</i> Endrődi	MH938363	–	MH938360
<i>Cyclocephala</i> sp.	JN969246	JN969202	EF487979
<i>Cyclocephala</i> sp.	HQ599137	HQ599096	HQ711605
<i>Cyclocephala</i> sp.	HQ599138	HQ599097	HQ711596
Dynastinae: Dynastini			
<i>Xylotrupes</i> sp.	KF802040	KF801877	KF801709
Dynastinae: Oryctini			
<i>Oryctes nasicornis</i> (Linnaeus)	JN969247	EF487735	EF487922
Dynastinae: Oryctoderini			
<i>Onychionyx</i> sp.	KF802089	KF801925	KF801761
<i>Oryctoderus</i> sp.	KF802090	KF801926	KF801762
Dynastinae: Pentodontini			
<i>Alissonotum binodulum</i> Fairmaire	DQ524763	DQ524544	DQ680957
<i>Alissonotum simile</i> Arrow	DQ524584	DQ524481	DQ681016
<i>Carneodon</i> sp.	KF802161	KF801998	KF801832
<i>Cheiroplatys</i> sp.	KF802054	KF801889	KF801725
<i>Heteronychus lioderes</i> Redtenbacher	DQ524753	DQ524542	DQ680955
<i>Metanastes</i> sp.	KF802007	KF801841	KF801675
<i>Neocorynophyllus</i> sp.	KF802137	KF801973	KF801809
<i>Novapus</i> sp.	KF802021	KF801858	KF801690
<i>Parapucaya amazonica</i> Prell	MH938364	–	MH938361
<i>Pentodon idiota</i> Herbst	EU084151	EU084045	EF487918
<i>Phyllognathus dionysius</i> Fabricius	EU084152	EF487737	EF487944
<i>Pimelopus dubius</i> Blackburn	JN969249	EF487738	EF487960
<i>Pucaya pulchra</i> Arrow	MH938365	–	MH938362
<i>Semanopterus</i> sp.	KF802008	KF801842	KF801676
<i>Semanopterus</i> sp.	KF802075	KF801909	KF801746
<i>Trissodon</i> sp.	KF802067	KF801900	KF801738

Taxa	28S accessions	CO1 accessions	16S/ND1 accessions
Dynastinae: Phileurini			
<i>Cryptodus</i> sp.	KF802020	KF801857	KF801689
<i>Eophileurus</i> sp.	KF802057	KF801892	KF801728
Rutelinae: Adoretini			
<i>Adoretus lasiopygus</i> Burmeister	DQ524794	DQ524555	DQ680980
<i>Adoretus</i> sp.	DQ524671	DQ524444	DQ680986
<i>Adoretus</i> sp.	DQ524672	DQ524445	DQ680964
<i>Adoretus versutus</i> Harold	DQ524766	DQ524450	DQ680948
<i>Prodoretus truncatus</i> (Arrow)	EU084292	EU084139	EF487915
<i>Trigonostomum mucoreum</i> Burmeister	EU084293	EU084140	EF487916
Rutelinae: Anomalini			
<i>Anomala bengalensis</i> (Blanchard)	DQ524741	DQ524510	DQ680971
<i>Anomala biharensis</i> Arrow	DQ524723	DQ524519	DQ680974
<i>Anomala bilobata</i> Arrow	DQ524607	DQ524495	DQ680977
<i>Anomala praenitens</i> Arrow	DQ524792	DQ524553	DQ681042
<i>Anomala variegata</i> Hope	DQ524760	DQ524524	DQ680938
<i>Blihopertha</i> sp.	EU084289	EU084137	EF487957
<i>Isoplia lasiosoma</i> Burmeister	HQ599172	HQ599124	HQ711583
<i>Mimela siliguria</i> (Arrow)	DQ524724	DQ524498	DQ680959
Rutelinae: Anoplognathini			
<i>Anoplognathus</i> sp.	KF802029	KF801866	KF801698
<i>Anoplostethus</i> sp.	KF802160	KF801997	KF801831
<i>Anoplostethus</i> sp.	KF802157	KF801994	KF801829
<i>Calloodes</i> sp.	KF802091	–	KF801763
<i>Phalangogonia sperata</i> Sharp	KJ845157	–	–
<i>Repsimus</i> sp.	KF802028	KF801865	KF801697
<i>Repsimus</i> sp.	KF802092	KF801927	KF801764
Rutelinae: Geniatini			
<i>Geniates</i> sp.	HQ599185	–	HQ711603
<i>Lobogeniates</i> sp.	HQ599186	–	HQ711604
Rutelinae: Rutelini			
<i>Anticheira</i> sp.	HQ599184	–	HQ711600
<i>Parastasia</i> sp.	KF802096	KF801930	KF801768
<i>Parastasia</i> sp.	KF802086	KF801920	KF801757
<i>Parastasia</i> sp.	KJ845160	–	–
<i>Pelidnota</i> sp.	HQ599187	–	HQ711602

analyses. *Isonychus* sp. was recovered as the most early-diverging member of a melolonthine clade sister to the clade containing all Cetoniinae + Rutelinae + Dynastinae exemplars (Gunter et al. 2016), making this taxon a suitable outgroup for examining relationships among these subfamilies and placing *Pucaya* and *Parapucaya* at the tribal level. Sequences were aligned using ClustalW (Larkin et al. 2007), with default settings, as implemented in MEGA7 (Kumar et al. 2016). The resulting concatenated sequence alignment contained 3,537 bp positions (1530 bp 16S; 550 bp ND1; 805 bp CO1; 652 bp 28S).

Maximum likelihood analyses of this matrix were conducted in W-IQ-TREE (Trifinopoulos et al. 2016). The matrix was partitioned by gene (16S, 28S, and ND1) and codon position (CO1). The best-fit model of sequence evolution for each partition

(GTR+F+I+G4 for 16S; TPM3u+F+G4 for ND1 and CO1 third position; TIM2e+I+G4 for 28S; HKY+F+I+G4 for CO1 first position; SYM+I+G4 for CO1 second position) was selected by ModelFinder (Kalyaanamoorthy et al. 2017), as implemented in W-IQ-TREE, using the Bayesian information criterion. Bootstrap support values for the most likely tree were calculated using 10,000 ultrafast bootstrap replicates (Hoang et al. 2017). Bayesian phylogenetic analyses were run in MrBayes 3.2.2 (Ronquist and Huelsenbeck 2003). Models of sequence evolution for the MrBayes analysis were determined with PartitionFinder 2.1.1 (GTR+I+G for 16S, ND1, 28S, CO1 second position, and CO1 third position; HKY+I+G for CO1 first position) (Lanfear et al. 2016).

Bayesian analyses comprised four independent runs, each with four chains (one cold and three heated). Partitions had their parameters unlinked and allowed to vary independently. Flat priors were used. Chains were run for 1 million generations, with trees sampled every 1,000 generations. Convergence was evaluated by examining the standard deviation of split frequencies among runs and by plotting the log-likelihood values from each run using Tracer 1.6 (Rambaut and Drummond 2013). Tracer diagnostics indicated that runs converged within 10,000 generations, and trees sampled during this period were discarded as burn-in before obtaining clade posterior probabilities. Parsimony tree searches were performed in MPBoot (Hoang et al. 2018). Heuristic searches were conducted using default parsimony ratchet search options in MPBoot. Bootstrap analyses were performed using the same ratchet search options and included 10,000 bootstrap replicates.

Results

Morphology

Morphological observations show that *Parapucaya* shares characters with genera in Cyclocephalini, most notably with some *Cyclocephala* species. For example, the two *Parapucaya* species share characters with *C. almitana* Dechambre, *C. macrophylla* Erichson, *C. melanocephala* (Fabricius), and *C. pseudomelanocephala* Dupuis. These characters include: 1) frontoclypeal suture complete; 2) clypeus weakly emarginate with lateral and apical margins reflexed; 3) clypeal apex broadly truncate; 4) the generally exposed and slender mandibles that lack lateral teeth; 5) mandibular apex acuminate and curved upward; 6) protibia strongly tridentate with the basal tooth removed from other two teeth; 7) protarsus in males enlarged (the larger claw strongly curved and incised at apex), while females have a simple protarsus; 8) inner portion of the apical margin of the 5th protarsomeres in males eroded, allowing the enlarged protarsal claw to be further articulated; 9) metatarsi reduced, shorter than metatibia, more evident in females (character shared with *C. melanocephala* and *C. almitana*); 10) prosternal process moderately long, columnar, with its apex densely setose, flattened, and with a large, raised, round “button” covering half of the apex; 11) hindwing vein RA, proximal to apical hinge, with 2 rows of pegs extending distally nearly to margin of apical

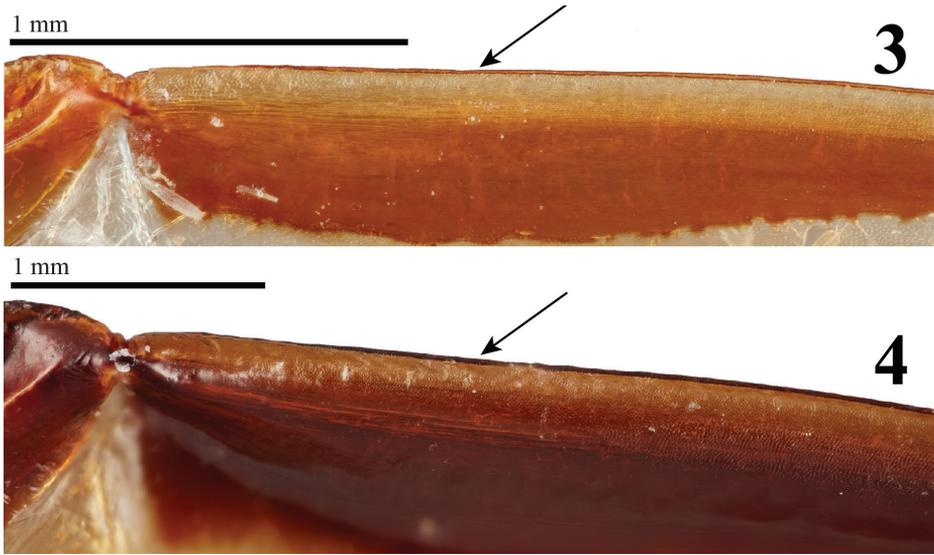
hinge; and 12) anterior edge of hindwing distal to apical hinge lacking setae and with a produced, membranous border (Figs 3, 4).

Like *Parapucaya*, *Pucaya* species share many characters with some *Cyclocephala* species (e.g., *C. freyi*). *Pucaya* also shares the character of a medially incomplete frontoclypeal suture with *Ancognatha* species. In *Pucaya* individuals, the frontoclypeal suture is visible from the lateral margins along the external side of the frontal horn, where it becomes obsolete medially. *Pucaya* and some *Ancognatha* species display weakly developed “armature” of the head and thorax. For example, *Ancognatha castanea* Erichson has tubercle-like swellings on the frontoclypeal region of the head. *Ancognatha jamesoni* Murray and *A. horrida* Endrődi show enlargement of the pronotum in males.

Other shared characters with other cyclocephalines include; 1) clypeus with lateral and apical margins reflexed; 2) clypeal apex broadly truncate, subquadrate; 4) maxillary galea with four teeth on inner margin (shared with *C. freyi* (Figs 5, 60), 5) slender mandibles that lack lateral teeth; 6) protibia strongly tridentate with the basal tooth removed from other two teeth; 7) protarsus in males enlarged (the larger claw strongly curved and incised at apex), while females have a simple protarsus; 8) inner portion of the apical margin of the 5th protarsomeres in males eroded, allowing the enlarged protarsal claw to be further articulated; 9) prosternal process short to moderately long, columnar, with its apex densely setose, flattened, and with a large, raised, round “button” covering half of the apex; 11) hindwing vein RA, proximal to apical hinge, with 2 rows of pegs extending distally nearly to margin of apical hinge; and 12) anterior edge of hindwing distal to apical hinge lacking setae and with a produced, membranous border.

Molecular phylogenetic analyses

W-IQ-TREE analyses found the most likely tree with a log likelihood score of -42928.5840. MPBoot heuristic tree searches recovered most parsimonious trees of score 9992 steps. Bayesian posterior probabilities and parsimony bootstrap support values for nodes are reported on the maximum likelihood bootstrap consensus tree topology (Fig. 7). Analyses conducted on the concatenated dataset recovered 27 strongly supported internal nodes (>75 BS and >0.95 PP) from all three tree search strategies. All three analyses strongly supported the monophyly of Cetoniinae and Dynastinae (Fig. 7). Like the analyses of Gunter et al. (2016), the subfamily Rutelinae was recovered as paraphyletic. *Parapucaya amazonica*, *P. pulchra*, and *C. freyi* were recovered together as a clade (94 ML BS, 0.97 PP, 73 Parsimony BS) sister to the other three *Cyclocephala* exemplars. Together, these six exemplars form a strongly supported cyclocephaline clade (99 ML BS, 1.0 PP, 79 Parsimony BS) within the broader Dynastinae clade (99 ML BS, 1.0 PP, 91 Parsimony BS) (Fig. 7). The remaining 14 Pentodontini species included here did not form a monophyletic group. Six pentodontine species fell out in a clade that includes *Cryptodus* sp. (Dynastinae: Phileurini) (96 ML BS, 1.0 PP). Eight pentodontine species were recovered in a clade (98 ML BS, 1.0 PP, 86 Parsimony BS) that also included *Oryctes nasicornis* (Linnaeus) (Dynastinae: Oryctini).



Figures 3–4. Hindwing vein RA3, distal to apical hinge. **3** *Parapucaya* sp. **4** *Pucaya* sp. Photo credits to Gavin J. Martin.

Discussion

Parapucaya and *Pucaya* were placed in Pentodontini by previous authors, and this tribal-level classification has been maintained since Endrődi's (1985) revision of world Dynastinae. *Parapucaya* and *Pucaya* species were placed in Pentodontini because of their armature, such as the minute tubercles of the pronotum in *Parapucaya* species and the cephalic horns and tubercles of *Pucaya* species. These characters violated the tribal circumscription of Cyclocephalini. However, these two genera also complicate the traditional circumscription of Pentodontini. For example, *Parapucaya* and *Pucaya* have slender mandibles, and males and females can be easily distinguished by external characters.

Based on the morphological observations outlined in the previous section, we think that *Parapucaya* species are most similar to the *C. melanocephala* section of *Cyclocephala*. Additionally, we think that *Pucaya* species are most similar to *C. freyi* based on the shared form of the four-toothed galea present in all these species (Figs 5, 6). The following characters also support the hypothesis that *Pucaya* and *Parapucaya* are cyclocephalines: clypeus with lateral and apical margins reflexed; the clypeal apex broadly truncate shared with several *Cyclocephala* species; mandibles lacking lateral teeth; protibia strongly tridentate with the basal tooth removed from other two apical teeth; protarsus in males enlarged (the larger claw strongly curved and incised at apex), while females have a simple protarsus; and the inner portion of the apical margin of the 5th protarsomeres in males eroded, allowing the enlarged protarsal claw to be further articulated.



Figures 5–6. Maxillary galea showing four teeth. **5** *Cyclocephala freyi* Endrödi **6** *Pucaya pulchra* Arrow. Photograph credits to Gavin J. Martin.

Study of the hindwings also showed that *Pucaya* and *Parapucaya* share the same character states: hindwing vein RA, proximal to the apical hinge, with two rows of pegs extending distally nearly to margin of apical hinge and the anterior edge of hindwing distal to apical hinge lacking setae and with a produced, membranous border. This exact combination of hindwing characters is also found in the cyclocephaline genera *Arriguttia* Martínez, *Aspidolea*, *Augoderia* Burmeister, most *Cyclocephala* (except black species formerly placed in *Mononidia* Casey or *Surutooides* Endrödi), and former *Mimeoma* species (Moore et al. 2018a). The genera *Acrobolbia*, *Ancognatha*, and *Ruteloryctes* also share the membranous border on the leading edge of RA3 but lack the double row of pegs on RA (Moore et al. 2018a). No other tribe of Dynastinae shares the character of a membranous border on RA3 (MRM, unpublished data). This hindwing character is a putative synapomorphy uniting these cyclocephaline genera plus *Pucaya* and *Parapucaya*.

Additionally, the molecular phylogenetic analyses presented here also support revised placement of *Pucaya* and *Parapucaya* in Cyclocephalini. Our analyses recovered a monophyletic Dynastinae with strong statistical support (Fig. 7). These analyses also recovered a strongly supported clade that included four *Cyclocephala* exemplars plus *P. castanea* and *P. amazonica* (Fig. 7). We think the weight of evidence supports the hypothesis that *Pucaya* and *Parapucaya* are part of the cyclocephaline lineage of Dynastinae. Based on morphological observations, we also think that *Pucaya* and *Parapucaya* are most likely to be closely related to sections of *Cyclocephala*. Thus, we formally move the genera *Pucaya* and *Parapucaya*, as a revised tribal placement, from Pentodontini into Cyclocephalini.

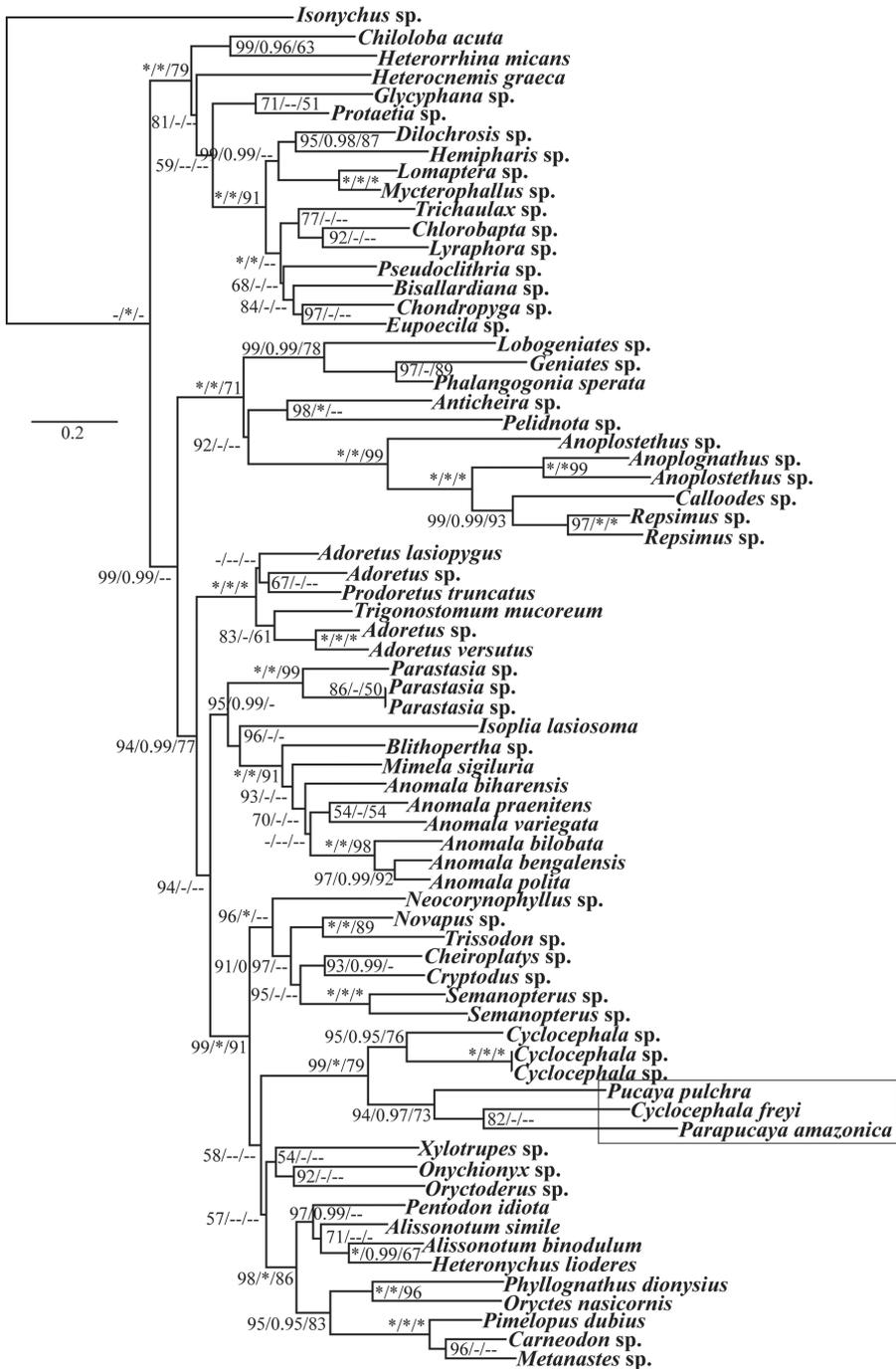
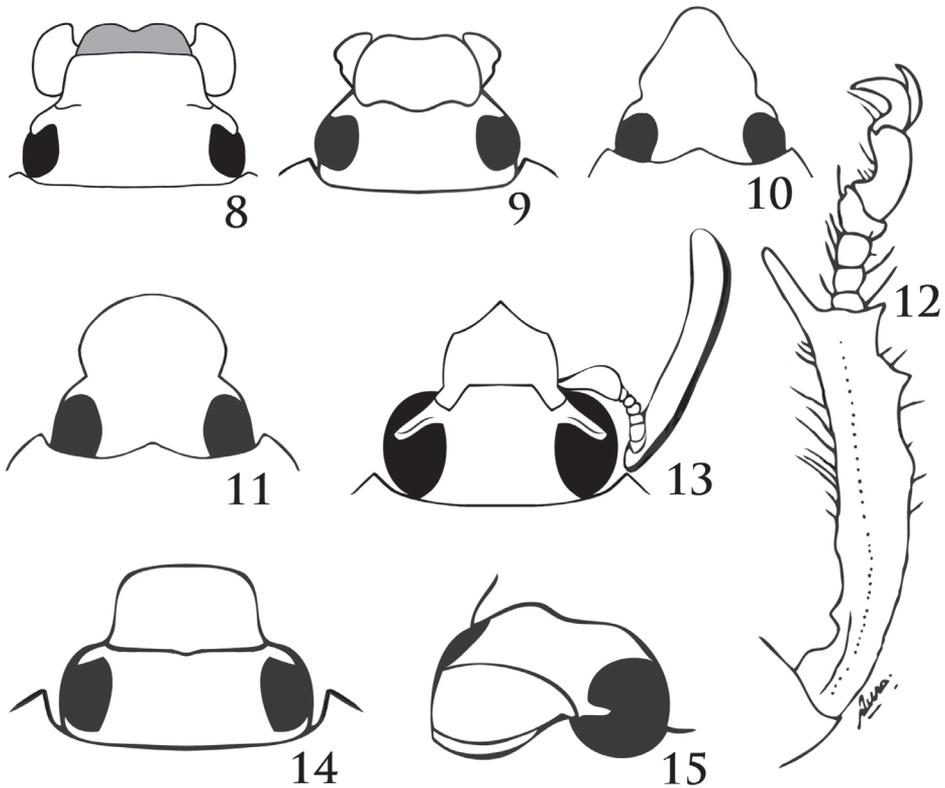


Figure 7. Bootstrap consensus tree from W-IQ-TREE analysis. Node support values from left to right are ML bootstrap, Bayesian posterior probability, and parsimony bootstrap. Support values labeled with a “*” have 100% bootstrap support or 1.0 posterior probability. Support values labeled with a “-” have bootstrap supports lower than 50% or posterior probability lower than 0.95. Nodes labeled “-” indicates that node was not recovered by an analysis.

Historically, Cyclocephalini has been defined by the lack of characters present in other tribes, such as the lack of horns or tubercles, foveae, or carinae. However, this was an inconsistent concept as *Ancognatha* species with weakly developed cephalic and thoracic armature, (e.g., tubercles, enlarged pronotum, and enlarged mandibles) were already classified in Cyclocephalini. This work categorically indicates that Cyclocephalini includes individuals with armature. This is a potentially fascinating re-circumscription of the tribe, as the role of cephalic and thoracic armature is completely unknown for *Pucaya*, *Parapucaya*, and Cyclocephalini more broadly.

Review of *Parapucaya* Prell and *Pucaya* Ohaus

We present a revised key to the New World Cyclocephalini genera. We include a re-description of the species of *Parapucaya* and *Pucaya*, diagnosis, distribution data, and available natural history information. We include keys to species of both genera.



Figures 8–15. Form of clypeal apex. **8** *Peltonotus silvanus* Jameson and Wada (subquadrate, note chitinized labrum) **9** *Ruteloryctes morio* (Fabricius) (emarginate, note round mandibles) **10** *Surutu seabrai* d'Andretta and Martínez (narrowly parabolic) **11** *S. hesperius* Ratcliffe (broadly parabolic) **12** Protibia of *Harposceles* sp. **13** *Acrobolia* sp. (pentagonal) **14** *Arriguttia* sp. **15** *Augoderia* sp. (thickened apex) (Figures 9–15 modified from Jameson et al. 2002, by permission).

Key to the world genera of adult Cyclocephalini

(Modified from Jameson et al. 2002)

- Males:* Apex of last abdominal sternite emarginate (Fig. 1). Protarsomeres 4–5 and/or anterior claw enlarged in all genera except *Stenocrates* and *Erioscelis*.
- Females:* Apex of last abdominal sternite entire, evenly parabolic (Fig. 2). Protarsomeres 4–5 and anterior claw always simple, not enlarged.
- 1 Head with small horn or tubercle mesad of each eye (Figs 35, 36). Costa Rica to Ecuador ***Pucaya* Ohaus, 1910**
 - Head without horn or tubercle mesad of each eye (*Ancognatha castanea* Erichson has frons with low, median knob or elevated, transverse tubercle) **2**
 - 2 Apex of labrum chitinized (thickened). Labrum extends past the apex of the clypeus in dorsal view (Fig. 8). Asia ***Peltonotus* Burmeister, 1847**
 - Apex of labrum not conspicuously thickened. Labrum does not extend past the apex of the clypeus in dorsal view..... **3**
 - 3 Mandibles broad, nearly as wide as long (Fig. 9). West Africa..... ***Ruteloryctes* Arrow, 1908**
 - Mandibles narrow, distinctly longer than wide **4**
 - 4 Propygidium mostly covered by elytra, with long, dense setae that protrude from beneath elytral apices; propygidium often elongated, so that pygidium appears moderately to extremely shortened. Body noticeably tapered at both ends. Protarsus in males with tarsomeres 4–5 and claw enlarged. South America, West Indies ***Chalepides* Casey, 1915**
 - Propygidium lacking long, dense setae; length of propygidium normal. Body not noticeably tapering at both ends. Protarsus in males with tarsomeres and claw enlarged or not..... **5**
 - 5 Body form strongly flattened, relatively large (24–44 mm). Color black. Clypeus with apex narrowly to broadly parabolic (Figs 10, 11) **6**
 - Body form not flattened, size smaller (6–29 mm, and some larger individuals of *Ancognatha*). Color variable, including patterns. Clypeus with apex variable, parabolic or not..... **7**
 - 6 Eyes large, interocular width equals 2.0 or less transverse eye diameters. Males with protibia slender, strongly curved, with distinct tooth on inner margin near base (Fig. 12); anterior trochanter with large, anteriorly projecting tooth. Northern South America ***Harposceles* Burmeister, 1847**
 - Eyes smaller, interocular width usually 3.0 or more transverse eye diameters. Males with protibia “normal”, not curved strongly, lacking tooth on inside near base; anterior trochanter lacking anteriorly projecting tooth. South America..... ***Surutu* Martínez, 1955**

- 7 Clypeus with sides slightly wider than base before abruptly narrowing to acuminate apex (Fig. 13). Males with antennal club almost twice as long as antennomeres 1–7 (Fig. 13). Meso- and metatibiae at apex with spinose process on external edge. Northwestern South America..... ***Acrobolbia* Ohaus, 1912**
- Clypeus with sides tapering from base to apex (rounded, parabolic, subtriangular, or sharply acuminate), or with sides divergent from base to apex, but with apex never abruptly acuminate (Figs 14–24). Males with antennal club slightly longer than, subequal to, or shorter than antennomeres 2–7. Meso- and metatibiae at apex without spinose process on external edge..... **8**
- 8 Lateral margins of clypeus near base raised into a subacute crest, evident in posterodorsal view (Fig. 25). Clypeus thickened along the frontoclypeal suture. Frontoclypeal disc concave (Fig. 25). Specimens with double tubercles or faint declivity near anterior margin of pronotum. Costa Rica to Peru and Brazil..... ***Parapucaya* Prell, 1934**
- Lateral margins of clypeus near base flat or faintly raised into a round crest, evident in posterodorsal view (Fig. 26). Clypeus flat or weakly thickened along the frontoclypeal suture. Frontoclypeal disc convex or concave (Fig. 26). Specimens without double tubercles or faint declivity near anterior margin of pronotum... **9**
- 9 Clypeus trapezoidal or subtrapezoidal, with marginal or apical bead (Fig. 27–28) **10**
- Clypeus with apex rounded, truncate, subquadrate, or emarginate, simple, with or without marginal bead (Figs 14–24) **11**
- 10 Frontoclypeal suture distinct, usually broadly depressed just before suture. Males with protarsomeres simple, not enlarged. Pronotum with anterior margin normally arcuate, not produced forward at middle (Fig. 27). Meso- and metafemora and meso- and metatibiae strongly flattened. Central and South America..... ***Stenocrates* Burmeister, 1847**
- Frontoclypeal suture a finely impressed line but not with deep and broad impression before it. Males with anterior claw and usually protarsomeres 4–5 enlarged. Pronotum on anterior margin produced anteriorly at middle (Fig. 28). Meso- and metafemora and meso- and metatibiae not strongly flattened. North, Central, and South America, West Indies..... ***Dyscinetus* Harold, 1869**
- 11 Body form short, suboval, stout; elytra nearly as wide as long. Clypeus subquadrate, about twice as wide as long, apex broad, subtruncate, broadly reflexed (Fig. 14). Size 14–16 mm. Brazil, French Guiana..... ***Arriguttia* Martínez, 1960**
- Body form usually elongate, not short or suboval or stout; if so, then length less than 14 mm (usually 9–12 mm). Clypeus with apex rounded, broadly parabolic, subquadrate, or emarginate (Figs 15–24) **12**

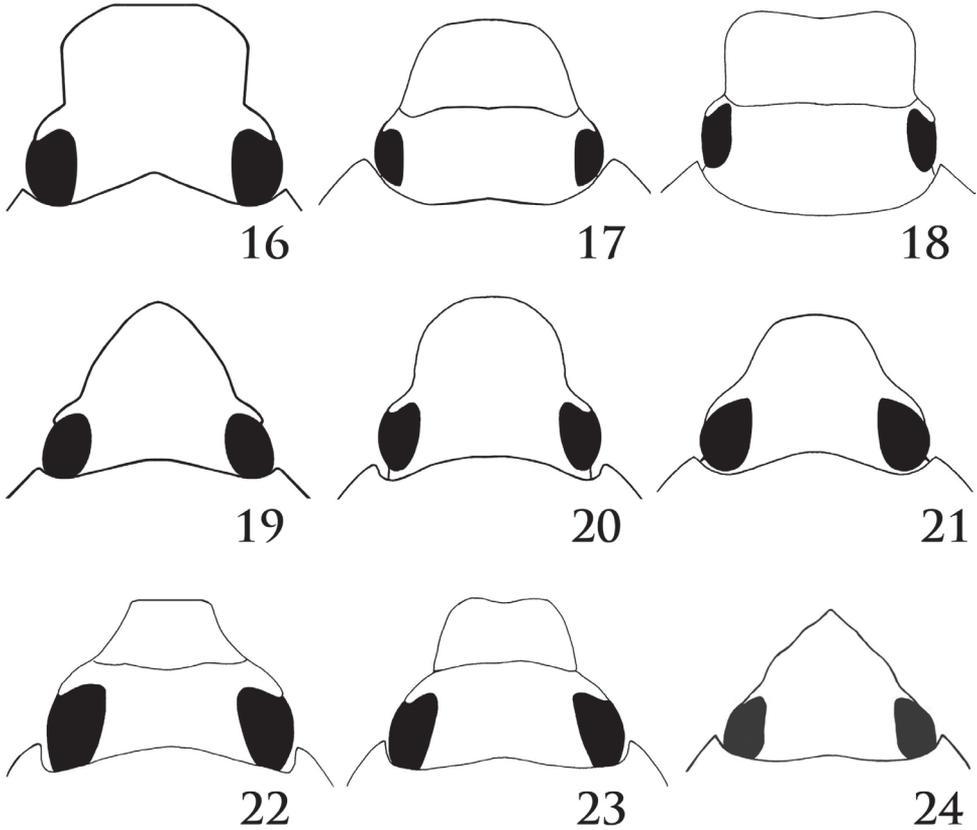
- 12 Clypeus with sides usually divergent (sometimes only slightly) from base to apex, apex broadly rounded (Fig. 16). Maxilla lacking well-developed teeth (when teeth present they are minute and obscured by setae), apex penicillate (setae usually long and dense). Mexico to Argentina..... ***Aspidolea* Bates, 1888**
- Clypeus with sides parallel or convergent from base to apex (never divergent), apex rounded, subtruncate, or emarginate. Maxilla armed with distinct teeth, apex rarely penicillate (a few species of *Cyclocephala*) **13**
- 13 Elytra distinctly, irregularly punctate, punctures not in regular rows; surface with or without weak metallic sheen. Clypeus with apex nearly semicircular, margin beneath apex distinctly thickened (Fig. 15). Venezuela, Peru, Bolivia, Brazil
..... ***Augoderia* Burmeister, 1847**
- Elytra smooth or distinctly punctate, some punctures in regular rows; surface never with metallic sheen. Clypeus with apex variable, semicircular or not, margin beneath apex not distinctly thickened **14**
- 14 Clypeus subquadrate, sides weakly converging to broad apex, apex truncate or emarginate (Figs 17, 18). Interocular width 6.0 or more transverse eye diameters (Figs 17, 18). Males protarsus and claw simple, not enlarged. Central and South America ***Erioscelis* Burmeister, 1847**
- Clypeus not subquadrate, instead with sides converging from base to rounded, parabolic, subtriangular, or emarginate apex (Figs 19–24). Interocular width 5.0 or less transverse eye diameters (Figs 19–24). Males protarsus enlarged, with bifurcate median claw **15**
- 15 Mentum with apex distinctly (often deeply) emarginate, surface at center furrowed in apical third (Fig. 29). Mandible elongated, apex extended to or beyond clypeal apex. Frontoclypeal suture obsolete medially. Length usually more than 18 mm, rarely as small as 15 mm. North, Central, and South America
..... ***Ancognatha* Erichson, 1847**
- Mentum with apex truncate or weakly emarginate (Fig. 30). Mandibles not elongated. Frontoclypeal suture more or less complete. Length variable, 6–35 mm. Canada to Argentina, West Indies (one species introduced to Australia, one species introduced to Hawaii) ***Cyclocephala* Latreille, 1829**

***Parapucaya* Prell, 1934**

Figs 3, 25, 31–34

Parapucaya Prell, 1934: 162.

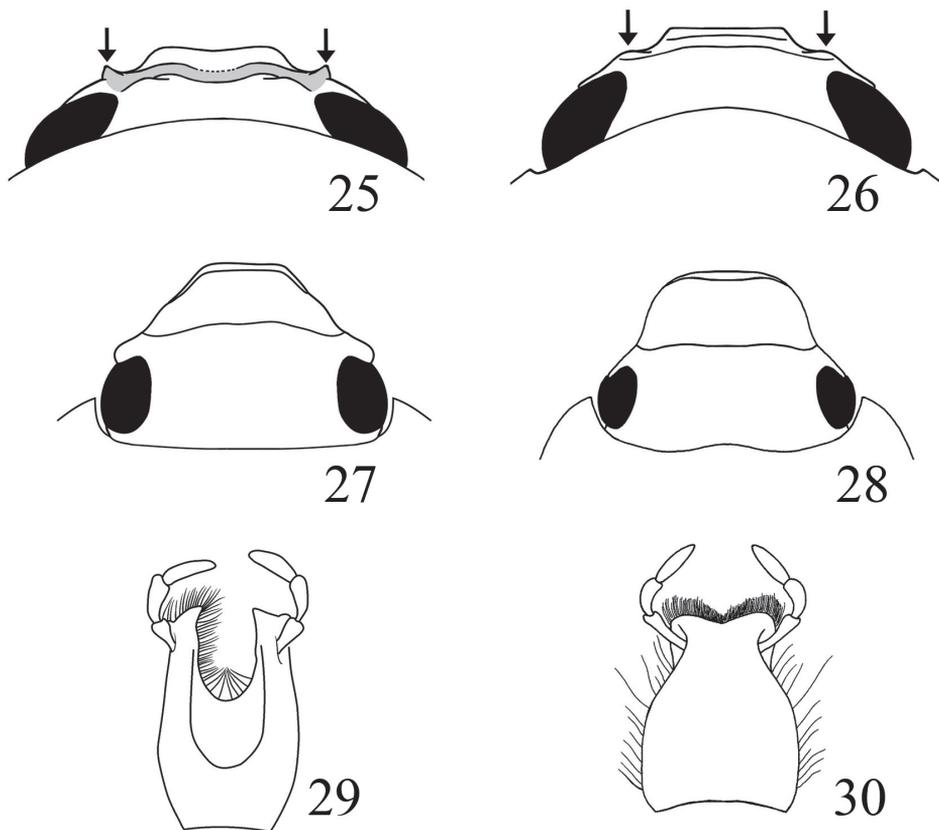
Notes. *Parapucaya* contains two Neotropical species. The genus is distinct from other Cyclocephalini because of the presence of a strongly impressed frontoclypeal suture with the clypeus raised along the suture; lateral margin of clypeus near base raised into a subacute crest, evident in posterodorsal view (Fig. 25); and the presence of double



Figures 16–24. Form of clypeal apex. **16** *Aspidolea* sp. (subquadrate, divergent from base to apex) **17** *Erioscelis* sp. (subquadrate truncate) **18** *Erioscelis* sp. (subquadrate emarginate) **19** *Ancognatha* sp. (narrowly parabolic) **20** *Ancognatha* sp. (parabolic) **21** *Cyclocephala* sp. (rounded) **22** *Cyclocephala* sp. (truncate) **23** *Cyclocephala* sp. (emarginate) **24** *Cyclocephala* sp. (sharply acuminate) (Figures modified from Jameson et al. 2002 and Ratcliffe 2003, by permission).

tubercles or declivity near the anterior margin of the pronotum. It is necessary to look closely at the anterior margin of the pronotum to see the two small tubercles that help to characterize this genus, which can occasionally be difficult in some specimens where these tubercles are nearly absent, especially in *P. amazonica*. The color and general appearance of specimens of *Parapucaya* make them appear similar to *C. melanocephala* and other related species.

Adults of *Parapucaya* have been collected at lights at night. Species of this genus are found distributed in tropical lowlands, such as coastal and Amazonian rainforests, but also in areas with temperate climate, such as cloud forests. Based on label data of Ecuadorian individuals, specimens have been found in pastures. Nothing is known about the immature stages of *Parapucaya* species.



Figures 25–30. Form of clypeus and pronotum. **25** *Parapucaya* sp. (clypeus thickened with sharp crest on margins) **26** *Cyclocephala melanocephala* (Fabricius) (clypeus not thickened, margins weakly raised, rounded). **27** *Stenocrates* sp. (clypeus trapezoidal, pronotum not produced anteriorly at middle) **28** *Dyscinetus* sp. (clypeus subtrapezoidal, pronotum with anterior margin produced at middle). Form of clypeus in posterodorsal view Mentum **29** *Ancognatha* sp. (with furrow) **30** *Cyclocephala* sp. (without furrow, weakly emarginate). (figures 28–30 from Ratcliffe 2003, by permission).

Key to the species of *Parapucaya*

Males with protarsomeres enlarged, protarsus with one claw simple and one enlarged.
 Females with protarsomeres slender, protarsus with both claws simple.

- 1 Pygidium glabrous. Male with round, minute, pronotal tubercle near mid-apex either side of midline; female with minute, transverse, pronotal tubercle near mid-apex either side of midline. Male parameres elongated (Fig. 34).....
 *P. nodicollis* (Kirsch)
- Pygidium setose around disc towards base. Male and female with barely perceptible declivity near mid-line of pronotal apex. Male parameres short (Fig. 32) *P. amazonica* Prell

***Parapucaya amazonica* Prell, 1934**

Figs 31, 32

Parapucaya amazonica Prell, 1934: 162 (original combination).

Redescription. Length 13.0–16.3 mm; width 6.3–8.0 mm. *Head:* Frons with sparse, small punctures, mostly on sides. Frontoclypeal suture complete, sinuate, deeply impressed. Clypeus sparsely, minutely punctate. Interocular width equals 2.7–3.0 transverse eye diameters. Antennal club subequal in length to antennomeres 2–7. *Pronotum:* Surface sparsely punctate; punctures minute on disc, small on sides. Two minute tubercles present just behind apex either side of midline, tubercles often reduced to a subapical declivity. *Elytra:* Surface with rows of small to moderate, ocellate punctures. *Pygidium:* Surface with disc sparsely punctate, punctures small. Base and lateral angles with moderately dense punctures; punctures small to moderate in size, base with transverse row of small setae appressed to surface (hence, difficult to see). In lateral view, surface strongly convex in males, weakly convex in females. *Legs:* Protibia strongly tridentate, basal tooth removed from other two teeth. Protarsus in males enlarged, larger claw strongly curved and incised at apex; females with protarsus simple. Metatibia with 7–8 short, thick spinules. *Venter:* Prosternal process moderate in length; apex transversely oval, with anterior 1/3–1/2 convex, posterior 2/3–1/2 flat. *Parameres:* Fig. 32.

Distribution. *Parapucaya amazonica* is found from Costa Rica to Peru and Brazil (Endrődi 1969, 1985; Ratcliffe 2003). In Ecuador, it is widely distributed and has been recorded in thirteen provinces: Bolívar, Carchi, Cotopaxi, Esmeraldas, Loja, Los Ríos, Manabí, Napo, Orellana, Pastaza, Pichincha, Santo Domingo de los Tsáchilas, and Sucumbíos.

Diagnosis. *Parapucaya amazonica* is invariably mistaken for species of *Cyclocephala* because of its similar appearance. The subapical declivity of the pronotum (or two tubercles in well-developed specimens), in combination with the raised basal margins of the clypeus and the raised clypeal surface along the frontoclypeal suture, will distinguish this genus from *Cyclocephala* species.

Parapucaya amazonica and *P. nodicollis* can be separated from each other by the shape of the mentum (concave from disc to apex in *P. amazonica*, evenly convex in *P. nodicollis*), the pronotal tubercles (subtle in *P. amazonica*, conspicuous in *P. nodicollis*), the presence or absence of pygidial setae (base and lateral angles of pygidium setose in *P. amazonica*, glabrous in *P. nodicollis*); size (in general, *P. amazonica* is larger and stouter than *P. nodicollis*, although some individuals overlap); and their parameres (Fig. 32).

Natural history. In Ecuador, *P. amazonica* occurs at elevations ranging from sea level to 2,450 m in the coastal, Andean, and Amazon regions. Based on label data, adults can be collected throughout the year but in higher numbers in February and December. Nothing is known of the immature stages of this species.



Figure 31. *Parapucaya amazonica* Prell.

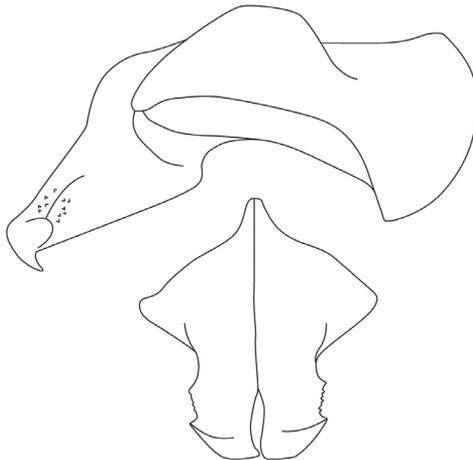


Figure 32. *Parapucaya amazonica* Prell parameres (from Ratcliffe 2003, by permission).

***Parapucaya nodicollis* (Kirsch, 1873)**

Figs 33–34

Cyclocephala nodicollis Kirsch, 1873: 344 (original combination).

Redescription. Length 11.8–13.0 mm; width 5.4–5.8 mm. *Head:* Frons rugulopunctate, punctures dense, moderate in size. Frontoclypeal suture complete, biarcuate. Clypeus subquadrate, surface rugo-punctate at base, shagreened at margins and disc; apex broadly truncate, slightly reflexed. Interocular width equals 2.5–3.0 transverse eye diameters. Antennal club slightly shorter than antennomeres 2–7. *Pronotum:* Surface moderately to densely punctate, punctures moderate in size, ocellate. *Pygidium:* Surface moderately to densely punctate, punctures moderate in size; glabrous. In lateral view, males with surface evenly rounded, females with surface nearly flat. *Legs:* Protibia tridentate, teeth subequally spaced. Protarsus in male weakly enlarged, median claw large, cleft at apex; protarsus and claw simple in female. *Venter:* Prosternal process moderately long, columnar; apex densely setose, flattened, and with large, raised, round “button” covering most of apex; setae long, tawny. *Parameres:* Fig. 34.

Distribution. *Parapucaya nodicollis* is known from Colombia, Ecuador, and Peru (Endrődi 1985). In Ecuador, it is recorded in five provinces in the coastal, Andean, and Amazonian regions: Esmeraldas, Morona Santiago, Napo, Pastaza, Pichincha, and Sucumbíos.

Diagnosis. *Parapucaya nodicollis* is usually mistaken for species of *Cyclocephala* because of its similar appearance. The two small tubercles on the pronotum, in combination with the raised basal margins of the clypeus and the raised clypeal surface along the frontoclypeal suture, will distinguish members of this genus from *Cyclocephala* species.

Parapucaya nodicollis and *P. amazonica* can be separated from each other by the shape of the mentum (evenly convex in *P. nodicollis*, concave from disc to apex in *P. amazonica*); the pronotal tubercles (conspicuous in *P. nodicollis*, subtle in *P. amazonica*); the presence or absence of pygidial setae (glabrous in *P. nodicollis*, present across the base of the pygidium in *P. amazonica*); size (in general, *P. nodicollis* is smaller and thinner than *P. amazonica*, although some individuals overlap); and their parameres (Fig. 34).

Natural history. In Ecuador, it occurs at elevations from 300 to 1,800 m on both sides of the Andes. Based on label data, adults can be collected in Ecuador throughout the year and in higher numbers in February, June to July, and in November. Nothing is known of the immature stages of this species.

***Pucaya* Ohaus, 1910**

Figs 4, 6, 35–40

Pucaya Ohaus, 1910: 675.

Notes. The genus *Pucaya* contains two species, *P. castanea* Ohaus and *P. pulchra* Arrow. López-García et al. (2015) compared type specimens and synonymized *P. punctata*



Figure 33. *Parapucaya nodicollis* (Kirsch).

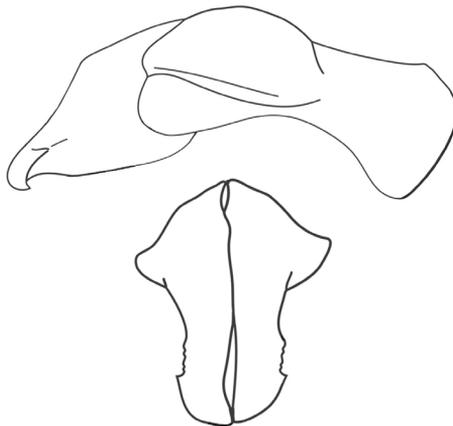


Figure 34. *Parapucaya nodicollis* (Kirsch) parameres.

Endrödi with *P. pulchra* based on similarities in body length, pronotal and elytral punctation, and the fact that the description of *P. punctata* was based on the color and punctation of a single female in a species where color pattern and punctation are variable.

Pucaya is distinguished from other cyclocephalines by its broadly truncate clypeus that conceals the mandibles; a small horn or tubercle near each eye (horns not as developed in Ecuadorian specimens as in Panamanian specimens); parameres with round, minute spinules (bumps) on the apical half; and a characteristic binodose pronotum.

Specimens can be taken at light traps, and some have been collected with pitfall traps. In Ecuador, species of this genus are widely distributed as follows: Chocó region in the coast; premontane, montane, and cloud forests in the Andean region; and rainforests in the Amazon basin. Life history information is lacking.

Key to the species of *Pucaya*

- 1 Elytra with impressed sutural stria at least on apical half. Protuberances on pronotum with their highest points close to midline, positioned between frontoclypeal tubercles in posterodorsal view (Fig. 35). Parameres as in Fig. 40.....*P. pulchra* Arrow
- Elytra without impressed sutural stria. Nodes on pronotum evenly round, widely separated, with their highest points about “in-line” with frontoclypeal tubercles in posterodorsal view (Fig. 36). Parameres as in Fig. 38.....*P. castanea* Ohaus

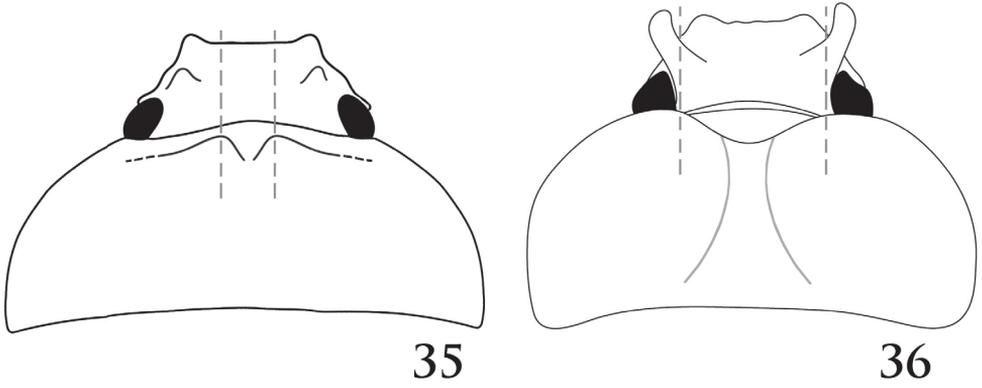
Pucaya castanea Ohaus, 1910

Figs 36–38

Pucaya castanea Ohaus, 1910: 676 (original combination).

Pucaya columbiana Beck, 1942: 47 (synonym).

Redescription. Length 24.0–30.1 mm; width 11.0–14.2 mm. Color light to dark reddish brown; head, tibiae, and tarsi often black. *Head:* Frons and clypeus completely rugulose in males, partially rugulose to nearly smooth in females. Base of clypeus at sides (and just in front of eye) with short, vertically upright horn in males or a large tubercle in females. Clypeus with apex very broadly truncate, shallowly emarginate, broadly reflexed in males, narrowly reflexed in females. Interocular width equals 5.0 transverse eye diameters. Antenna with 10 antennomeres, club subequal to antennomeres 2–7. Mandibles small, narrow, not visible in dorsal view. *Pronotum:* Surface with sparse, minute punctures. A tumescent boss present either side of broadly depressed midline. Narrow marginal bead present on base. *Elytra:* Surface also with sparse, minute punctures; punctures becoming denser along lateral margins. Striae totally lacking. *Pygidium:* Surface with sparse, minute punctures. In lateral view, regularly convex in males, nearly flat in females. *Legs:* Protibia tridentate, basal tooth slightly removed from others. Males with claw of



Figures 35–36. Pronota. **35** *Pucaya pulchra* Arrow **36** *Pucaya castanea* Ohaus.



Figure 37. *Pucaya castanea* Ohaus.

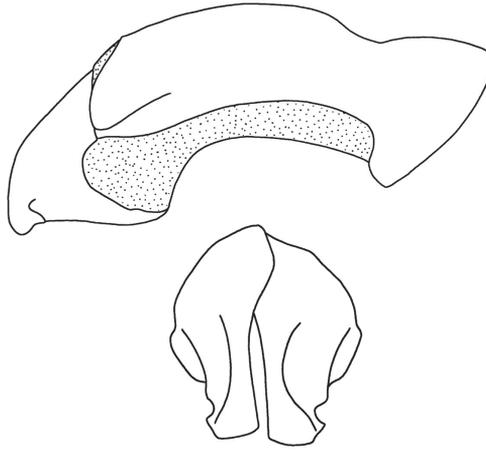


Figure 38. *Pucaya castanea* Ohaus parameres (from Ratcliffe 2003, by permission).

anterior tarsus enlarged, apex split. Apex of posterior tibia arcuate and with 9 short, stout spinules. Apex of first tarsomere of posterior tarsus triangularly elongated. *Venter*: Prosternal process short; apex transversely oval, anterior 1/2–2/3 convex, posterior 1/2–1/3 flat, a transverse sulcus often separating anterior and posterior parts. *Parameres*: Fig. 38.

Distribution. *Pucaya castanea* occurs in Costa Rica, Panama, Colombia, and Ecuador (Beck 1942b; Endrödi 1969, 1985; Ratcliffe 2003; López-García et al. 2015). In Ecuador, it is widely distributed in thirteen provinces: Azuay, Cañar, Carchi, Cotopaxi, Esmeraldas, Imbabura, Loja, Morona Santiago, Napo, Orellana, Pichincha, Santo Domingo de los Tsáchilas, and Zamora Chinchipe.

Diagnosis. *Pucaya castanea* can be distinguished from *P. pulchra* by its elytral punctation. In *P. castanea*, the entire elytral surface has sparse, minute punctures, while in *P. pulchra* the elytral surface is striate-punctate from the base to 2/3 the length of the elytra. The punctures are dense, moderate in size, and ocellate, but on the apical third of the elytra the punctures are sparse and minute. The form of the parameres (Fig. 38) also separates both species.

Natural history. In Ecuador, *P. castanea* occurs at elevations ranging from sea level to 2,550 m in the coastal, Andean, and Amazon regions. Based on label data, adults can be collected throughout the year but in higher numbers from February to May and from November to December. Nothing is known of the immature stages of this species.

Pucaya pulchra Arrow, 1911

Figs 6, 35, 39–40

Pucaya pulchra Arrow, 1911: 167 (original combination).

Redescription. Length 20.4–23.7 mm; width 9.8–11.2 mm. Color of head black or piceous. Pronotum completely black or black with brown, elongate markings on



Figure 39. *Pucaya pulchra* Arrow. Image by B.C. Ratcliffe.

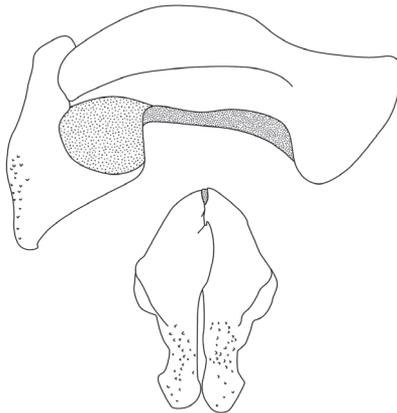


Figure 40. *Pucaya pulchra* Arrow parameres.

margins, with or without brown spots on base of disc. Elytra entirely black or black with brown margins or brown with black markings on the suture, humerus and behind scutellum; markings can be short near elytral base or extend to umbone area. Scutellum, pygidium, venter, and legs black or brown. *Head*: Frons sparsely punctate at base, becoming progressively rugo-punctate anteriorly; punctures moderate in size. Frontoclypeal sutural area at sides with tubercle in both sexes; tubercle smaller in females, conical in males. Clypeus with apex very broadly truncate, reflexed, surface rugose at disc, smooth to shagreened at margins. Interocular width equals 4.1–4.3 transverse eye diameters. Antenna with 10 antennomeres, club slightly longer than antennomeres 2–7. *Pronotum*: Surface moderately to densely punctate at base, punctures moderate in size; sparsely punctate from disc to apex, punctures minute. Broadly depressed midline, with round depressions on each side of midline: 1 on apex, 2 between mid-disc and margins; depressions shallow in females. *Elytra*: Surface from base to 2/3 striate-punctate; punctures dense, moderate in size, ocellate; from 2/3 to apex with sparse, minute punctures. *Pygidium*: Surface densely punctate, punctures moderate in size. In lateral view, males with surface evenly rounded, females with surface nearly flat. *Legs*: Protibia tridentate. Protarsus in male weakly enlarged, median claw large, strongly curved, cleft at apex; protarsus and claw simple in female. *Venter*: Prosternal process moderately long, columnar; apex densely setose, flattened, and with large, raised, round “button” covering most of apex; setae long, tawny. *Parameres*: Fig. 40.

Distribution. *Pucaya pulchra* occurs in Colombia and Ecuador (Endrődi 1985; López-García et al. 2015). In Ecuador, adults were collected in five provinces: Esmeraldas, Loja, Napo, Pastaza, Pichincha, Santo Domingo de los Tsáchilas, Tungurahua, and Zamora Chinchipe.

Diagnosis. *Pucaya pulchra* can be distinguished from *P. castanea* by the elytral punctuation. In *P. pulchra*, the elytral surface is striate-punctate from the base to 2/3 of the elytra; the punctures are dense, moderate in size, and ocellate, but the apical third has sparse, minute punctures. In *P. castanea*, the entire elytral surface has sparse, minute punctures. The form of the parameres (Fig 40.) also separates both species.

Natural history. In Ecuador, *P. pulchra* occurs at elevations ranging from 20 to 1,900 m in the coastal, Andean, and Amazon regions. Some specimens have been collected in pitfall traps.

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