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Studies of the genus *Enchodelus* Thorne, 1939 (Nematoda, Nordiidae) from Arctic polar deserts. 1. Species with long odontostyle: *E. makarovae* sp. n. and *E. groenlandicus* (Ditlevsen, 1927) Thorne, 1939, with an identification key to the species of the *E. macrodorus* group

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Abstract

Two nematode species of the genus *Enchodelus* Thorne, 1939, one new and one known from Arctic polar deserts were studied. *Enchodelus makarovae* **sp. n.** is an amphimictic species, characterised by females with body length of 1.57–2.00 mm, lip region 15–17.5 µm wide, amphid duplex, odontostyle 38–43 µm long or 2.3–2.8 times lip region diam. Odontophore with flanges, 1.2–1.4 times as long as odontostyle; pharynx length 320–377 µm, pharyngeal expansion 113–130 µm long or 32–37% of total pharynx length; female genital system amphidelphic, uterus tripartite, *pars refringens vaginae* with two trapezoid sclerotisations, vulva a transverse slit (V=45–51%); tail bluntly conoid (25–35 µm, c=45.8–70.3, c'=0.6–0.9 in females, and 29–33 µm, c=46.4–58.9, c'=0.7–0.8 in males). Males with 65–74 µm long spicules and 10–12 spaced ventromedian supplements. Additional information for *Enchodelus groenlandicus* is provided, this being a new geographic record for the Putorana Plateau, Russian Arctic.

Keywords

Taxonomy, morphology, morphometrics, Nematoda, cold desert, new geographic record

Introduction

Currently, the genus *Enchodelus* Thorne, 1939 (Nordiidae, Pungentinae) contains 28 species distributed mainly in the northern hemisphere (Peña-Santiago et al. 2005); only one species (*E. signyensis* Loof, 1975) has been described from Antarctica. The members of the genus are common at high altitudes (1260-4400 m a.s.l) and latitudes, frequently associated with mosses and rock vegetation (Ahmad and Jairajpuri 1980, Eliava and Eliashvili 1990, Peneva et al. 2009). According to their feeding habits, representatives of the genus *Enchodelus* are attributed to the omnivorous trophic group (Yeates et al. 1993).

Ahmad and Jairajpuri (1980) provided a revision of the genus and grouped species into five subgenera (*Enchodelus, Paraenchodelus, Heterodorus, Rotundus, Nepalus*) on the basis of tail shape, odontostyle length, odontophore morphology and presence of a peculiar chamber in the female reproductive system. Recently, Guerrero et al. (2007a, 2008) divided the genus into three groups, based on tail shape and odontostyle length: species with long odontostyle (>35 μm) and rounded tail; species with medium size odontostyle (<35 μm) and rounded tail, and species with conical tail. The subgenera of *Enchodelus* are also not recognized by Andrássy (2009a) and species with conical tail are considered as belonging to the genus *Heterodorus* Altherr, 1952 (Andrássy 2011).

Here we provide data on two species of *Enchodelus* which belong to the first group with long odontostyles recovered from Arctic polar deserts.

Materials and methods

Soil samples were collected by Dr Olga Makarova (Institute for Problems of Ecology and Evolution, Russia) from two arctic regions, i.e. Bol'shevik Island, Severnaya Zemlya Archipelago, representing a zonal type of landscape (polygonal polar desert) and the highlands of Putorana Plateau, southern Taymyr, representing an altitudinal analogue of the zonal polar deserts, i.e. a nival desert. Nematodes were extracted from 1–3 g of soil by using a Baerman funnel method for 48 hours exposition, killed by gentle heat and fixed in 4% formalin.

Nematodes were processed in anhydrous glycerin by a Seinhorst method (1959) and mounted on permanent slides. Drawings and photographs were taken using an Olympus BX51 compound microscope. Images were taken with a ColorView IIIu camera and Cell^P software (Olympus Soft Imaging Solutions Gmbh). Measurements were made using an Olympus BX 41 light microscope with a drawing tube and digitizing tablet (CalComp Drawing Board III, GTCO CalCom Peripherals, Scottsdale, AZ, USA) and Digitrak 1.0f computer program (Philip Smith, John Hutton Institute), Dundee, UK). Identification key was performed by DELTA-package software (Dallwitz 1974).

Taxonomy

***Enchodelus makarovae* sp. n.**
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http://species-id.net/wiki/Enchodelus_makarovae
Figs 1–6

Material examined. Eight females, six males and two first stage juveniles collected from Bol'shevik Island, Severnaya Zemlya Archipelago, Russian Arctic (Table 1).

Measurements. See Table 2.

Description. *Female.* Body slightly ventrally curved after fixation, rarely adopting an open C shape. Cuticle smooth when viewed under light microscopy, composed of several layers with optically different appearance. Cuticle 2–4 μm thick at postlabial region, 2–3 μm - at mid body and 8–11 μm on tail, posterior to anus. Subcuticle clearly striated. Lateral chord 6–9 μm wide, occupying 10–12 % of mid body diam. Lip region with slightly angular appearance, offset by depression, 2.3–3.1 times as broad as high. Labial and cephalic papillae distinct. Amphid duplex, amphidial fovea cup-shaped, opening at level of depression. Cheilostom almost cylindrical with a narrower mid-section. Odontostyle 2.3–2.8 times longer than lip region diam. or 2.0–2.6% of total body length. Odontophore 1.2–1.4 times as long as odontostyle, with flanges. Guiding ring double, located at 1.4–2.0 lip region diam. from anterior end, collar (distance between the first and second guiding ring) 3 μm. Pharynx attains the full width at 65–70% of its length from anterior end. Pharyngeal expansion 113–130 μm long or 32–37% of total pharynx length. Pharyngeal characters are presented at Table 3. Nuclei of dorsal glands 4.5–5 μm diam. and ventrosublateral 1 μm and 3–4 μm of the first and second pair, respectively. Cardia small, rounded to elongate conoid. Genital system amphidelphic, both branches almost equally developed, anterior 264–310 μm, posterior 240–310 μm. Ovaries large, 206–218 μm long; oocytes first in two or more rows, then in one row. Oviduct 168–172 μm long, 2.1–2.4 times body diam., *pars dilatata oviductus* well developed. Sphincter between oviduct and uterus distinct. Uteri long, anterior and posterior uterus with almost equal length (267.6±56.3 (220–346) μm, n=5 and 284.0±25.5 (256–332) μm, n=6), or 2.9–4.9 times corresponding body diam. Uterus tripartite, consisting of a wider proximal portion with distinct lumen (146 μm, n=1), followed by a slender median portion (118, 112 μm, n=2) and ending with a well developed spheroid *pars dilatata distalis uteri*. Vagina extending inwards 27–42 μm or 38–59% of body diam., *pars proximalis* 24x26 μm (n=1), *pars refringens* with two trapezoid sclerotisations, with a combined width of 20–21 μm and length 6–8 μm (n=2), *pars distalis* 5–7 μm, n=4. Two females with 3 and 4 uterine eggs, respectively, measuring 37–45 × 98–106 μm. Prerectum variable in length, 2.1–3.5 times the anal body width; rectum 0.6–1.1 anal body diam. long. Tail bluntly conoid with elongated saccate bodies present mostly along ventral side. Hyaline part of tail 8–12 μm thick or 24–47 % of total tail length. Two pairs of subterminal caudal pores, one subdorsal, another lateral.

Table 1. Distribution of *Enchodelus makarovae* sp. n. and *E. groenlandicus* in Arctic polar deserts.

Locality and samples	Type of landscape and vegetation	Abbreviation	Nematode species
Bol'shevik Island Severnaya Zemlya Archipelago 78°12'N, 103°17'E	Polygonal polar desert		*Enchodelus makarovae* sp. n.
Site 1 Collected on 09.08.1997			
Sample № 2	*Alopecurus alpinus* Sm.	AA	3♀ 1♂
Sample № 3	*Gymnomitrium coraloides* Nees.	GC	1♀ 1♂
Site 2 Collected on 13.08.2000			
Samples № 6, 8 and 9	*G. coraloides* and *Lopadium* sp.	GC & L	4♀ 3♂
Sample № 13	Black crust with a small tuft *Deshampsia borealis* (Trautv.) Roshev.	DB	1♂
Sample № 7	Black crust	BC	2 J_1
Putorana Plateau Taymyr Peninsula 69°09'N, 91°52'E	Polygonal nival desert		*Enchodelus groenlandicus*
750 m a.s.l Collected on 3.08.1996			
Sample № 7	Old *D. borealis* tuft with *G. corralioides* and *Cladonia* sp.	DB, GC, C	3♀
Samples № 9 and 10	Large green *D. borealis* tuft	DB_1	7♀

Male. General morphology similar to that of the female, except for genital structures. Arrangement of pharyngeal gland nuclei is presented at Table 3. Lateral chord very narrow (4–6 μm) occupying 10–12 % of mid body diam. with scattered glandular bodies. Reproductive system diorchic, composed of two opposed testes, anterior 311, 319 μm (n=2) and posterior 275, 285 μm (n=2) long. Sperm cells spindle-shaped, measuring 6–9 × 2 μm. Spicules dorylaimoid, 1.5–1.7 times anal diam. long, lateral accessory pieces paired, more or less cylindrical with bifurcate end, measuring 16–18 × 3 μm (n=2). Ventromedian supplements 10–12 in number preceded by one adcloacal pair of papillae located at 8–11 μm apart from cloacal opening, 0–1 in the range of spicules; moderately developed postcloacal papilla present. Prerectum 3.3–4.0 anal body diam. long. Tail bluntly conoid, ventrally almost straight, dorsally convex with broadly rounded terminus, two pair of caudal pores.

Juveniles. Two first stage juveniles were recovered. Body almost straight. Lip region flat, continuous with the body, genital primordium 11 μm long, tail conical with long central peg, 30, 33 μm long.

Diagnosis and relationships. The new species *E. makarovae* sp. n. is an amphimictic species distinguished by females with body length of 1.57–2 mm, lip

Table 2. Morphometrics of *Enchodelus makarovae* sp. n. from Bol'shevik Island, Severnaya Zemlya. All measurements, unless indicated otherwise, are in μm.

Characters		GC&L		GC		AA		DB	Range		BC
	Holotype	Female	Male	Female	Male	Female	Male	Male	Female n=8	Male n=6	J_1 n=2
L (mm)	2.00	1.76, 1.79, 1.62	1.70; 1.67; 1.79	1.85	1.71	1.64,1.57,1.85	1.77	1.49	1.76±0.1 (1.57-2.00)	1.69±0.1 (1.49-1.79)	0.62, 0.53
a	28.3	33.1, 25.6, 21.6	28.1, 26.5, 29.2	24.2	29.8	22.6,23.1, 23.1	23	19.6	25.2±3.8 (21.6-33.1)	26.0±3.9 (19.6-29.8)	24.7, 25.7
b	5.6	5.7, 5.3, 4.4	5.4, 4.4, 5.3	4.9	4.9	5.1, 4.7, 5.3	5.2	4.5	5.1±0.4 (4.4-5.7)	4.9±0.4 (4.4-5.4)	3.9, 3.4
c	70.3	69.9, 60.5, 45.8	58.9, 54.9, 55.8	59.7	51.7	54.1, 49.6, 61.2	53.0	46.4	61.1±7.6 (45.8-70.3)	53.4±4.2 (46.4-58.9)	11.4, 9.8
c‘	0.6	0.6, 0.7, 0.9	0.7, 0.7, 0.8	0.7	0.8	0.8, 0.9, 0.6	0.7	0.8	0.7±0.1 (0.6-0.9)	0.7±0.1 (0.7-0.8)	2.9, 3.1
V %	51	49, 51, 48	-	49	-	48, 48, 45	-	-	48.6±1.8 (45-51)		-
Lip region width	17	17, 17, 16	16, 17, 17.5	17.5	16	17, 16, 15	17	16	16.6±0.8 (15-17.5)	16.7±0.5 (16-18)	9, 9
Odontostyle	40	41, 41.5, 38	44, 39, 44	43	44	38.5, 42, 41	44.5	43	40.7±1.6 (38-43)	42.9±2.1 (39-44.5)	10, 9.5
Replacement odontostyle	-	-	-	-	-	-	-	-			12, 11
Odontophore	54	49, 49.5, 50	49, 50, 53	57.5	52	47, 53, 57	52	54	52.3±3.9 (47-57.5)	51.3±1.6 (49-54)	-
Spear	95	90, 91, 89	93, 89, 96	100.5	96	85.5, 95, 99	96	97	93±5.1 (85.5-100.5)	94.3±2.9 (89-97)	-
Anterior end guiding ring	26	24, 24, 24	22, 25, 28	26	27	25, 28, 28	26	28	25.7±1.8 (24-28)	25.9±2.0 (22-28)	5.5, 6.0
Neck length	355	320, 336, 366	318, 384, 342	377	354	321, 341, 349	340	333	345.7±20.3 (320-377)	344.9±22.3 (318-384)	160, 155
Width at pharynx base	63	51, 63, 69	56, 62, 58	66.5	60	66, -, 69	72	70	64.0±6.1 (51-69)	62.9±6.6 (56-72)	25, 22

Characters		GC&L		GC		AA		DB	Range		BC
	Holotype	Female	Male	Female	Male	Female	Male	Male	Female n=8	Male n=6	J_1 n=2
Width at mid-body	71	54, 70, 75	61, 63, 62	77	58	73, 68, 80	77	76	70.9±8.06 (54-80)	66.0±8.3 (58-77)	25, 21
Prerectum length	138	87, -, 139	-, 185, 132	126	163	140,-,138	-	163	128±20.6 (87-140)	160.7±21.7 (132-185)	53, -
Rectum length	40	23, 47, 40	-	49	-	41, -, 42	-	-	40.3±8.3 (23-49)		10, -
Tail	29	25, 30, 35	29, 31, 32	31	33	30, 32, 30	33	32	29.2±3.3 (25-35)	31.7±1.6 (29-33)	55, 55
Spicules	-	-	65, 73, 67	-	71	-	74	70		70.1±3.5 (65-74)	
Ventromedian supplements	-	-	10, 12, 10	-	11	-	12	11		10-12	

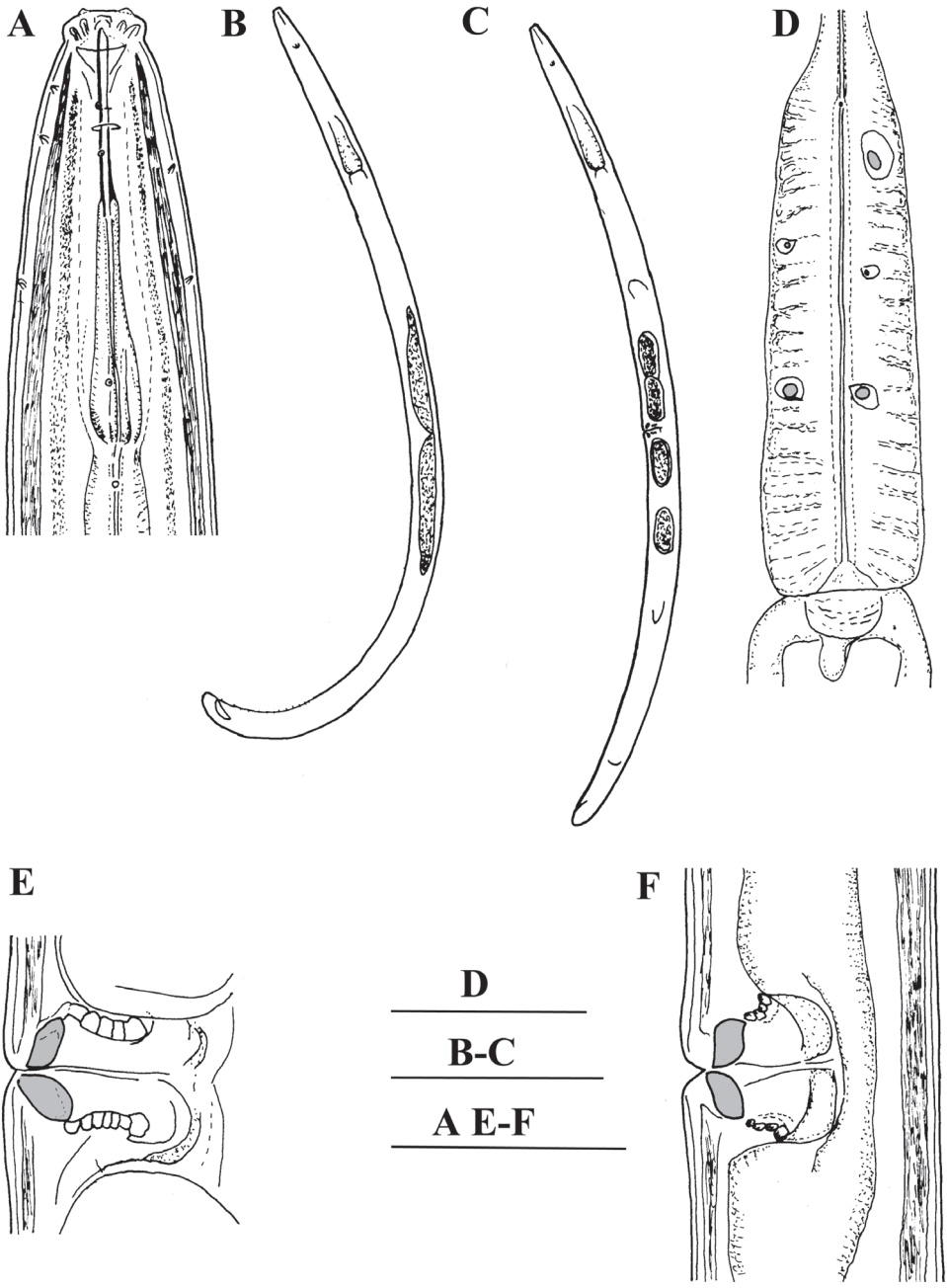

Figure 1. *Enchodelus makarovae* sp. n. *Female*: **A** Anterior region **C** Entire body **D** Pharyngeal bulb, dorsal and ventrosublateral glands **E, F** Vulval region. *Male*: **B** Entire body. Scale bars: **A, D, E, F** 50 μm; **B, C** 0.5 mm.

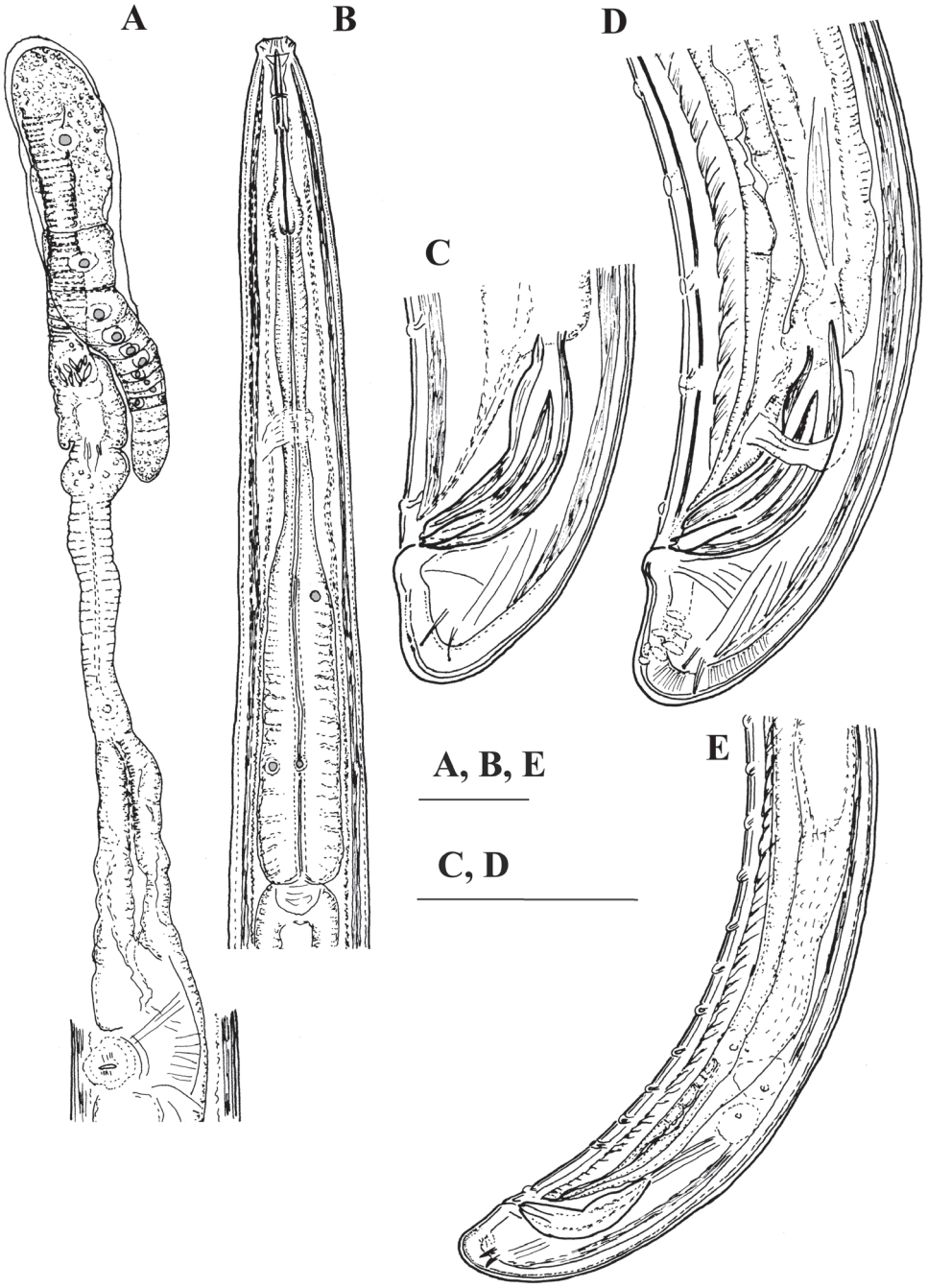

Figure 2. *Enchodelus makarovae* sp. n. **A, B** *Female*: **A** Anterior genital branch **B** Neck region *Male*: **C, D, E** Posterior ends. Scale bars: **A–E** 50 μm.

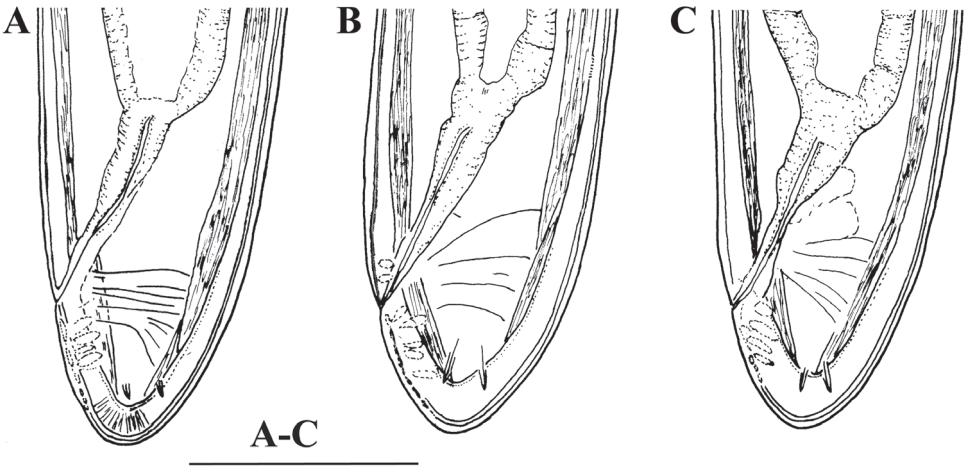

Figure 3. *Enchodelus makarovae* sp. n. **A–C** *Female*: Variability of female tail. Scale bars: **A–C** 50 μm.

region 15–17.5 μm wide, amphid duplex, odontostyle 38–43 μm long or 2.3–2.8 times lip region diam. Odontophore with flanges, 1.2–1.4 times as long as odontostyle, pharynx length 320–377 μm, pharyngeal expansion 113–130 μm long or 32–37% of total pharynx length, female genital system amphidelphic, uterus tripartite, *pars refringens vaginae* with two trapezoid sclerotisations, vulva transverse slit, V=45–51%, tail rounded conoid (25–35 μm, c=45.8–70.3, c'=0.6–0.9 in females, and 29–33 μm, c=46.4–58.9, c'=0.7–0.8 in males). Males with 65–74 μm long spicules and 10–12 spaced ventromedian supplements.

Based on tail morphology and odontostyle length this species can be assigned to the *E. macrodorus* – group as defined by Guerrero et al. (2008). This group includes *E. babakicus* Pedram et al. 2009, *E. carpaticus* Ciobanu et al., 2010, *E. distinctus* Ahmad & Jairajpuri, 1980, *E. groenlandicus* (Ditlevsen, 1927) Thorne, 1939, *E. macrodorus* (de Man, 1880) Thorne, 1939, *E. microdoroides* Baqri & Jairajpuri, 1974 and *E. saxifragae* Popovici, 1995. This homogeneous group is characterised by the presence of a rather long odontostyle (>35μm), odontophore with well developed flanges, uterus tripartite (except for *E. distinctus*, which has been described with a bipartite uterus (Ahmad and Jairajpuri 1980) and hemispheroid to rounded conoid tail.

In having a lip region set off by a depression the new species is most similar to *E. carpaticus, E. groenlandicus, E. macrodorus* and *E. microdoroides*. However, it can be separated from *E. carpaticus* by its shorter pharyngeal expansion (113–130 *vs* 136–167 μm), different arrangement of pharyngeal glands, DN and S2N situated more posteriorly (DN=69–72% *vs* DN=63–65%, S2N=86–89% *vs* SN=82–86 %, respectively), absence of dorsal cell mass near cardia *vs* presence, ovaries large (206–218 μm long) *vs* short (61–155 μm long), prerectum shorter (87–140 *vs* 164–272 μm or 2.1–3.5 *vs* 4.1–6.6 anal body diam), saccate bodies present *vs* absent, males abundant *vs* absent (in

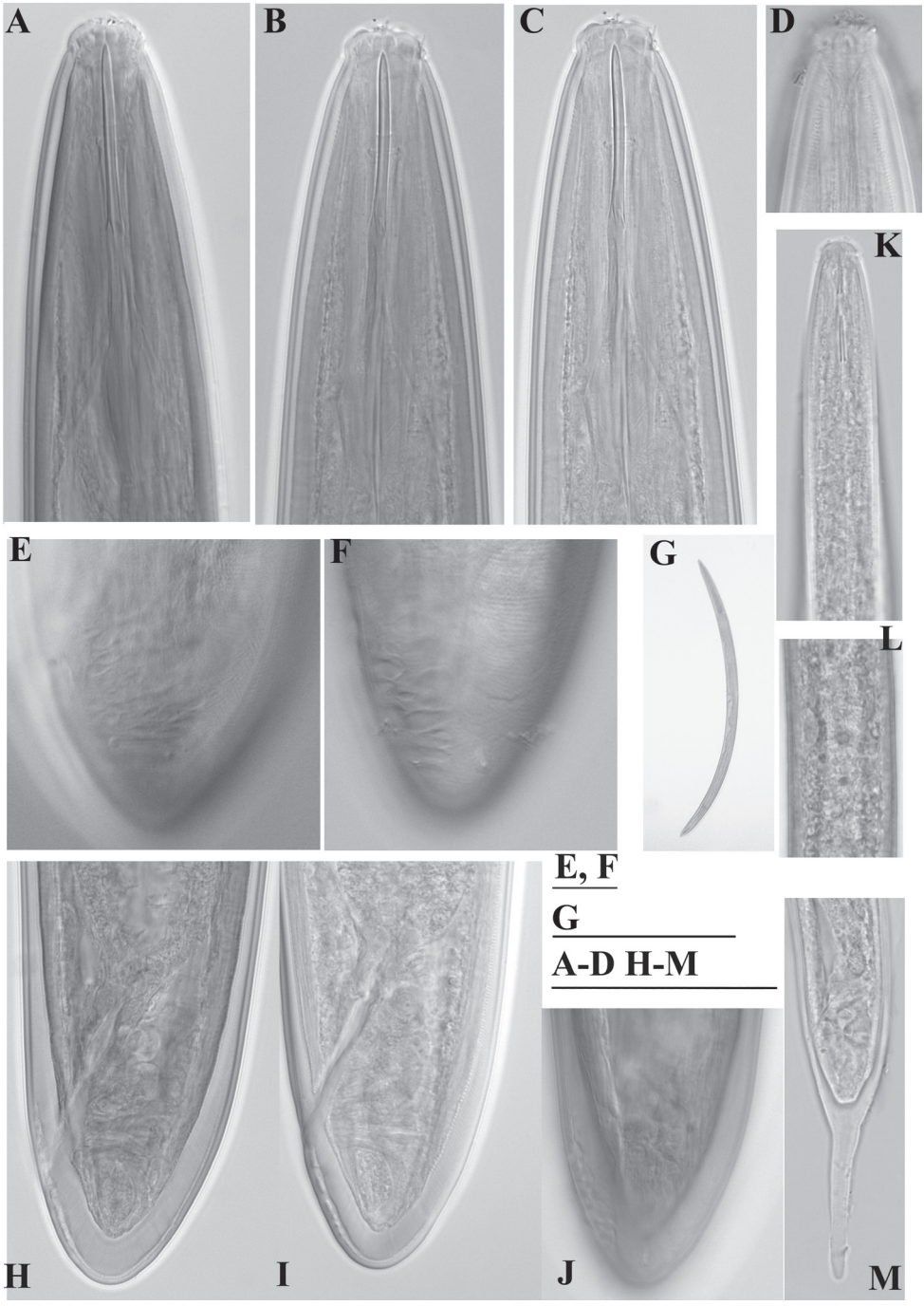

Figure 4. *Enchodelus makarovae* sp. n. **A–J** *Female*: **A–C** Variability of anterior region **D** Amphidial fovea **G** Entire body **E, F, J** Variability of tail with saccate bodies **H, I** Tail end **K–M** *Juveniles* **K** Anterior region **L** Genital primordium **M** Tail. Scale bars: **A–D H–M** 50 μm; **G** 1 mm, **E, F** 10 μm.

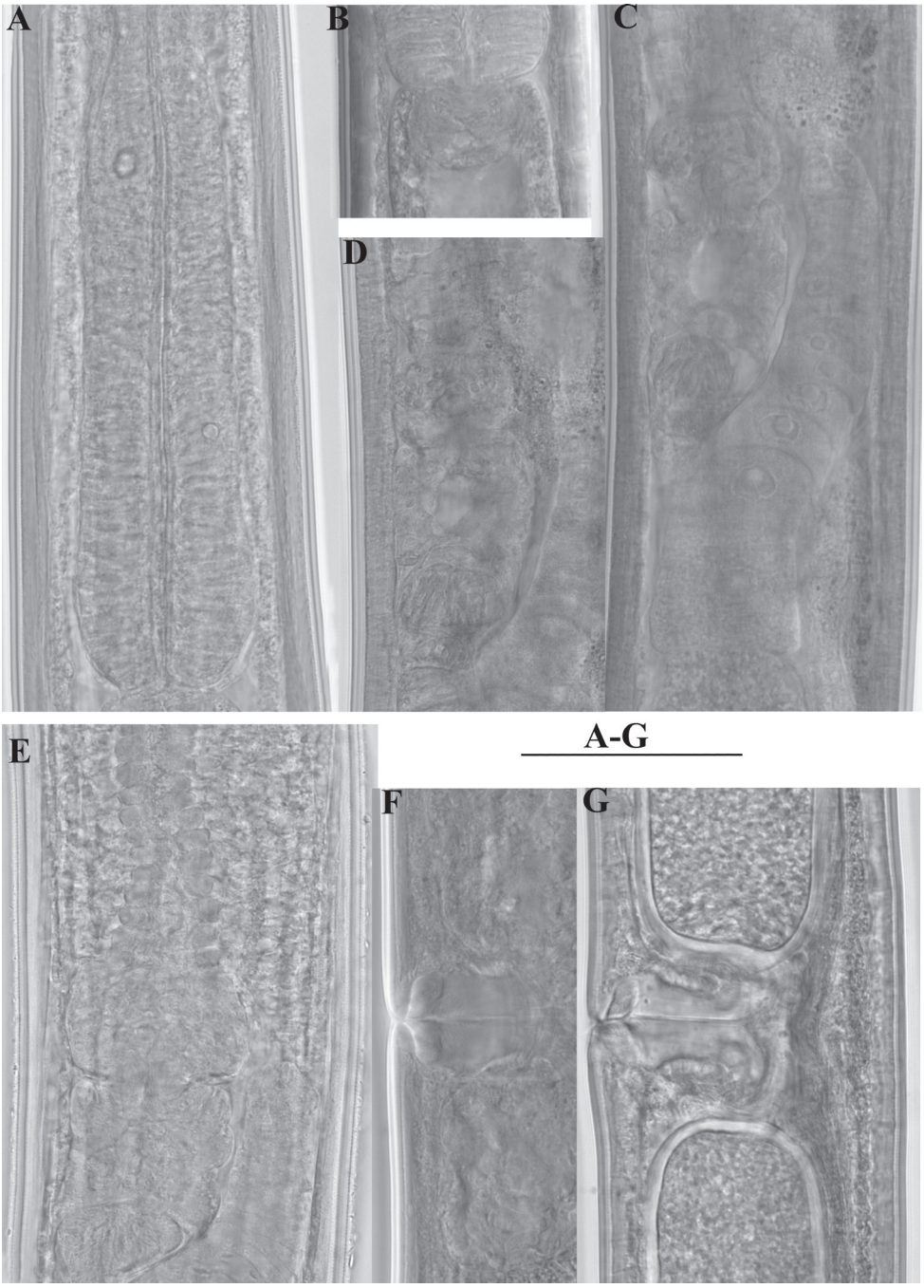

Figure 5. *Enchodelus makarovae* sp. n. *Female* **A** Pharyngeal bulb, dorsal and ventrosublateral glands **B** Cardia **C, D** *Pars dilatata oviductus* and ovarium **E** *Pars dilatata distalis uteri* **F–G** Vulval region. Scale bars: **A–G** 50 μm.

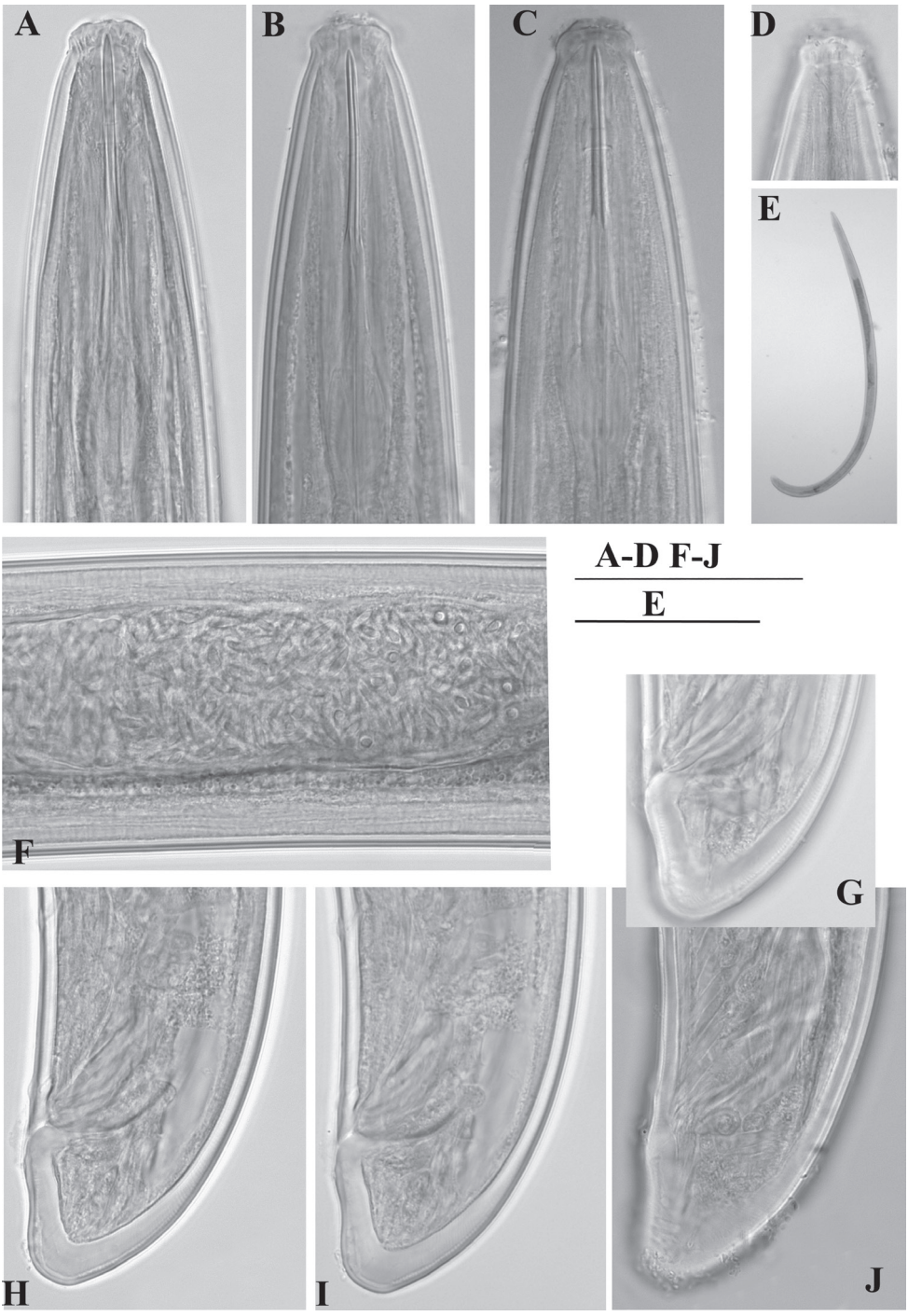

Figure 6. *Enchodelus makarovae* sp. n. **A–J** *Male*: **A–C** Anterior ends **D** Amphidial fovea **E** Entire body **F** Sperm cells in testis **G** Lateral piece **H, I** Tail ends **J** Tail with saccate bodies. Scale bars: **A–D, F–J** 50 μm; **E** 1 mm.

Table 3. Pharyngeal characters of *E. makarovae* sp. n. and *E. groenlandicus*. For abbreviations see (*) Loof and Coomans (1970) and (**) Andrássy 1998. All data are given in percent.

	***E. makarovae* sp. n.**						***E. groenlandicus***	
	Bol'shevik Island						**Putorana Plateau**	
Characters	GC&L		GC		AA	DB	DB_1	DB, GC, C
	females	males	female	male	females	male	females	females
DN=D	69, 70,70	69, 67, 70	71	70	72, 71	69	64-71 (n=7)	62, 60
S_1N_1*		76	77				75-80 (n=5)	72, 70
S_1N_2*			78				76	
S_2N_1*	86, 87, 86	85, 87, 87	87		87, 88	86	85-87 (n=7)	84, 81
S_2N_2*	87, 87, 86	84, 87, 87	88		88, 89	86	85-88 (n=7)	84, 81
AS_1**		18	21				15-35 (n=5)	26, 24
AS_2**			26				17	
PS_2**	55, 57, 53	53, 60, 56	55		55, 58	55	52-60 (n=7)	56, 54
PS_2**	59, 56, 52	49, 59, 55	56		56, 61	54	53-60 (n=7)	58, 53

E. carpaticus males not found, but sperm cells were observed in one female from a Romanian population (Ciobanu et al. 2010)); it should be mentioned also that there are differences in average values of odontostyle (av. 40.7 (38–43 µm) *vs* av. 43.3 (39.5–47 µm) and tail length (av. 29.2 (25–35) *vs* av. 23.7 (21–29) µm), and c' value (c'= av. 0.7 (0.6–0.9) *vs* av. 0.6 (0.5–0.7); from *E. groenlandicus* by its shorter odontostyle (38–43 *vs* 44–53 µm), somewhat more anteriorly located guiding ring (24–28 *vs* 27–37 µm), narrower lip region (15–17.5 *vs* 19–22 µm), males present *vs* absent; from *E. macrodorus* this new species differs in having a longer ovarium and oviduct (206–218 *vs* 83–188 µm and 168–172 *vs* 97–159 µm, respectively (Thorne's specimens), longer uterus (220–346 *vs* 61–143 and 56–115 µm) and shorter prerectum (2.1–3.5 *vs* 3.9–5.8 anal body diam), tail somewhat longer (25–35 *vs* 18–24 and 22–28 µm) and differently shaped (bluntly conoid *vs* rounded to hemispherical), saccate bodies large elongated *vs* small round; males abundant *vs* males rare; longer tail in males (29–33 *vs* 18–22 µm, c=46.4–58.9 *vs* 67–100 and c'=0.7–0.8 *vs* 0.6) (Guerrero et al., 2007b, 2008); from *E. microdoroides* by its longer body in females (1.57–2 *vs* 0.94–1.29 mm), wider lip region (15–17.5 *vs* 13–14 µm), guiding ring located more anteriorly (24–28 *vs* 28–39 µm from anterior end), different shape of *pars refringens vaginae* (trapezoid *vs* rectangular), longer tail (25–35 *vs* 13–27 µm) and males with longer spicules (65–74 *vs* 45–50 µm).

The new species can be distinguished from the remaining three species of *E. macrodorus* group by its lip differentiation: lip region set off by depression *vs* offset by a distinct constriction. Further, it differs from *E. babakicus* by its longer body in female (1.57–2 *vs* 1.21–1.56 mm), ovaries longer (206–218 µm *vs* 39–63 µm), longer uterus (220–346 vs 130–175 µm) and tail (25–30 vs 16–22 µm); shorter prerectum (87–140 *vs* 151–232 µm or 2.1–3.5 *vs* 4.5–8.5 anal body diam. long), males with longer spicules (65–74 *vs* 49–61 µm) and narrower lateral chord (10–12 vs 15–20% of corresponding body diam.); different tail shape in first stage juvenile (straight *vs* ventrally curved); from *E. distinctus* the new species is differentiated by its longer odontostyle (38–43 *vs*

36 μm), more posteriorly located guiding ring (24–28 *vs* 21–23 μm), different structure of uterus (tripartite *vs* bipartite), saccate bodies present *vs* absent. Finally, the new species can be distinguished from *E. saxifragae* by a narrower lip region (15–17.5 *vs* 18–22 μm or 2.3–2.8 *vs* 1.8–2.3 odontostyle as lip region diam.), shorter pharyngeal expansion (av.121 (113–130) *vs* av.153 (144–162.5) and av. 147 (116–186) μm), shorter prerectum (87–140 *vs* 140–294 μm or 2.1–3.5 *vs* 4–8 anal body diam) and fewer ventromedian supplements (10–12 *vs* 13–16) (Popovici 1995, Guerrero et al. 2008).

Type-locality and habitat. Different types of vegetation from a polygonal polar desert on Bol'shevik Island, Severnaya Zemlya Archipelago, Russian Arctic (Table 1).

Type-material. Holotype, 5 paratype females, 4 paratype males and 2 juveniles deposited in the Nematode collection of the Institute of Biodiversity and Ecosystem Research, BAS; one female and one male paratypes each at the nematode collections of the following institutions: The Center of Parasitology of Institute for Problems of Ecology and Evolution, RAS, Russia and Plant Protection Service, Wageningen, The Netherlands.

Etymology. The species is named in honor of Dr. Olga Makarova (Institute for Problems of Ecology and Evolution, Russia) who is an outstanding biologist investigating polar habitats and has kindly provided us with numerous nematode materials from Arctic polar deserts.

Enchodelus groenlandicus (Ditlevsen, 1927) Thorne, 1939

http://species-id.net/wiki/Enchodelus_groenlandicus
Figs 7–11

Material examined. Ten females collected from Putorana Plateau, Russian Arctic (Table 1).

Measurements. See Table 4.

Description. *Female.* Nematodes of medium to large size, habitus from slightly curved ventrad to open C- shape after fixation. Cuticle with fine, but distinct transverse striations, especially visible at neck and on tail regions; 4–6 μm thick at postlabial region, 3–4 μm at mid-body and 7–8 μm on tail. Lateral chord narrow, 6–9 μm wide or occupying *ca* 9–13 % of mid body diam. Lip region rounded, offset by a depression, 2.3–3.1 times as wide as high. Amphidial fovea cup-shaped, located at level of labial depression, occupying 65% of lip diam. Cheilostom cylindrical. Odontostyle long, 2–2.5 times longer than lip region diam. or 2.2–2.7% of total body length. Odontophore distinctly flanged, 1.1–1.3 times as long as odontostyle. Guiding ring double, located 1.4–1.6 lip region diam. from anterior end. Pharynx attains full width at 56–64% of its length from anterior end. Pharyngeal characters are presented at Table 3. Cardia rounded measuring 6–10 × 15–17 μm. Genital system amphidelphic, both branches equally and well developed, anterior 277–370 μm, posterior 287–375 μm long. Ovaries relatively large, 142–303 μm long; oocytes firstly in two or more rows, then in a single row. Anterior and posterior oviduct 119–143 μm (n=9) and 119–153 μm (n=8) long, 1.6–1.9 and 1.6–2.0 times body diam. respectively, consisting of slender part and well developed *pars dilatata oviductus*. Sphincter distinct. Uterus thick walled, tripartite, consisting of

Table 4. Morphometrics for females of *Enchodelus groenlandicus* (Ditlevsen, 1927) Thorne, 1939. All measurements, unless indicated otherwise, are in µm (and in the form: mean±SD (range).

Characters	Russia – Putorana Plateau		Greenland	Spain	Albania	Iran
	Present study		Ditlevsen, 1927	Guerrero et al. 2008	Andrássy 2009b	Pedram et al. 2011
	DB_1	DB, GC, C				
n	7	3	1*	14	2	4
L (mm)	1.94±0.16 (1.8-2.16)	1.77, 1.70, 1.92	2.5	1.78±0.15 (1.57-2.07)	1.54-1.68	1.86±0.09 (1.76-1.97)
a	24.4±1.8 (21.7-25.9)	24.3, 25.9,	25	23.4±1.6 (21.3-25.3)	22-23	23.0±2.5 (20.3-26.0)
b	5.3±0.3 (5-5.6)	4.6, 4.7, 4.8	6	5.1±0.3 (4.5-5.5)	4.0-4.6	5.0±0.2 (4.6-5.1)
c	64.9±4.9 (59.9-70.8)	61.5, 52.4, 62.1	50	67.5±9.2 (53-83)	40-46	85.5±14.0 (73-104)
c’	0.6±0.1 (0.5-0.7)	0.6, 0.7, 0.7	0.7	0.7±0.1 (0.6-0.8)	0.7-0.8	0.5±0.1 (0.4-0.6)
V %	42.4±1.8 (40-44)	46, 43, 42	43	44.2±1.9 (41.6-49.4)	44-45	42.5±1.0 (41.5-44.0)
Lip region width	19.8±0.8 (19-20.5)	21, 21, 19	20	20.5±0.9 (19-22)	19-20	22.5±0.5 (21-23)
Odontostyle	46.7±0.4 (46-47)	47, 44, 43	48-49	49.3±2.3 (44-53)	50-51	48.5±0.5 (48-49)
Odontophore	49±0.2 (48.7-49)	50, 48, 55	49	50.4±2.9 (45-55)	52-54	52±1 (51-53)
Spear	95.6±0.3 (95-96)	97.5, 93, 98	98	100±4.1 (94-108)	102-106	102.5±1.0 (101-103)
Anterior end to guiding ring	30.4±1.9 (29-33)	30, 28, 30	29	32.8±2.4 (27-37)	-	-
Neck length	376.6±12.4 (361-398)	389, 361, 398	417	354±24.0 (322-401)	-	377.5±19.0 (350-392)
Width at pharynx base	68.5±3.9 (65-75)	69, 60, 62	-	66.0±9.0 (49-75)	-	78.5±5.0 (75-82)
Width at mid body	79.5±4.1 (75.5-83)	73, 66, 68	100	76.1±5.5 (67-87)	77-80	82.0±9.5 (68-89)
Prerectum length	185.6±10.6 (178-193)	187,-, 213	50	186±36 (116-252)	-	203.0±19.5 (176-223)
Rectum length	42.1±2.5 (39-44.5)	38, 46, 42	-	42.1±7.3 (27-52)	-	-
Tail	29.9±1.7 (28-32)	29, 33, 31	31	26.8±4.2 (22-37)	28-30	22.0±2.5 (19-24)

*followed by Guerrero et al. 2008

a wider proximal portion with distinct lumen, followed by a narrower median portion (43–115 µm (n=4)) and ending with a well developed spheroid *pars dilatata distalis*. Vagina extending inwards 42–53 *µ*m or 53–68 % of body diam., *pars proximalis* 25–30 µm × 21–22 µm, *pars refringens* with two trapezoid sclerotisations, with a combined width of 18–18.5 µm and length 6–8 µm (n=2) *pars distalis* 6 µm long (n=2). Vulva a transverse slit, pre-equatorial (40–47%). Eggs observed in eight females, measuring

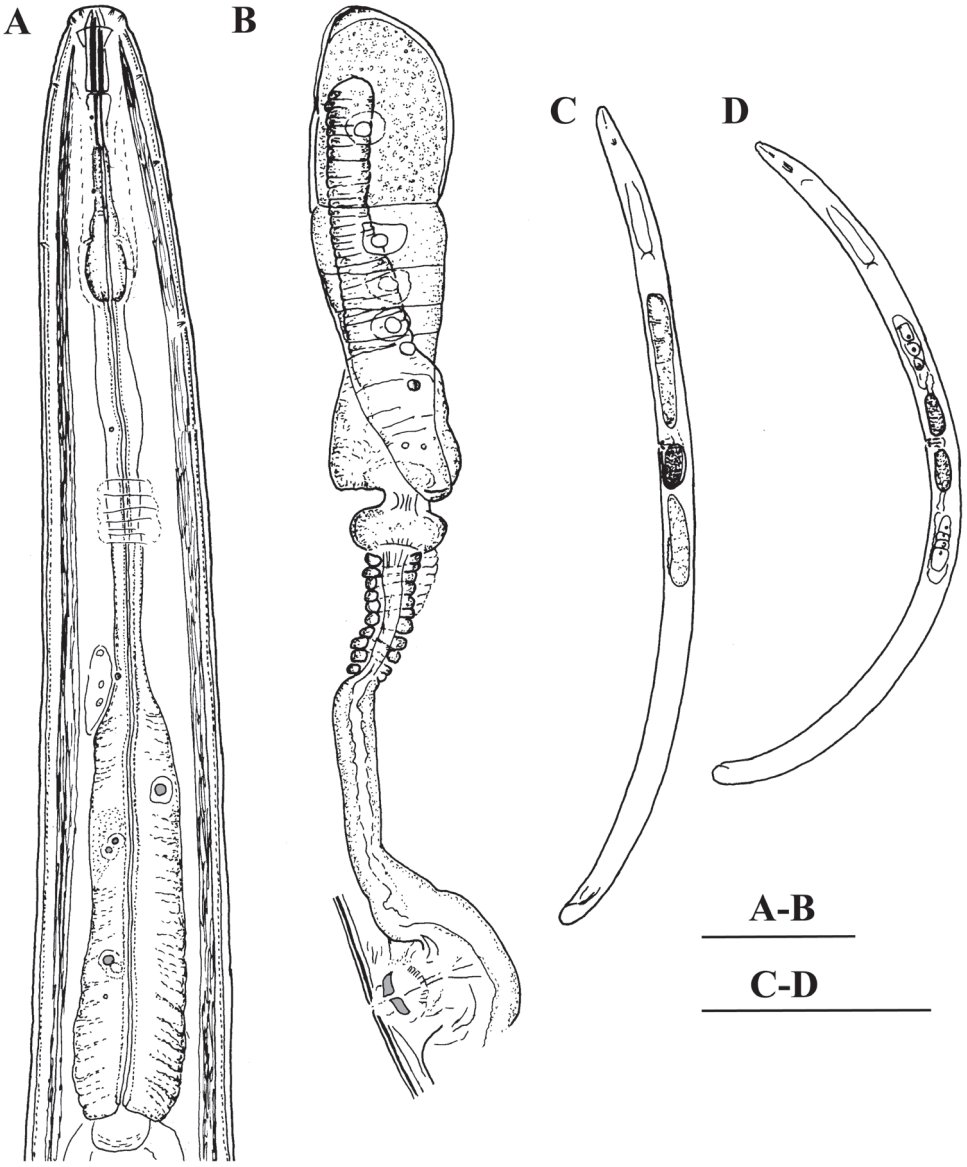

Figure 7. *Enchodelus groenlandicus.* **A–D** *Female* **A** Neck region **B** Anterior genital branch **C, D** Entire body. Scale bars: **A, B** 50 μm; **C, D** 500 μm.

96–109 × 43–64 μm, most frequently located in *pars dilatata oviductus* (n=6), rarely in uterus (n=2). Prerectum 3–4.5 anal diam. long, rectum 0.8–1.0 times anal body width. Tail hemispheroid. Numerous small elongated saccate bodies observed on tail, mostly on ventral side. Hyaline part of tail 8.0–10 μm thick or 25–33 % of total tail length.

Male. Unknown

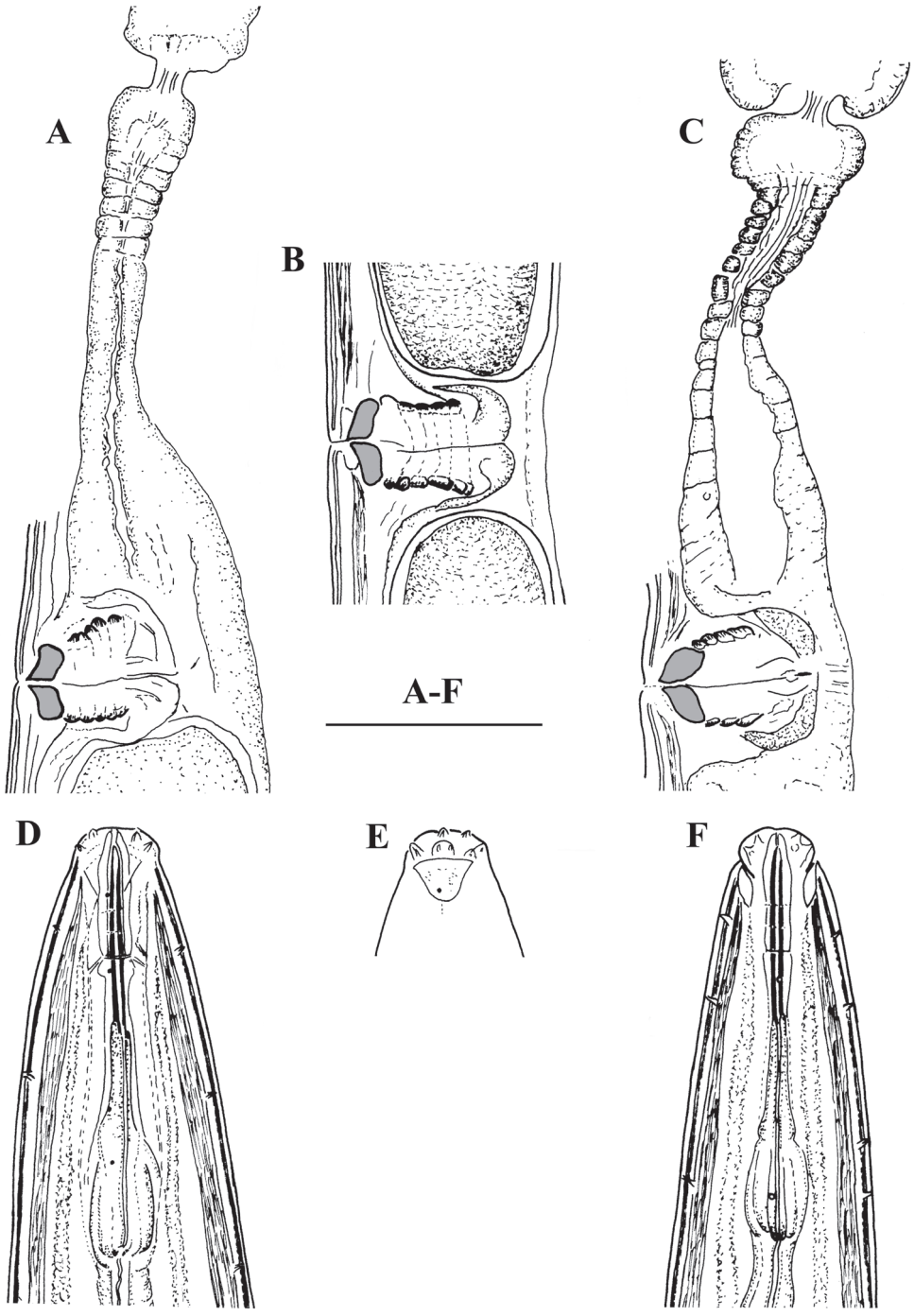

Figure 8. *Enchodelus groenlandicus.* **A–F** *Female* **A, C** Vulval region and uterus **B** Vulval region **D** Anterior region, lateral view **E** Amphidial fovea **F** Anterior region, ventral view. Scale bars: **A–F** 50 µm.

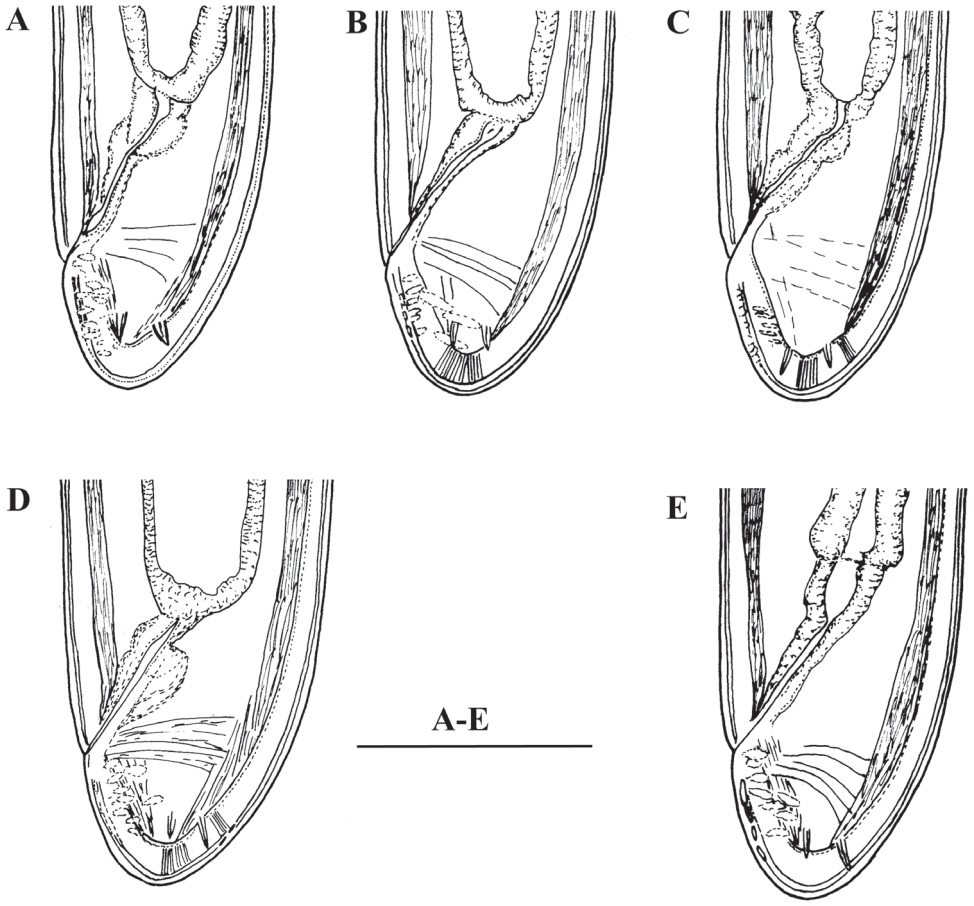

Figure 9. *Enchodelus groenlandicus.* **A–E** *Female* **A–E** Tail ends. Scale bars: **A–E** 50 μm.

Locality and plant associations. Different types of vegetation from a polygonal polar desert on Plateau Putorana, Russian Arctic (Table 1).

Remarks. The data on *E. groenlandicus* geographical distribution, *i.e.* the original description from Disko Island, Greenland (Ditlevsen 1927) and recent reports from Spain, Albania and Iran (Guerrero et al. 2008, Andrássy 2009b, Pedram et al. 2011) indicate a disjunctive type of range. It occurs at high altitudes 950 m to 2450 m a.s.l in Southern Europe and Iran, and at high latitudes in the polar region (Putorana Plateau and Greenland), Guerrero et al. (2008) hypothesize that such a distribution pattern might stem from quaternary glacial events. The specimens examined generally agree well with data reported for this species, although some differences occurred: the Arctic population has somewhat shorter odontostyles (43–47 *vs* 44–53 μm) and a more anterior position of the vulva (40–46 *vs* 41.5–49.4%, see Table. 4 for details); Iranian specimens had shorter female tails (19–24 *vs* 28–33 μm and c'= 0.4–0.6 *vs* 0.5–0.7). We consider the morphometric differences as representing intraspecific variation.

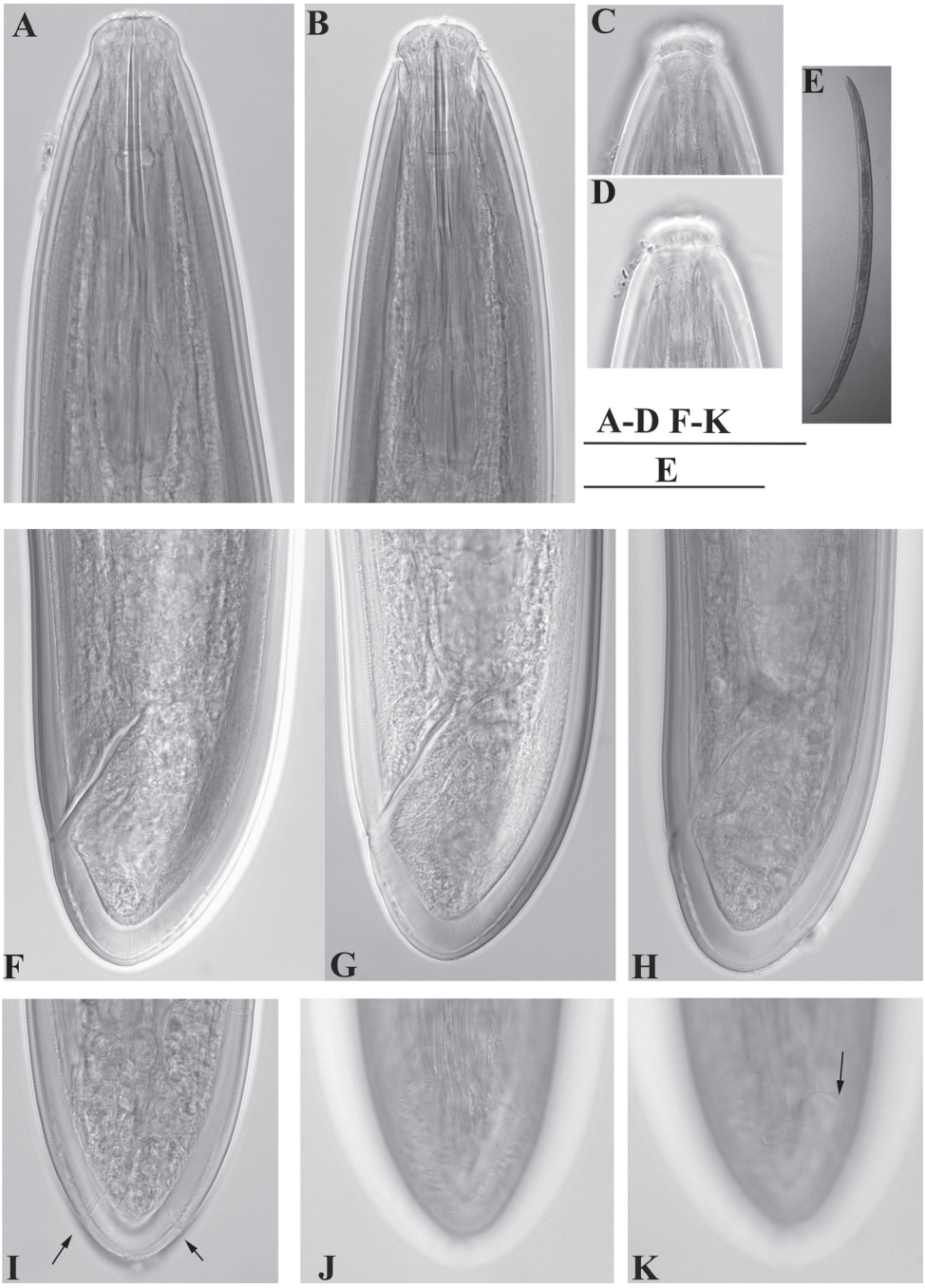

Figure 10. *Enchodelus groenlandicus.* **A–K** *Female*: **A, B** Anterior region **C, D** Amphideal fovea **E** Entire body **F–H** Tail ends **I** Subterminal caudal pores indicated by arrows **J** Tail with saccate bodies **K** Tail in ventral view, anus marked by an arrow. Scale bars: **A–D, F–K** 50 μm; **E** 1 mm.

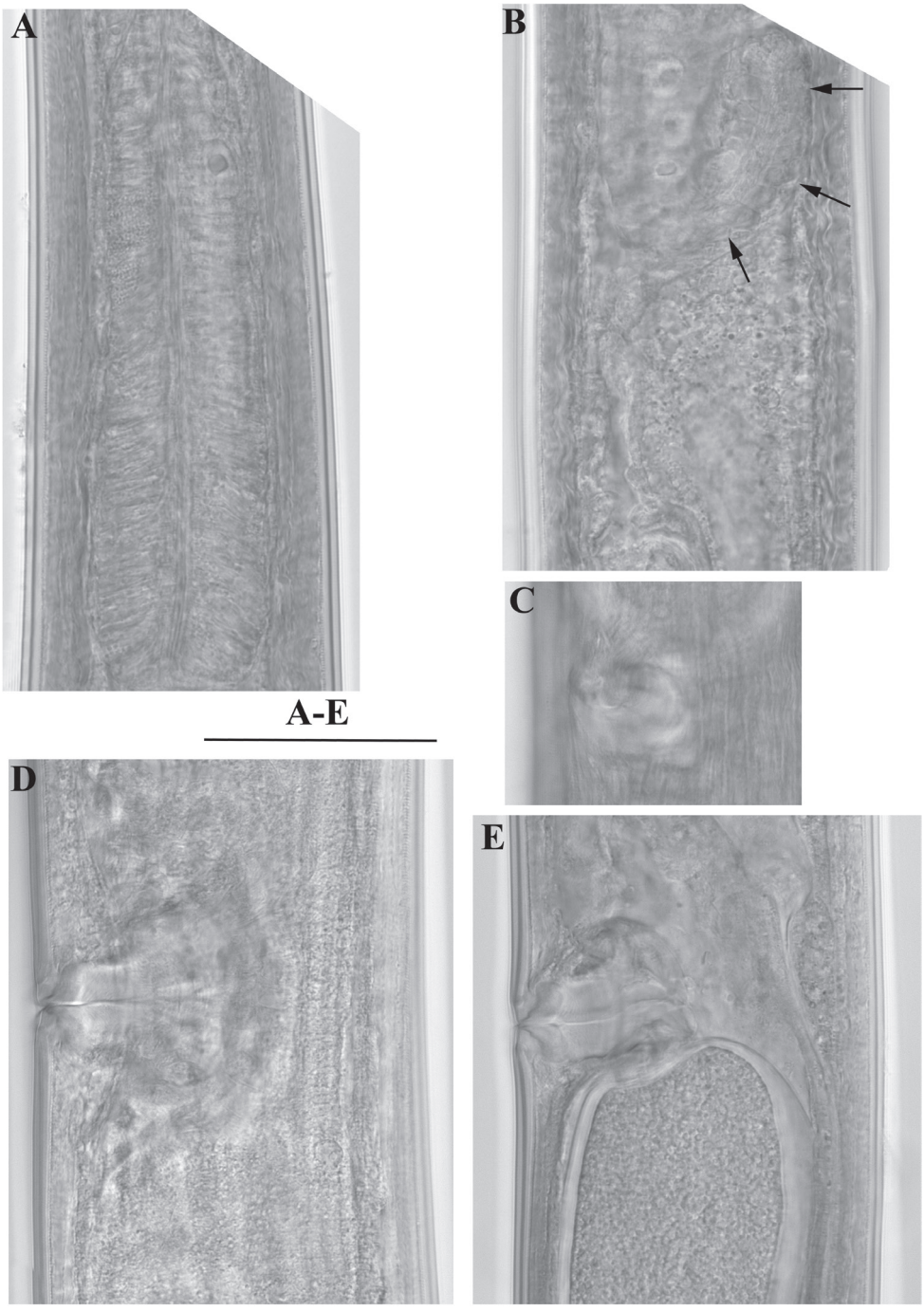

Figure 11. *Enchodelus groenlandicus.* **A–E** *Female*: **A** Pharyngeal bulb **B** *Pars dilatata distalis uteri* (arrows) **C** Vulval region in subventral view **D, E** Vulval region in lateral view. Scale bars: **A–E** 50 μm.

Identification key to species belonging to *E. macrodorus* group

1 Odontostyle ≤ 36 µm; uterus bipartite (♀ L=1.85 mm, a=20, b=5.1, c=58, c'=0.76, V=53%, Odontostyle=36 µm; ♂ unknown) (India) ..... ***E. distinctus*** **(Ahmad & Jairajpuri, 1980)**

– Odontostyle ≥37 µm; uterus tripartite **2**

2 Lip region separated by constriction **3**

– Lip region separated by depression..... **4**

3 Body long (>1.6 mm) (♀ L=1.8–2.38 mm, a=21–34, b=4.8–6.1, c=54–92, c'=0.6–0.9, V=44–50%, Odontostyle=38–45 µm; ♂ L=1.66–2.21mm a=24.4–32.7, b=5.1–5.9, c=53.2–68, c'=0.7–0.8, Odontostyle=27.5–40 µm, Spicules= 56–70 µm) (Romania, Spain)..... ***E.. saxifragae*** **(Popovici, 1995)**

– Body short (<1.6 mm) (♀ L=1.21–1.56 mm, a=20–25.5, b=3.0–5.0, c=60.5–92.5, c'=0.5–0.7, V=44–49%, Odontostyle=40–45 µm; ♂ L=1.31–1.53 mm, a=22.5–28, b=4.3–5.1, c=49–71.5, c'=0.5–0.9, Odontostyle=39–44 µm, Spicules=49–61 µm) (Iran)..... ***E. babakicus*** **(Pedram et al., 2009)**

4 Uterus short (1–2 times corresponding body diam.) (♀ L=1.38–1.92 mm, a=19–32, b=4.0–6.2, c=55–91, c'=0.5–0.7, V=37–47%, Odontostyle=37–44 µm; ♂ L=0.94–2.16 mm, a=19–39, b=3.6–6.0, c=41–100, c'=0.6–0.9, Odontostyle=24–33 µm, Spicules=46–70 µm) (Holarctic region)..... ***E. macrodorus*** **(de Man, 1880) Thorne, 1939)**

– Uterus long (> 2 times corresponding body diam.) **5**

5 Body length <1.3 mm; (♀ L=0.94–1.29 mm, a=19–28, b=3.5–5.6, c=47–73, c'=0.5–1.0, V=43–55%, Odontostyle=37–45 µm; ♂ L=1.24–1.28 mm, a=26–37, b=4.6–4.8, c=52–54, c'=0.7–0.8, Odontostyle=38–40 µm, Spicules = 45–50 µm) (India, Korea)..... ***E. microdoroides*** **(Baqri & Jairajpuri, 1974)**

– Body length >1.5 mm..... **6**

6 Dorsal cell mass near cardia present. (♀ L=1.59–1.87 mm, a=21.1–28.6, b=4.3–5.3, c=55.3–87.5, c'=0.5–0.7, V=41.7–49.7%, Odontostyle=39.5–47 µm) (Romania)..... ***E. carpaticus*** **(Ciobanu et al., 2010)**

– Dorsal cell mass near cardia absent..... **7**

7 Lip region narrow < 18 µm, males present (♀ L=1.57–2 mm, a=21.6–33.1, b=4.4–5.7, c=45.8–70.3, c'=0.6–0.9, V=45–51%, Odontostyle=38–43 µm; ♂ L=1.49–1.79 mm, a=19.6–29.8, b=4.4–5.4, c=46.4–58.9, c'=0.7–0.8, Odontostyle=39–44.5 µm, Spicules=65–74 µm) (Russia – Severnaya Zemlya Archipelago) ..... ***E. makarovae*** **sp. n.**

– Lip region wide, > 19 µm, males absent (♀ L=1.54–2.5 mm, a=20.3–25.9, b=4.0–6.0, c=40–104, c'=0.4–0.8, V=40–49%, Odontostyle=43–51 µm) (Greenland, Spain, Albania, Iran, Russia – Putorana Plateau)..... ***E. groenlandicus*** **(Ditlevsen, 1927)**

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RESEARCH ARTICLE

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Four new species of the leafhopper genus *Kapsa* Dworakowska from China (Hemiptera, Cicadellidae, Typhlocybinae), with a key to Chinese species

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Abstract

In the present paper, four new species, *Kapsa acuminata*, *K. quadrispina*, *K. puerensis* and *K. yanheensis* **spp. n.** from southwest China are described and illustrated, and a key to the species recorded from China is provided.

Keywords

Morphology, taxonomy, Erythroneurini

Introduction

The leafhopper genus *Kapsa* Dworakowska (1972) belongs to the tribe Erythroneurini (Typhlocybinae) with *Typhlocyba furcifrons* Jacobi, 1941 as its type species. Recent taxonomic work on the genus includes Chiang and Knight (1990), Dworakowska (1972, 1979, 1980, 1981a, 1981b, 1994), Dworakowska et al. (1978), Dworakowska and Sohi (1978), Sohi and Mann (1992) and Song and Li (2008). So far, twenty-four species are known in the world of which seven species of *Kapsa* have been recorded from

China in the above studies. In this paper, four new species from southwest China are described and illustrated and a key to males of Chinese *Kapsa* is given. All specimens examined are deposited in the collection of the Institute of Entomology, Guizhou University, Guiyang, China (GUGC) and British Museum Natural History (BMNH).

Taxonomy

***Kapsa* Dworakowska**
http://species-id.net/wiki/Kapsa

Kapsa Dworakowska, 1972: 402; 1978: 243; 1979: 22; 1980: 186; Chiang and Knight 1990: 215; Song and Li 2008: 389

Type species. *Typhlocyba furcifrons* Jacobi, 1941

Description. Dorsum beige, yellow or white. Vertex unicolorous or with pair of preapical spots or with large median apical spot. Scutellum pale with or without dark lateral triangles or entirely dark.

Head narrower than pronotum, fore margin weakly produced, broadly rounded. Forewing with outer apical cell short; hind wing submarginal vein not extended to wing apex.

Male pygofer lobe with oblique dorsolateral internal ridge, usually with sparse long fine setae on lateral surface; dorsal appendage movably articulated; ventral appendages absent. Subgenital plates with 2-6 basal macrosetae. Style apex with extension; preapical lobe prominent. Connective Y-shaped, with central lobe well developed. Aedeagus with or without processes, gonopore apical on ventral surface. Anal tube usual with basal processes.

The genus is similar *Tautoneura* Anufriev, 1969 externally (body slim, dorsum yellow or white, head and face narrow) but the forewing lacks the red dots found in *Tautoneura*. It also differs in having the male pygofer lobe with basolateral setae not distinctly enlarged, and the pygofer without ventral appendages. The genus is also similar to *Empoascanara* Distant, 1918 in the male genitalia although differing in having the subgenital plate microsetae on the dorsal margin not in groups and the style with a 2nd extension. It differs externally from *Emopoascanara* in its narrower head.

Distribution. India; Nepal; Sri Lanka; China (Taiwan, Sichuan, Guizhou, Yunnan); Vietnam; Indonesia; New Guinea.

Key to Chinese species of the genus *Kapsa* (males)

1 Aedeagus with processes (Figs 9, 15, 23, 31) **2**
– Aedeagus without processes **6**
2 Aedeagus with both basal and apical processes (Figs 15, 16) ..... ***K. quadrispina* sp. n.**
– Aedeagus either with basal processes or apical processes (Figs 9, 23, 31) **3**

3 Pygofer with dorsal appendage bifurcate (Figs 5, 27) **4**
– Pygofer with dorsal appendage not bifurcate (Figs 13, 20) **5**
4 Aedeagus with pereatrium and basal processes moderately long (Fig. 8) ..... ***K. acuminata* sp. n.**
– Aedeagus with preatrium and basal processes long (Fig.30) ..... ***K. yanheensis* sp. n.**
5 Aedeagus with processes placed apically on shaft, bifurcate near base (Figs 22, 23) ..... ***K. puerensis* sp. n.**
– Aedeagus with processes placed medially on shaft, not bifurcate ..... ***K. biprocessa* Song & Li**
6 Aedeagus with dorsal apodeme short and small, not expanded in lateral view ..... ***K. fangxianga* Song & Li**
– Aedeagus with dorsal apodeme large, greatly expanded in lateral view..... **7**
7 Pygofer dorsal appendage short, distinctly expanded at base ..... ***K. diasonica* Chiang & Knight**
– Pygofer dorsal appendage long, not distinctly expanded at base **8**
8 Gonopore long (as in Fig. 9) **9**
– Gonopore short (as in Figs 22, 23, 30, 31) **10**
9 Aedeagus with preatrium short ..... ***K. arca* Song & Li**
– Aedeagus with preatrium extremely long ..... ***K. elscinta* Chiang & Knight**
10 Aedeagal shaft slender and sinuate ..... ***K. dolka* Dworakowska**
– Aedeagal shaft broad and straight..... ***K. suaoensis* Chiang & Knight**

***Kapsa acuminata* sp. n.**
urn:lsid:zoobank.org:act:C3213F38-E901-470D-BF1C-0A6D218E5B5F
http://species-id.net/wiki/Kapsa_acuminata
Figures 1–10

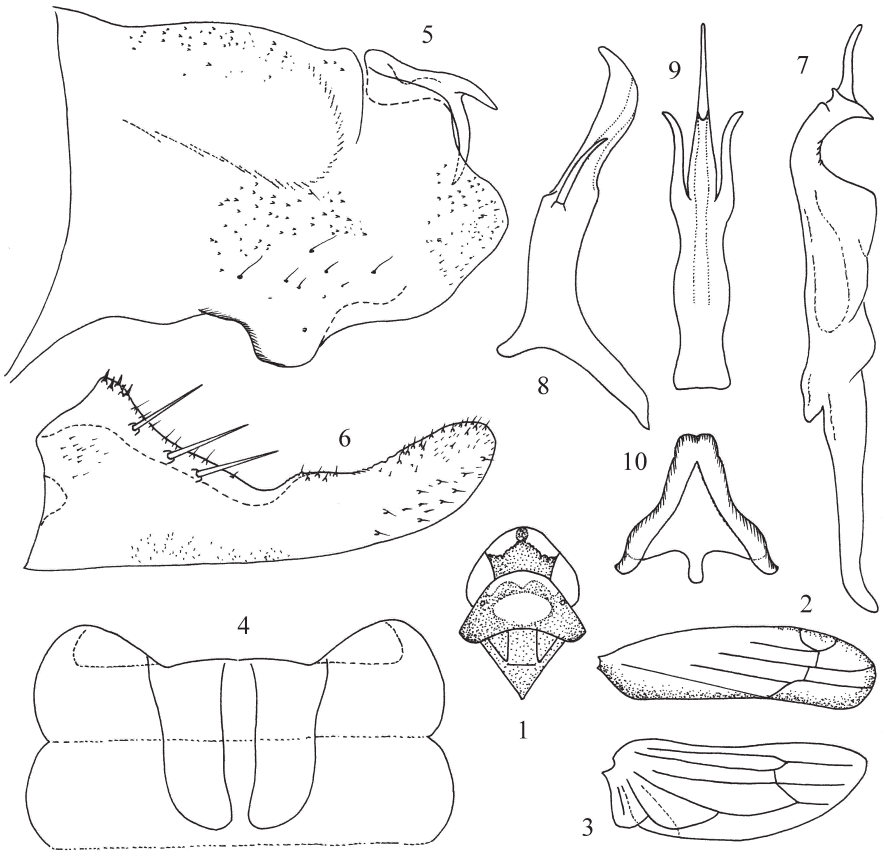
Description. Dorsum beige. Vertex with pair of milky yellow preapical spots; pronotum with anterior margin and median area ivory-white (Fig. 1). Forewing brownish yellow along inner and outer margin (Fig. 2).

Abdominal apodemes nearly reaching posterior margin of 4th sternite (Fig. 4).

Male pygofer with dorsal appendage bifurcate far from base (Fig. 5). Anal tube processes indistinct. Subgenital plate long, extended beyond pygofer apex, with three long macrosetae in oblique row (Fig. 6). Style elongate, preapical lobe distinct (Fig. 7). Connective Y-shaped with central lobe broad and arms short (Fig. 10). Aedeagal shaft laterally compressed distally, tapered to acute apex in ventral view (Fig. 9), with pair of processes at mid-length; gonopore long; preatrium long and dorsal apodeme short (Figs 8, 9).

Measurement. Body length males 2.3–2.5 mm.

Type material. *Holotype*, male, China: Guizhou Province, Mayanghe National Nature Reserve, 4 Oct. 2007, coll. Yue-hua Song. *Paratypes*: five males, same date as holotype.



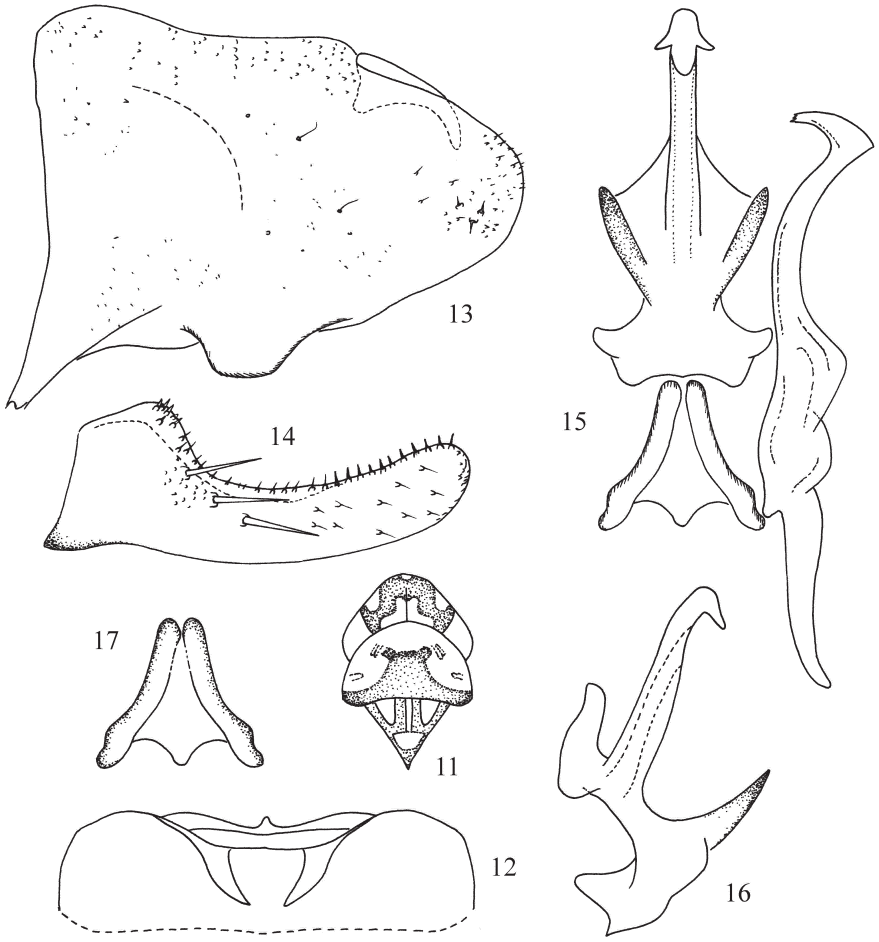
Figures 1–10. *Kapsa acuminata* sp. n. **1** Head and thorax, dorsal view **2** Forewing **3** Hind wing **4** Abdominal apodemes **5** Pygofer lobe, lateral view **6** Subgenital plate **7** Style **8** Aedeagus, lateral view **9** Aedeagus, ventral view **10** Connective

Remarks. The new species is similar to *K. biprocessa* Song & Li (2008), but can be distinguished mainly by the aedeagus with pair of basal processes close to shaft; the more acute apex of shaft in ventral view with the gonopore longer (Figs 8, 9).

Etymology. The specific epithet is derived from the Latin word "*acuminata*" which refers to the acuminate apex of aedeagus in ventral view.

***Kapsa quadrispina* sp. n.**
urn:lsid:zoobank.org:act:2C2E709E-3CC3-4DED-A4E4-CD274D604A76
http://species-id.net/wiki/Kapsa_quadrispina
Figures 11–17

Description. Dorsum beige. Vertex with large median apical spot, brownish yellow; pronotum with median area and posterior margin, brownish yellow; scutellum with



Figures 11–17. *Kapsa quadrispina* sp. n. **11** Head and thorax, dorsal view **12** Abdominal apodemes **13** Pygofer lobe, lateral view **14** Subgenital plate **15** Style, aedeagus and connective, ventral view **16** Aedeagus, lateral view **17** Connective.

basal triangles and T-shaped streak medially, milky yellow (Fig. 11). Forewing with brochosome field orange yellow.

Abdominal apodemes slim, not exceeding 3rd sternite (Fig. 12).

Male pygofer lobe with dorsal appendage slightly curved downward in lateral view (Fig. 13). Anal tube with processes very short, indistinct. Subgenital plate with three long macrosetae in oblique row and row of short stout setae along upper margin (Fig. 14). Style elongate, with apex slightly expanded; preapical lobe prominent (Fig. 15). Connective Y-shaped with central lobe broad and arms short (Fig. 17). Aedeagus with pair of basal atrial processes, well separated from shaft, the latter with pair of short apical processes; gonopore moderately long; preatrium broad and dorsal apodeme short (Figs 15, 16).

Measurement. Body length male 2.8 mm.

Type material. *Holotype*, male, China: Guizhou Province, Mayanghe National Nature Reserve, at light, 30 Sep. 2007, coll. Yue-hua Song. *Paratypes*: two females, same date as holotype.

Remarks. The new species is similar to *K. distalis* Sohi & Mann (1992), but the aedeagus has a pair of atrial processes and apical processes (Figs 15, 16) and the dorsal pygofer appendage is not apically bifurcate (Fig. 13).

Etymology. The specific name is derived from the Latin prefix "*quadri-*" and the Latin word "*spina*", referring to the aedeagus with four processes (Figs. 15, 16).

***Kapsa puerensis* sp. n.**
urn:lsid:zoobank.org:act:EBB34F64-A357-4FB2-94A9-206E38FBC92E
http://species-id.net/wiki/Kapsa_puerensis
Figures 18–24

Description. Dorsum brownish yellow. Pair of preapical patches on vertex and medial area of pronotum, milky yellow (Fig. 18). Forewing beige.

Abdominal apodemes large, broad, extended to 5th sternite (Fig. 19).

Male pygofer with dorsal appendage expanded medially and tapering towards apex (Fig. 20). Anal tube with basal processes long, slightly curved (Fig. 20). Subgenital plate with four long macrosetae in oblique row and row of short rigid setae along upper margin (Fig. 20). Style not long, apex extremely elongate, little less than half length of style; preapical lobe distinct (Fig. 21). Connective Y-shaped with central lobe broad and arms short (Fig. 24). Aedeagal shaft with pair of apical processes, bifurcate near base, upper branch short, tooth-like; lower branch very long; gonopore short (Figs 22, 23); dorsal apodeme slender in lateral view and pretrium expanded laterally at base (Figs 22, 23).

Measurement. Body length males 2.8–2.9 mm, females 2.9–3.0 mm.

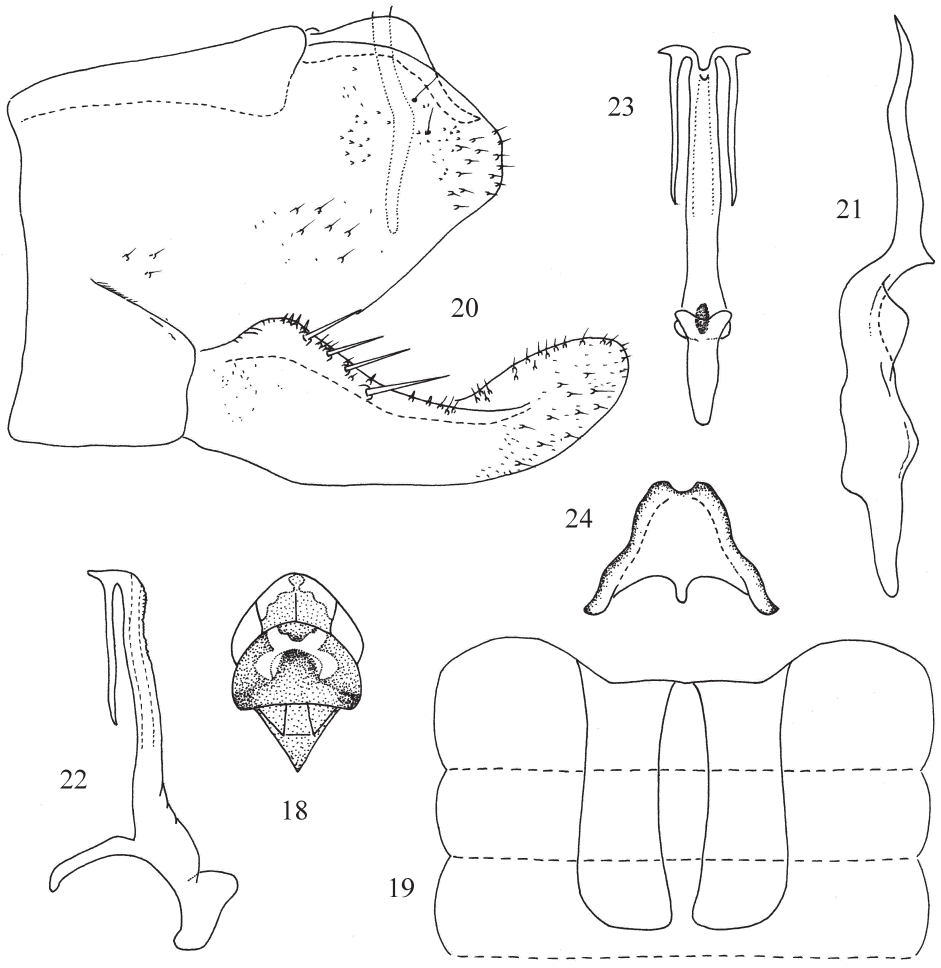
Type material. *Holotype*, male, China: Yunnan Province, Pu'er City, Meizihu Park, 23 July 2008, coll. Yue-hua Song. *Paratypes*: three males, two females, same date as holotype.

Remarks. The new species is similar to *K. decorata* Dworakowska (1981), but the aedeagus has branched apical processes, the lower one much longer than upper one (Figs 22, 23) and the preatrium is expanded laterally at base and the dorsal apodeme is slender (Fig. 22).

Etymology. The specific name is named for its type locality.

***Kapsa yanheensis* sp. n.**
urn:lsid:zoobank.org:act:B54E04DD-B5B8-4D6F-B11A-6A09489C75A9
http://species-id.net/wiki/Kapsa_yanheensis
Figures 25–33

Description. Dorsum beige. Vertex with large dark median apical spot; anterior margin of vertex and pronotum milky yellow.



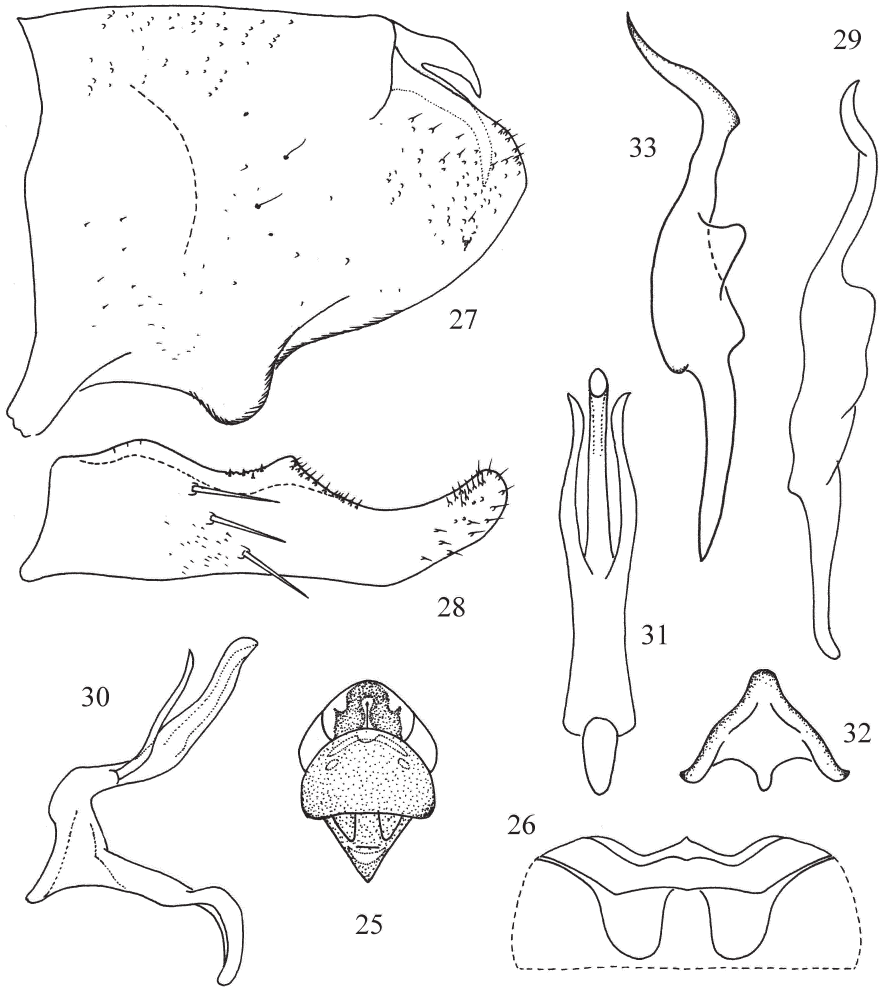
Figures 18–24. *Kapsa puerensis* sp. n. **18** Head and thorax, dorsal view **19** Abdominal apodemes **20** Male pygofer and anal tube process, lateral view **21** Style. **22** Aedeagus, lateral view **23** Aedeagus, ventral view **24** Connective.

Abdominal apodemes small, not exceeding 3rd sternite (Fig. 26).

Male pygofer lobe with dorsal appendage bifurcate near base, curved ventrally (Fig. 27). Anal tube processes indistinct. Subgenital plate with three long macrosetae in oblique row on lateral surface (Fig. 28). Style apex elongate, little sinuate; preapical lobe prominent (Fig. 29). Connective Y-shaped with central lobe broad and arms short (Fig. 32). Aedeagal shaft with pair of long basal processes, extending to near apex of shaft; gonopore short (Figs 30, 31); dorsal apodeme short and preatrium long (Fig. 30).

Measurement. Body length males 2.5–2.7 mm, females 2.6–2.8 mm.

Type material. *Holotype*, male, China: Guizhou Province, Yanhe County, Mayanghe National Nature Reserve, 30 Sep. 2007, coll. Yue-hua Song. *Paratypes*: four males, ten females, same date as holotype.



Figures 25–33. *Kapsa yanheensis* sp. n**. 25** Head and thorax, dorsal view **26** Abdominal apodemes **27** Male pygofer lobe, lateral view. **28** Subgenital plate **29** Style, lateral view **30** Aedeagus, lateral view **31** Aedeagus, ventral view **32** Connective, ventral view **33** Style, dorsal view.

Remarks. The new species is similar to *K. mingorensis* (Ahmed, 1970) (see also Dworakowska et al. 1978), but the aedeagus has a pair of basal processes, without apical vestiture (Figs 30, 31) and the preatrium is not expanded in lateral view (Fig. 30).

Etymology. The new species is named for its type locality: Yanhe.

Acknowledgements

We thank Mr. M. D. Webb (Natural History Museum, London, UK) for reading the manuscript and making some suggestions. The project was supported partly by

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REVIEW ARTICLE

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A new ant species of the genus *Tapinoma* (Hymenoptera, Formicidae) from Saudi Arabia with a key to the Arabian species

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Abstract

Tapinoma wilsoni **sp. n.** is described and illustrated from Saudi Arabia based on the worker caste collected from Al Baha, Saudi Arabia. It closely resembles *Tapinoma lugubre* Santschi 1917, from Zimbabwe in body measurements but can be distinguished from the latter species by the yellowish brown color; the yellowish pubescence, the two pairs of hairs present on the anterior part of the head; and the distinctly concave anterior clypeal margin. Biological and ecological notes of the new species are presented. An identification key to the workers of the Arabian species of the genus *Tapinoma* is given.

Keywords

Dolichoderinae, Kingdom of Saudi Arabia, Middle East, new species, Palaearctic, Al Sarawat Mountains

Introduction

The genus *Tapinoma* was established by Foerster (1850), with the type-species *T. collina* Foerster. The genus currently comprises 126 described species and subspecies (Bolton et

al. 2007) distributed worldwide in tropical and temperate regions (Brown 2000). Members of this genus are generalized foragers (Brown 2000), nesting in a wide variety of habitats, ranging from grasslands, open fields, woodlands, to inside buildings. The majority of species nest in the ground under objects such as stones or tree logs, other species build nests under bark of logs and stumps, in plant cavities, insect galls or refuse piles (Smith, 1965). *Tapinoma simrothi* Krausse in Saudi Arabia was observed nesting in a decaying carpet, among roots of graminae plants and attending unidentified mealybugs, and also coexisting with *Solenopsis saudiensis* Sharaf & Aldawood (Sharaf and Aldawood 2011).

Terminology used to characterize *Tapinoma* follows Bolton (1973, 1994): Mandibles with two or three large apical teeth, followed by a row of denticles; palp formula 6,4; clypeus with or without median anterior border emarginated; antennae 12-segmented; propodeum unarmed or rarely with a pair of blunt tubercles; petiole reduced or vestigial, overhung by the first gastral segment and not visible in dorsal view; only four gastral segments visible in dorsal view; fifth tergite reflexed below the fourth, visible in ventral view where it forms a transverse plate abutting the fifth sternite; the anal and associated orifices are thus situated ventrally.

Only two named species of *Tapinoma* have been recorded from countries occupying the Arabian Peninsula, *T. melanocephalum* (Fabricius) from Saudi Arabia and Oman (Collingwood 1985), UAE (Collingwood et al. 1997, Collingwood et al. 2011),Yemen (Collingwood and Agosti 1996, Collingwood and Van Harten 2001) and Socotra Archipelago (Collingwood et al. 2004); *T. simrothi* from Saudi Arabia (Collingwood 1985), Kuwait (Collingwood 1985, Collingwood and Agosti 1996), UAE (Collingwood et al. 1997, Collingwood et al. 2011), Qatar (Sharaf and Abdeldayem, in preparation), Oman (Collingwood 1988) and Yemen (Collingwood and Agosti 1996).

In the present study, a new species of the genus *Tapinoma* is described from Saudi Arabia and a key to the known Arabian species is given.

Materials and methods

Measurements and indices follow Bolton (2007).

Measurements

Total Length (TL): The total outstretched length of the ant from the mandibular apex to the gastral apex.

Head Length (HL): The length of the head capsule, excluding the mandibles; measured in full-face view in a straight line from the mid-point of the anterior clypeal margin to the mid-point of the posterior margin. In species where one or both of these margins are concave, the measurement is taken from the mid-point of a transverse line that spans the apices of the projecting portions.

Head Width (HW): The maximum width of the head behind the eyes, measured in full-face view.

Scape Length (SL): The maximum straight-line length of the scape, excluding the basal constriction or neck that occurs just distal of the condylar bulb.

Pronotal Width (PW): The maximum width of the pronotum in dorsal view.

Weber's length of Mesosoma (WL): The diagonal length of the mesosoma in profile, from the most anterior point of the pronotum to the posterior basal angle of the metapleuron.

All measurements are expressed in millimeters.

Indices

Cephalic Index (CI): HW divided by HL, × 100.

Dorsal Thoracic Index (DTI): In dorsal view, the length from the mid-point of the anterior pronotal margin to the midpoint of the metanotal groove, divided by PW, × 100.

Eye Position Index (EPI): In full-face view the straight-line length (parallel to the long axis of the head) from the most anterior point of the eye to the anterior clypeal margin, divided by the straight-line length from the most posterior point of the eye to the posterior margin, × 100.

Ocular Index (OI): Maximum diameter of eye divided by HW, × 100.

Scape Index (SI): SL divided by HW, × 100.

Illustrations

Specimens were photographed by using Digital color images that were created using a Leica DFC 425 camera in combination with the Leica Application Suite software (version 3.8). All images presented are available online at AntWeb (http://www.antweb.org).

Depositories of type specimens

BMNH	Natural History Museum, London, United Kingdom.
CASC	California Academy of Sciences Collection, San Francisco, California, USA.
KSMA	King Saud Museum of Arthropods, King Saud University, Riyadh, Kingdom of Saudi Arabia.
MCZC	Museum of Comparative Zoology, Cambridge, MA, USA.
MHNG	Muséum d'Histoire Naturelle, Geneva, Switzerland.
NHMB	Naturhistorisches Museum, Basel, Switzerland.
WMLC	World Museum Liverpool, Liverpool, United Kingdom.
SEMC	Division of Entomology (Snow Entomological Collections), University of Kansas Natural History Museum, Lawrence, Kansas, USA.

Results

***Tapinoma wilsoni* Sharaf & Aldawood, sp. n.**
urn:lsid:zoobank.org:act:2680E437-3109-4F74-B21D-5A99A8ABB8C0
http://species-id.net/wiki/Tapinoma_wilsoni
Figs 1–3

Holotype worker. Saudi Arabia, Al Baha, Al Sarawat Mountains, Dhi Ayn Archaeological Village, 19.92972°N, 41.44278°E, 741 m, 15.v.2011 (*M. R. Sharaf Leg.*); deposited in the King Saud Museum of Arthropods, College of Food and Agriculture Sciences, King Saud University, Riyadh, Kingdom of Saudi Arabia.

Paratype workers. 29 workers, same locality as holotype, deposited as follows: 1 in **MHNG** (Dr Bernhard Merz); 1 in **NHMB** (Mrs. Isabelle Zürcher-Pfander); 1 in **CASC** (Dr Brian Fisher); 1 in **MCZC** (Dr Stefan Cover); 2 in **WMLC** (Tony Hunter), 1 in **BMNH** (Mr. Barry Bolton); 1 in SEMC (Prof. Michael S. Engel) the remaining specimens in **KSMA** (M. R. Sharaf).

Figure 1. Lateral view of paratype worker of *Tapinoma wilsoni* sp. n. (CASENT0263919)

Figure 2. Dorsal view of paratype worker of *Tapinoma wilsoni* sp. n. (CASENT0263919)

Additional paratype workers. Saudi Arabia, Al Baha, Dhi Ayn Archaeological Village, 19.92976°N, 41.44187°E ± 50 m, 23.ix.2011 *(B.L. Fisher Leg.)* 4 deposited in **CASC.**

Measurements. Holotype: TL: 1.84, HL: 0.51, HW: 0.41, SL: 0.46, PW: 0.29, WL: 0.56, EL: 0.11. Indices: CI: 80, SI: 112, OI: 27, EPI: 71, DTI: 134.

Paratypes: TL: 1.56-1.84, HL: 0.49-0.53, HW: 0.36-0.42, SL: 0.35-0.51, PW: 0.25-0.31, WL: 0.49-0.63, EL: 0.09-0.14. Indices: CI: 73-84, SI: 105-133, OI: 22-33, EPI: 67-82, DTI: 114-145 (11 measured).

Description of worker. Head distinctly longer than broad with feebly convex posterior margin and sides; anterior clypeal margin broadly and distinctly concave; scapes, in full-face view, surpassing posterior margin of head by about 1/6 of its length; all funicular segments clearly longer than broad; eyes relatively large (OI 22-33) with 8 ommatidia in the longest row; mandibles large, armed with two distinct apical teeth followed by two smaller teeth, the third tooth being smaller than the fourth; the remaining masticatory margin equipped with several indistinct and tiny denticles; mandibles with several long yellow hairs; head pilosity a fine, whitish, appressed pubescence; promesonotum in profile straight or feebly convex; metanotal groove indistinct; propodeum in profile with the transition from dorsum to declivity sharply defined, the declivity concave and the angle with a raised apex; body pilosity restricted to two pairs of setae on dorsum of head, located close to antennal

Figure 3. Frontal view of paratype worker of *Tapinoma wilsoni* sp. n. (CASENT0263919)

insertions and at the level of the anterior eye margin, none on mesosoma, one pair on second and third gastral tergites (absent in some individuals), apex of gaster with several pairs of long hairs; body very finely and densely shagreenate; mesosoma dull, head and gaster more or less shining. Color brownish yellow or yellowish with very faint brownish tint on dorsum of head, appendages clear yellow.

Etymology. A patronymic name honors Prof. Edward O. Wilson in recognition of his valuable contribution to the science of myrmecology over several decades.

The following key separates the members of the genus *Tapinoma* hitherto known from the Arabian Peninsula, including *T. wilsoni*.

Key to the Arabian species of the genus *Tapinoma*

1 Larger species, TL more than 2.0 mm; color darker, uniformly blackish brown or black.....***simrothi* Krausse**

– Smaller species, TL less than 2.0 mm; uniformly pale yellow or brownish yellow, or at least with gaster yellow **2**

2 Propodeum in profile with the transition from dorsum to declivity sharply defined, the declivity concave and the angle with a raised apex; brownish yellow or yellowish with very faint brownish tint on head dorsum, appendages clear yellow ..... ***wilsoni* sp. n.**

– Propodeum in profile with the transition from dorsum to declivity no more than a rounded angle; head and mesosoma dark yellowish-brown, gaster yellow ..... ***melanocephalum* (Fabricius)**

Discussion

Tapinoma wilsoni appears most similar to *T. lugubre* Santschi, 1917, which was described from Zimbabwe. The two species are similar in size (TL 1.50–1.80) and both have the propodeum in profile with the transition from dorsum to declivity sharply defined, the declivity concave, and the angle with a raised apex. *Tapinoma wilsoni* can be easily separated from *T. lugubre* by the following characters: color brownish yellow or yellowish with fine brownish tint on head dorsum, appendages clear yellow, while *T. lugubre* is much darker brown or dull yellowish black, with occiput and gaster blackish. In *T. wilsoni*, the scape surpasses the posterior margin of head by about 1/6 of its length, whereas in *T. lugubre*, the scape surpasses the posterior margin of head by about 1/4 not similar in formatting to 1/6 in the above line!. In addition, *T. wilsoni* has the anterior clypeal margin distinctly concave, while in *T. lugubre* the middle of the anterior clypeal margin is shallowly concave. Moreover, *T. wilsoni* has two pairs of setae on the dorsum of the head, one close to antennal insertions and the other at the level of the anterior margin of eyes and several pairs on clypeus; whereas *T. lugubre* lacks hairs on the dorsum of the head. *T. wilsoni* can be easily separated from other Arabian species by the concave propodeal declivity and the well-defined angle between dorsum of propodeum and declivity.

Habitat and biology. The specimens of *T. wilsoni* were found foraging on the ground, and coexisting with the ant species *Carebara abuhurayri* Sharaf & Aldawood, *Tetramorium sericeiventre* Emery, *Pheidole minuscule* Bernard, *Pheidole* sp., *Monomorium destructor* (Jerdon), *Monomorium exiguum* (Forel), *Monomorium* sp., and *Crematogaster* sp. The type locality (Fig. 4) of this new species is a semi isolated area which is completely surrounded by high mountains and largely under banana cultivation. The new species was collected at the base of banana trees. Due to continuous irrigation of the banana plantations, the soil is moist throughout the year. The type locality still has a diversity of native plants as well as many other cultivated species, especially date palm, *Ficus* trees, alfalfa and some lemon trees. Numerous small streams drain this area.

Tapinoma wilsoni is the first new species to be described in the genus since Collingwood's (1985) review of the Arabian ant fauna. We believe that the Mountains of Al Sarwat and Asir (southwestern region of the Arabian Peninsula) may yield a wealth of undescribed ant species.

Figure 4. Type Locality Dhi Ayn Archaeological Village, Al-Baha Province, Saudi Arabia. (Brian Fisher photo)

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On immature and adult forms of *Trichognathus marginipennis* Latreille, 1829 (Coleoptera, Carabidae, Galeritini)

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Abstract

The pupa of *Trichognathus marginipennis* Latreille, 1829 is described for the first time and the adult is redescribed. Habitus and important structures of larva, pupa and adult are illustrated. This work improves the knowledge on immatures and adults of *T. marginipennis*.

Keywords

Trichognathus, Galeritini, biology, Brazil, immatures, taxonomy

Introduction

Trichognathus marginipennis Latreille, 1829 is the only species in the monobasic genus. Reichardt (1964) considered *T. cinctus* Chaudoir, 1848 and *T. immarginipennis* Steinheil, 1875 as variants of *T. marginipennis* and synonymized the three names. A Neotropical precinctive, the known geographical range of this species includes the South American countries of Venezuela, Brazil, Colombia, Peru, Bolivia, Paraguay and Argentina, with all localities being east of, or on the lower eastern slopes of, the Andes mountain range.

Reichardt (1967), in his magisterial taxonomic monograph of the American Galeritini redescribed the adult stages of *Trichognathus* Latreille and its single species, *T. marginipennis*. Ball (1985), published a study of the galeritine genera, in-

cluding *Trichognathus,* featuring characteristics of mandibles and ovipositors, two character systems that Reichardt had not studied. These features and others were illustrated with partially labeled scanning electron microscope images, *Trichognathus marginipennis* was again redescribed in a study about carabids of Colombia (Martinez 2005). Hunting (2008) also included this species in his study of the internal female genital system of galeritines.

The knowledge of immatures of Galeritini is very incipient. According to Arndt and Drechsel (1998), the few studies conducted on larval and pupal stages were related to *Galerita* species: *G. lecontei* Dejean, 1831 by Sallé (1849); *G. nigra* Chevrolat, 1861 and *G. simplex* Chaudoir, 1852 by Candèze (1861); *G. janus* (Fabricius, 1792) by Schaupp (1882); a redescription of *G. janus* by Kirk (1980); and the description of the last instar larvae of *G. brasiliensis* Dejean, 1826 and *G. carbonaria* Mannerheim, 1837 by Costa et al. (1988). Some notes about larval characteristics of Galeritini were made by van Emden (1942) and others by Thompson (1979) based on *G. lecontei* and *G. bicolor* Drury, 1773. Arndt and Drechsel described in 1998 the third instar larva of *Trichognathus marginipennis* and compared it with *Galerita* larvae in general.

In relation to the pupal stage, only that of *Galerita carbonaria* was described by Costa et al. (1988).

In the present study, the pupa of *Trichognathus marginipennis* is described for the first time and is compared with that of *Galerita carbonaria*. The adults of *T. marginipennis* are redescribed and details of external structures, including metathoracic wing venation, are illustrated, as well as male and female genitalia. The larva is compared with a previous description (Arndt and Drechsel 1998) and the differences noted.

Material and methods

Dozens of *Trichognathus marginipennis* (adults and larvae) were collected on July 31, 2008, on the sandy banks of the Rio Verde at Fazenda Soledad (Fig. 9c) in Campo Novo do Parecis, Mato Grosso, Brazil, after sunset.

The larvae and adults were transported to the lab in single plastic capped pots with some sand as substrate. The larvae were kept in the laboratory to obtain the pupae and the adults. Reared adults confirmed that the larvae and adults collected together are conspecific.

At the laboratory, each larva was transferred to a plastic covered pot approximately 8cm in diameter and 12cm in height containing medium-grained sand as substrate. Larvae of *Tenebrio* sp. (Tenebrionidae) were used as food, but as they were very large it was necessary to cut them into pieces and these were offered on tweezers to the carabid larvae. The adults were transferred to a large glass bowl (15cm in diameter and 9cm in height) with the same substrate used for the larvae; a large Petri dish (16cm diameter) was used as cover.

In order to fix the pupae, they were quickly boiled in water to extend them and to prevent the appearance of roughness when transferred to alcohol. Five larvae, two

pupae and six adults were fixed and deposited in MZSP (Museu de Zoologia da Universidade de São Paulo) collection. All the examined material is deposited in MZSP.

For illustrations, the pupa was placed in a transparent container with alcohol gel. The alcohol gel is more viscous and prevents the specimen from changing position. A stereomicroscope with drawing tube was used. The pencil sketches were scanned and digitally redesigned with Adobe Photoshop CS4 and Adobe Illustrator CS4.

The same process for the illustration of pupa was used to prepare the larvae.

The living animals were photographed with a Canon Rebel XT DSLR camera with Canon EF 100mm 2.8 Macro lenses; a Canon Speedlite 430EX was used, too. Some reflectors made of paper were placed beside the specimen to improve the lighting.

The photo of the lateral view of the adult´s pronotum and head, as well as external views of the female genitalia, were made from pinned specimens of the MZSP collection using a Leica M205C stereomicroscope with a Leica DFC295 camera coupled. The photos of the different layers were combined with the Helicon Focus software or Leica Application Suite (Version 3.4.1). The same equipment and process was used to photograph the larva. The detail of the mandible was photographed with a Nikon Coolpix 4500 digital camera on the ocular of a Zeiss Axioscope 20 microscope.

Terms are based on Reichardt (1977) for general morphology, Snodgrass (1935) and Ball et al. (2011) for the mouthparts, Kukalová-Peck and Lawrence (1993) for the metathoracic wing, Deuve (1993) for the male genitalia, and Hunting (2008) for female genitalia.

The *Galerita carbonara* immature characters were based on the description and drawings by Costa et al. (1988).

Descriptions

***Trichognathus marginipennis* Latreille, 1829**
http://species-id.net/wiki/Trichognathus_marginipennis

Pupa. (Figs 1b–d, 7e–g) Body length: 11.0–12.0 mm.

Adecticous, exarate. Yellowish white with legs long and thin, antenna with two setae at base of scape. Antenna long, longer than half body length, folded posteriorly and fitted at inferior margin of eye, directed through ventral surface of legs. Eyes prominent, each about ¼ width of head. Labrum with rounded anterior margin. Mandible relatively long and markedly sclerotized at apex. Pronotum subtrapezoidal, anterior margin prominent and rounded at middle; many widely spaced setae, these more concentrated near margins. Mesonotum wider than pronotum with setae at middle, these more concentrated near base. Metanotum longer than mesonotum; higher concentration of setae on median region; metathoracic legs longer than abdomen. Abdomen with eight segments visible in dorsal view. Five pairs of lateral projections, wide at base, extended over a narrow stalk, widened slightly at apex, with a pair of short setae. The first lateral projection at junction of first and second visible abdominal segments,

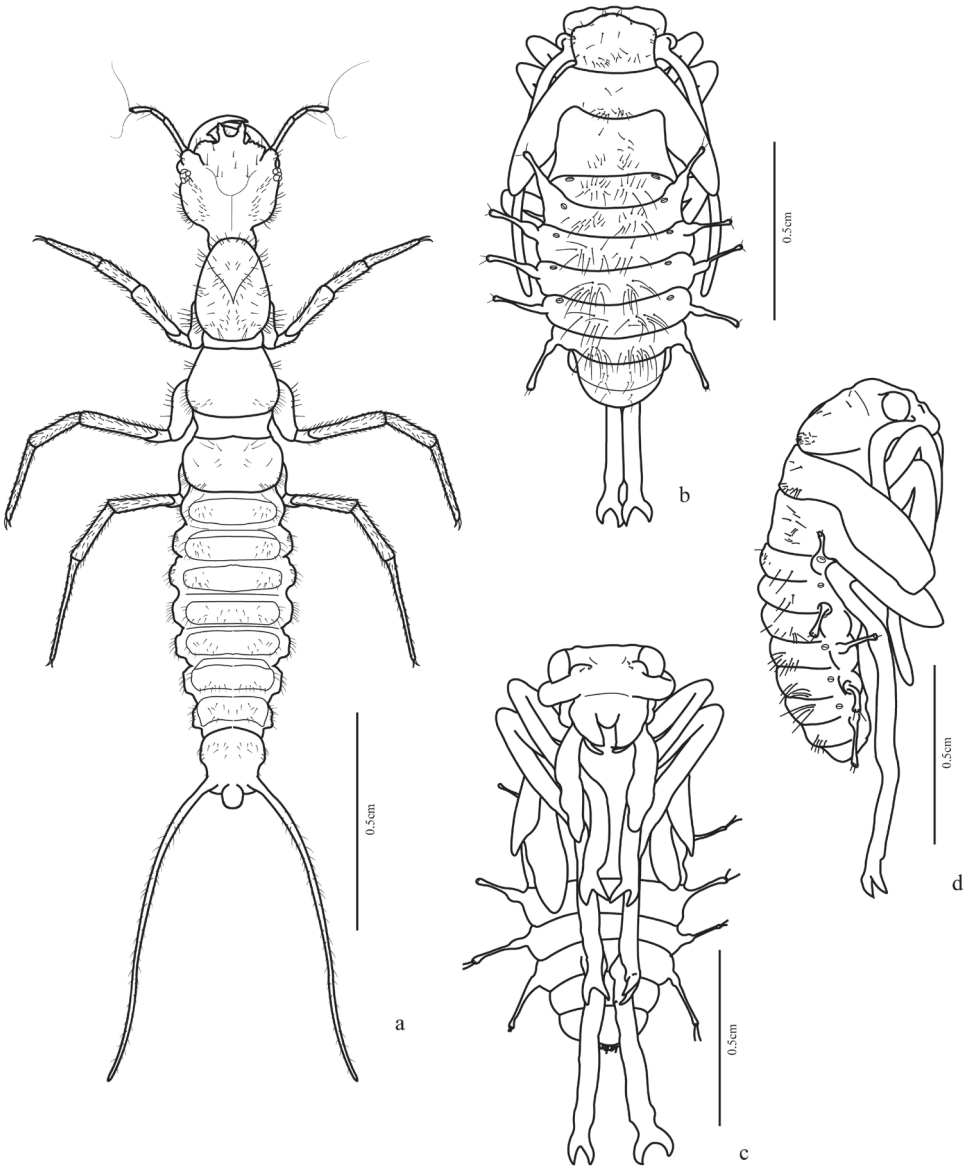

Figure 1. *Trichognathus marginipennis*: **a** habitus of third instar larva in dorsal view; habitus of pupa **b** dorsal view **c** ventral view **d** lateral view.

second from third segment, third from fourth and so on until sixth segment. Terga one to six dorsally with a marked concentration of long setae, these formed in two groups close to the midline. Segments seven and eight with many fewer setae. Spiracles visible in segments one to six, above the base of the lateral projections.

Adults (Figs 2a–f, 3a–j, 4a–e, 5a–h, 6a–d, 7b–d, 8a, 8f, 9a). Body length**:** 16–18.5mm. Body form: dorso-ventrally depressed.

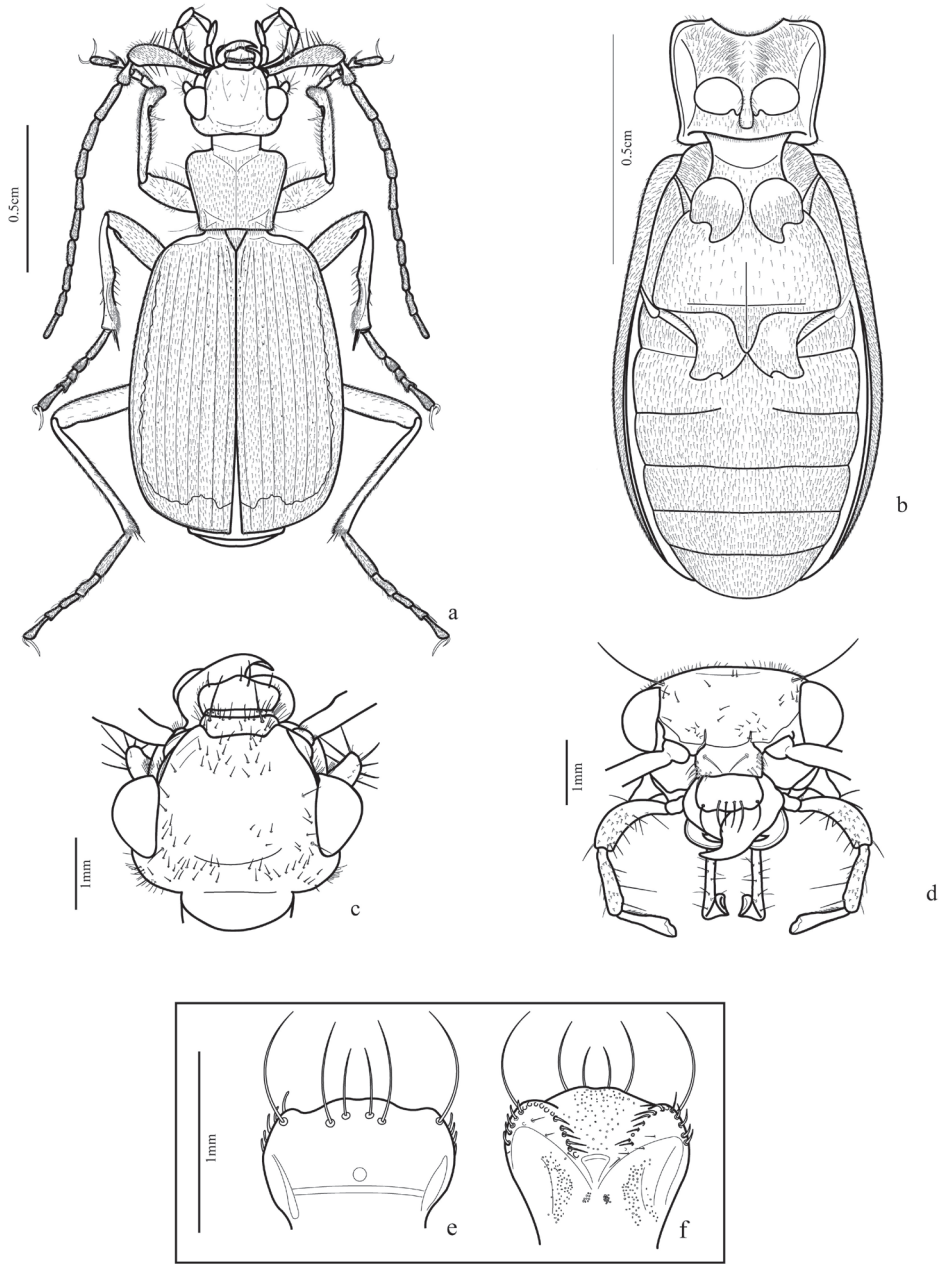

Figure 2. *Trichognathus marginipennis* (adult male): **a** habitus dorsal **b** thorax and abdomen in ventral view **c** head in dorsal view **d** head in front view; **e**. labrum, dorsal view **f** epipharynx, ventral view.

Color: head and pronotum from yellowish-brown to dark-brown; elytra dark-greenish with lateral margins and apex yellowish (Fig. 7b), legs from light to dark-brown, femora the same color as pronotum, some specimens with distal third darker;

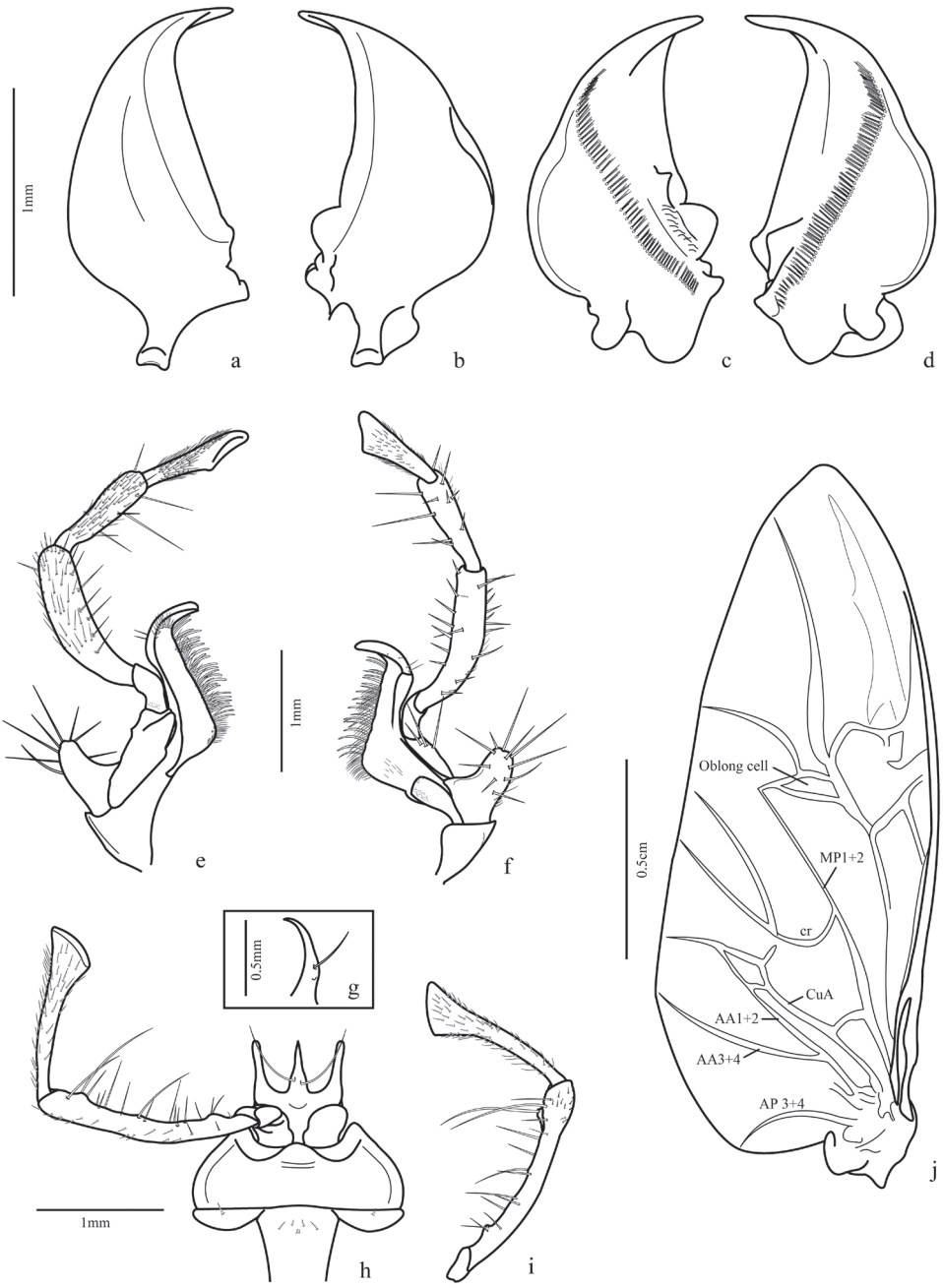

Figure 3. *T. marginipennis*, male: **a** left mandible in dorsal view **b** right mandible in dorsal view **c** right mandible in ventral view **d** left mandible in ventral view; maxilla **e** dorsal view; f. ventral view **g** glossa in lateral view **h** labium in ventral view **i** labial palp in dorsal view **j** hind wing – **AP**: anal posterior **AA** anal anterior **CuA** cubitus anterior **MP** media posterior.

Vestiture: integument covered dorsally and ventrally with testaceous setae; those of antennae and especially the scape, noticeably longer and more robust than on the other segments.

Head (Figs 2c–d, 7d): wider behind eyes; two pairs of long orbital setae, short scattered dorsal setae, sparser at middle ventrally, suborbital zone with an elevation near the inner margin bearing 5-10 thick setae, like those of scape and some sparser and shorter. Gula glabrous.

Antenna (Fig. 2a): long (approximately $^{2}/_{3}$ of the body length) and covered with short setae; antennomere 1 very long, as long as antennomeres 3 and 4 together, robust, club-shaped bearing long ventral thick setae; antennomere 2 short widened at apex**,** with thick ventral setae, antennomeres 3-11 setiform.

Labrum (Figs 2e–f): subrectangular, lateral margins rounded, lobed anteriorly; six long apical setae: one on each angle and four near middle. Epipharynx with two rounded rows of anterior parapedial setae converged medially, each row bearing approximately 13 setae; median region with thin setae near the thick ones.

Mandibles asymmetrical (Figs 3a–d): incisor region 3-4 times longer than molar region, terebral margin smooth, scrobe glabrous, anterior retinacular tooth prolonged ventrally; ventral groove (fig. 8f) crosses entire mandible with many ventral microtrichia inserted in each puncture.

Maxilla (Figs 3e–f): basistipes with lobular projection and about ten spine-shaped setae and a few thin setae; lacinia with tooth-shaped apex with setae concentrated on inner margin and a row of thicker setae, basal pubescence present; galea two segmented, basigalea longer than distigalea with some setae; palpifer with three thick spine-shaped setae; palpomere 1 with one seta and many punctures near the base, palpomeres 2 and 3 with fine pubescence and ventral spine-like setae; palpomere 4 securiform and covered with fine pubescence.

Labium (Figs 3g–i): submentum-mentum suture present; mentum transverse, emarginate, its lateral lobes with acute apices and rounded tooth between them, palpiger glabrous, longer than palpomere 1, palpomere 2 longer than 3, covered with setae and some long ventral ones; palpomere 3 securiform and covered with fine pubescence; prementum with each paraglossa narrow, separated from glossal sclerite, latter unciform, upwardly directed (Fig. 3g) with two long setae ventrally, on proximal third.

Prothorax (Figs 2a–b, 7d): subtrapezoidal, height in lateral view similar to width in dorsal view (pronotum slightly convex and prosternum markedly convex), anterior margin slightly larger than posterior one, anterior angles more widely rounded than posterior ones; pronotum covered with fine setae, one or two longer setae on the anterior third of the margins and another one next to posterior angles. Proepisternum with short setae near anterior margin. Prosternum covered with many thick setae and a few thin ones, high concentration of thick setae near the midline. Proepimeron dark with few sparse thin setae.

Mesothorax (Fig. 2b): with mesosternum darker laterally, covered with setae; mesepisternum subrectangular, dark, with margin adjacent to mesocoxae wider than its opposite and covered with thin setae; mesepimerum dark and usually glabrous.

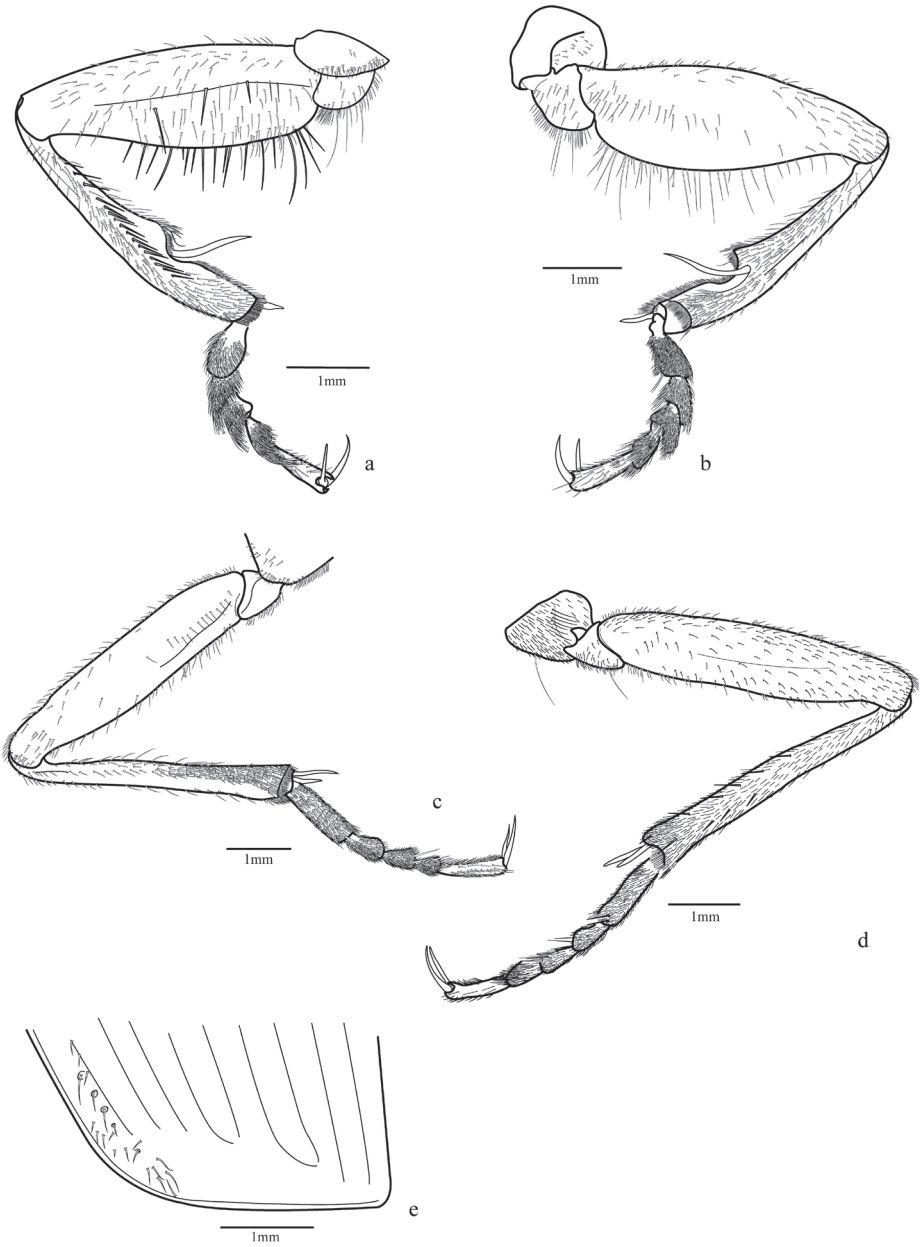

Figure 4. *T. marginipennis,* male. Fore leg **a** external view **b** internal view; median leg **c** internal view **d** external view **e** elytra apex.

Metathorax (Fig. 2b): metasternum wide, darker laterally, pubescence more concentrated laterally and near posterior margin; metepimeron elongate, dark and glabrous with blunt and wide proximal portion that partially covers ventrite I, middle region more tapered and wide inner margin.

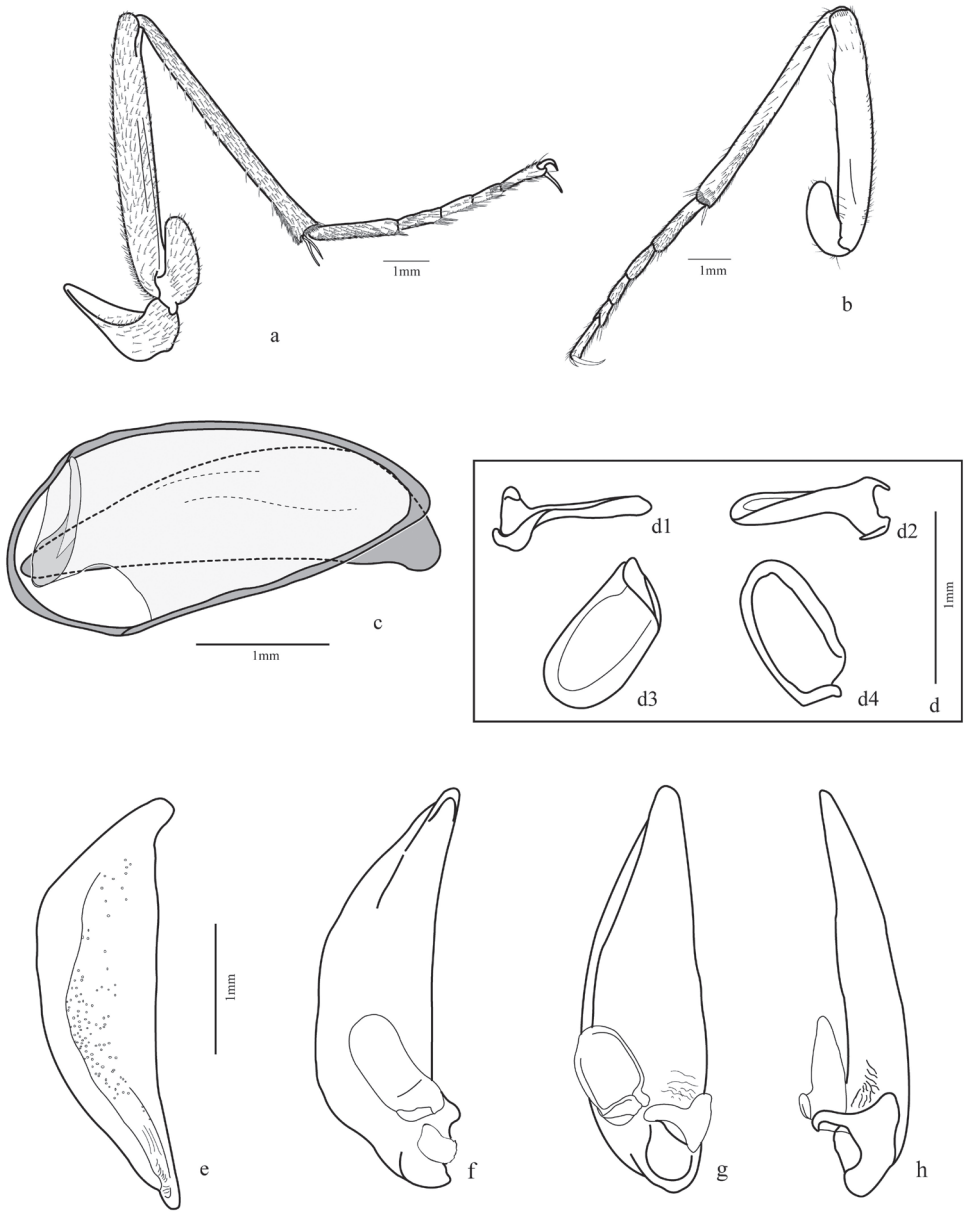

Figure 5. *T. marginipennis*, male. Hind leg: **a** external view **b** internal view **c** male genital segments (median lobe in dash line) **d** left paramere in lateral view (**d1** and **d2** lateral views **d3** ventral view **d4** dorsal view) **e** median lobe in side view; aedeagus **f** lateral view **g** ventral view **h** ventro-lateral view.

Legs (Figs 4a–d; 5a–b; 9b): fore and median coxae globose covered with thin setae, hind coxa with only few setae at middle and one or two long setae near anterior margin; median coxa with one or two long setae near the posterior margin; trochanter subtriangular, fore trochanter with a few sparse short setae on entire surface and thick and long ones

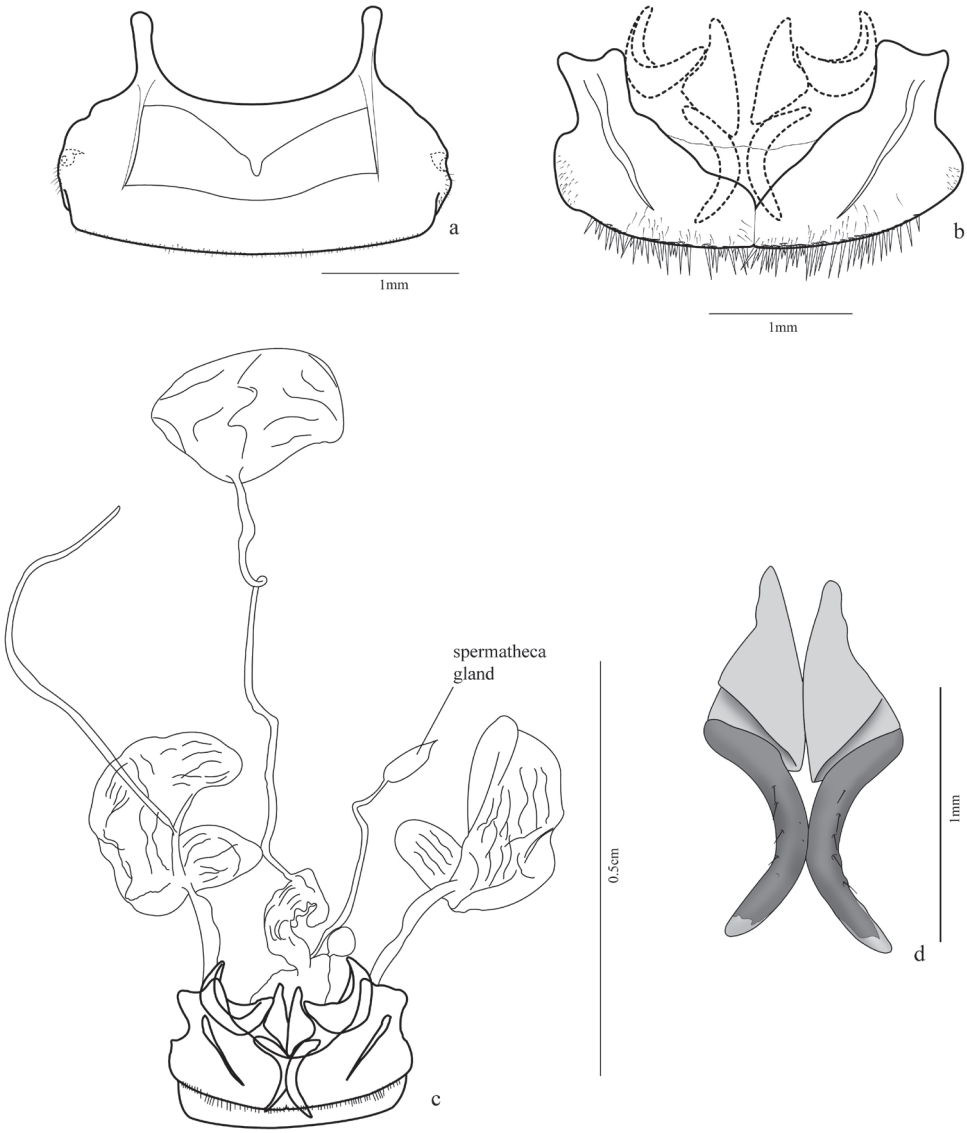

Figure 6. *T. marginipennis*, female **a** sternite VIII **b** tergites VIII (laterotergites IX, gonocoxites 1 and 2 in dash line) **c** female genitalia and pygidial glands **d** gonocoxites 2.

on ventral margin; median trochanter with one or two long setae ventrally; femur long and covered ventrally with short setae, fore femur broader than others, flattened laterally with outer surface with a band of thicker and longer setae midline, inner surface with more concentration of setae near base, ventral margin with very long and thick spine-like bristles**;** hind femur longer than others; tibial length subequal to femur, tibia covered with thin setae and two dark spurs at the apex, except the fore tibia with widely separated spurs, only one distally; antenna cleaner on the distal third with a strong dark spur curved

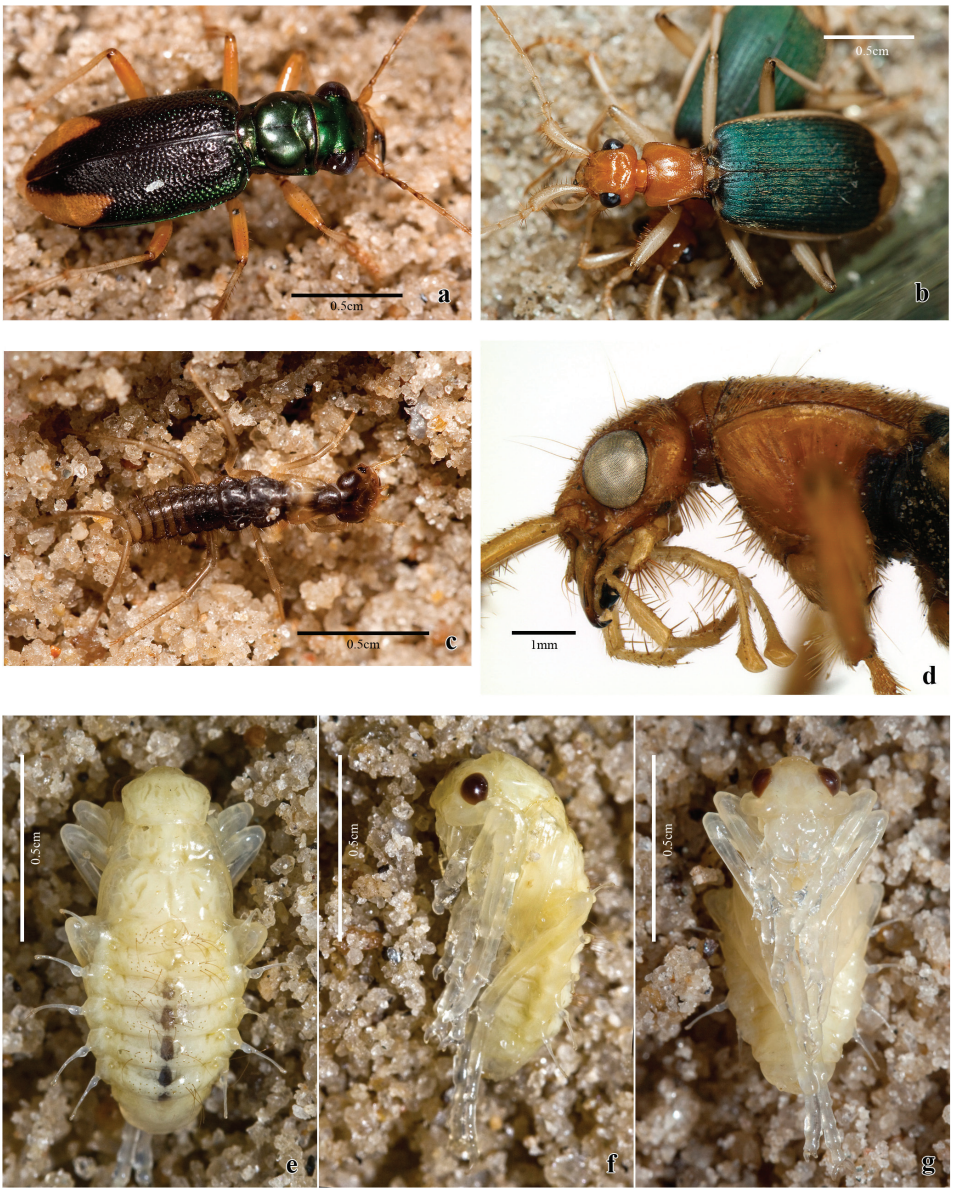

Figure 7. a *Tetracha* sp. **b,c,d,e** *T. marginipennis* **a** *Tetracha* sp. collected with *T. marginipennis* **b** dorsal view of adults **c** living larva in dorsal view **d** head and prothorax of the adult in lateral view; pupa **e** dorsal view **f** lateral view **g** ventral view.

at base and a row of thick setae on the inner surface extended from base to apex; median and hind tibiae with more concentrated pubescence ventrally, especially on posterior half and two dark spurs at apex; tarsomeres 1-4 covered with setae, denser ventrally; fore tarsomeres 1-3 wider in males with rows of adhesive setae with a wide and rough plate (Fig. 9b); tarsomere 5 elongate with only few setae; tarsal claws simple and glabrous.

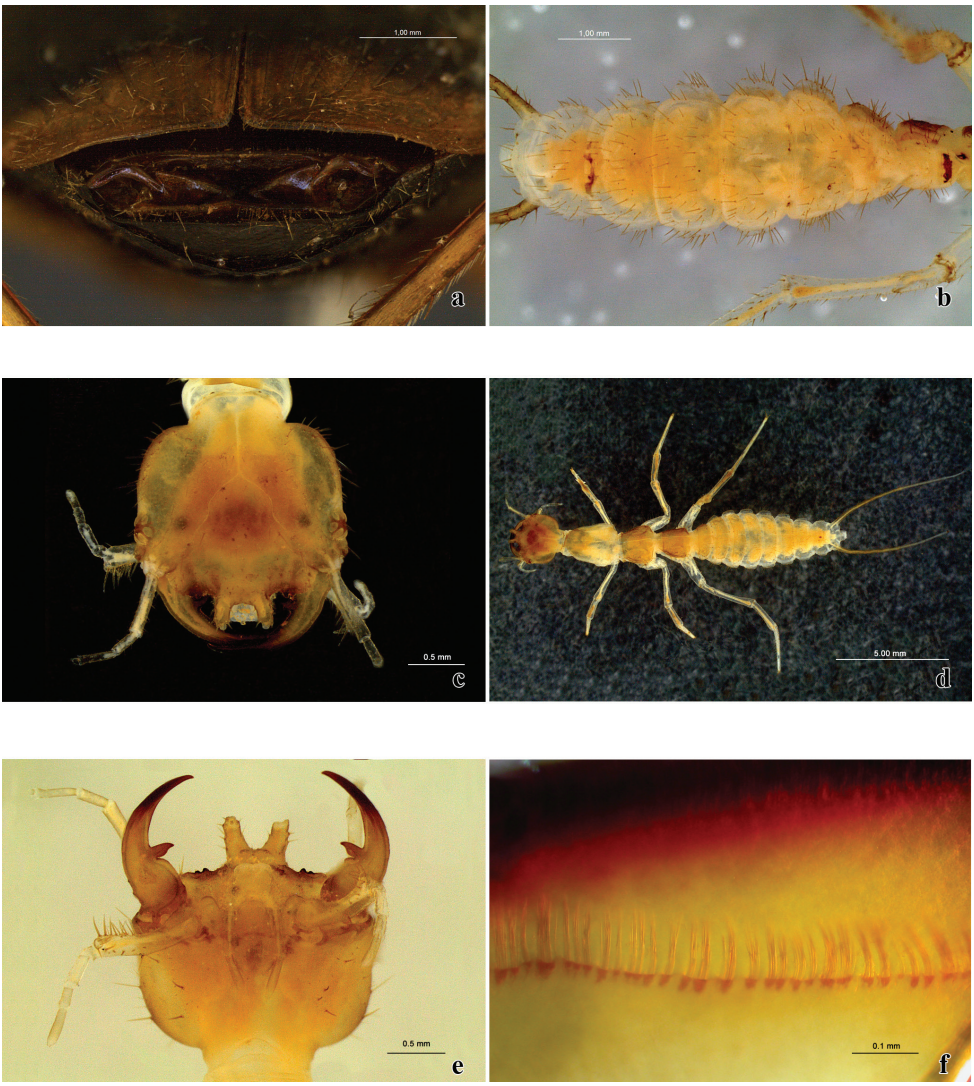

Figure 8. *T. marginipennis*: **a** gonocoxites from the outside **b** abdominal segments of the larva in ventral view **c** head of the larva in dorsal view **d** larva in dorsal view **e** head of the larva in ventral view **f** detail of the mandible filtering apparatus.

Elytra (Figs 2a, 4e): stria 1 very short, ranging from level of scutellum to approximately anterior fifth terminated in thick punctuation; fine setae covering entire structure with a few longer bristles in more defined punctations, especially near stria 1; posterior third near external margin and in the apex; striae 4 and 5 very close to one another at the apex, as are striae 6 and 7.

Hind wing (Fig. 3j): fully developed, about 2.5 times longer than wide, rounded anal lobe and tapered apex; anal vein bifurcated near base, proximal branch reaching margin and other branch (AA1+2) fused with cubitus anterior (CuA) at level of poste-

Figure 9. *T. marginipennis* (adult): **a** sternite VIII with pygidial glands **b** male fore tarsomeres 1–4 in ventral view **c** Rio Verde view from Fazenda Soledad.

rior third, forming a cell; a small branch extended from cell formed to cr branch, but not connected; oblong cell present.

Male genital segments (Fig. 5c): tergite IX formed by antecostal region, a tergite and two laterotergites; antecostal region arc shaped, mediotergite IX shorter and less curved; laterotergites IX form a comma-shaped structure.

Aedeagus (Figs 5d–h): median lobe cylindrical, slightly curved downward; phallobase rounded and distal region tapered with very short tip, dorsal surface slightly sclerotized and wrinkled with many punctures except anterior fifth and at the base; left paramere (Fig. 5d) broad, concave, base deflected and left basal projection going over the base; right paramere smaller and markedly attached at base of median lobe.

Female genital segments: sternite VIII (Figs 6a, 9a) 2.45 times wider than long, sclerotized, more weakly at medio-basal region; two basal projections (apodemes) almost half size of ventrite length, with rounded apex; fine setae posterior to spiracles and bordering posterior margin; two transverse lateromedian sclerotized stripes from base of projections to distal third of ventrite. Tergum 8 (Fig. 6b) formed by two laterotergites united at middle by a thin membrane, each laterotergite with a wide projection at the anterior margin, slightly bilobed at apex, and a lateral sclerotized band similar to that of sternite VIII, short thin setae at lateroexternal margin and distal margin with many long spine-like setae and a few thinner ones.

Female genitalia (Figs 6c–d, 8a). Ovipositor with gonocoxites 1 subtriangular, falciform; gonocoxites 2 with apex turned out and some setae near inner margin, lat-

erotergite IX folded upon itself in internal margin, thus half-moon shaped. Internal organs comprised of a wrinkled bursa coiled at base; secondary spermathecal gland globose; spermathecal gland fusiform, attached by long duct, spermatheca 2 of similar size to pygidial glands, but more rounded.

Examined material. BRAZIL, Amazonas: Rio Juruá, 1902, E. Garbe col., Departamento de Zoologia São Paulo, 1♀, 2♂. Mato Grosso: Barra do Garças, IX.1943, Departamento de Zoologia São Paulo, 2♀; Campo Novo do Parecis, 25.VII – 04. VIII, S. Rosa, S. Casari, G. Ide & L. Prado cols., 4♀, 2♂; Corumbá, XI.1917, E. Garbe col., Departamento de Zoologia São Paulo, 1♀, 1♂ ; Diauarum, 02.XI.-11.XII.1973, G. R. Kloss col., 4♀, 5♂; Três Lagoas, Fazenda Floresta, 13-20.IX.1964, Exp. Depto. Zool., 6♀, 1♂; same locality, Fazenda Retiro de Telhas, 16.X.1964, Exp. Depto. Zool. col., 1♀; same locality, left margin Sucuriu river, Fazenda Canaã, XI.1966, F. Lane col., 2♂; same locality, X.1966, F. Lane col., 13♀, 7♂ ; same locality, IV.1967, F. Lane col., 1♀, 1♂; same locality, I.1967, F. Lane col., 8♀, 5♂; same locality, VI.1967, F. Lane col., 2♀, 3♂. Minas Gerais: Paracatu, VII. 1960, Exp. Formoso col., 1♀. São Paulo: Boa Esperança do Sul, Fazenda Itaquerê, left margin of Jacaré-Guaçu river, under rotten plank, very humid place, 20.VI.1965, K. Lenko col., 2♂; Funil, 28.V.1902, O. Dreher col., Departamento de Zoologia São Paulo, 2♀, 2♂; Franca, XI.1902, O. Dreher col., Departamento de Zoologia São Paulo, 1♀; Indiana, IV.1944, Dirings, 1♀; same locality, 02.III.1935, 1♀, 1♂; same locality, II.1935, Departamento de Zoologia São Paulo, 1♂; same locality, II.1934, Departamento de Zoologia São Paulo, 1♂; same locality, XI.1935, 2♀; Onda Verde, Fazenda São João, I.1946, F. Lane col., 1♀, 2♂; Pirassununga, Emas, without date, Schubart col., 1♀; São Roque, 1961, H. Lane col., Departamento de Zoologia São Paulo, 2♀; without locality and date, 1♀; Ribeirão Preto, Tamanduá, 15.XI.1954, Barreto col., 1♂; same locality, 1896, Departamento de Zoologia São Paulo, 1♀; same locality, X.1954, Barreto col., 1♀. Paraná: Curitiba, 1938, Departamento de Zoologia São Paulo, 1♂; Porto Tibiriçá, Rio Paraná, IX.1938, 3♂; same locality, IX.1940, 1♀. Santa Catarina: Anita Garibaldi, VII.1929, Dirings col., 3♀, 1♂; same locality, VI.1929, Dirings, 4♂; Nova Teutônia (currently Seara), II.1966, F. Plaumann col., 2♀, 1♂; Rio Grande do Sul: Cruz Alta, without date, E. Garbe col., Departamnto de Zoologia São Paulo, 1♂; Porto Alegre, II.1929, Dirings, 1♂. PERU – Inca: Chanchamayo, 1200m, XII.1948, Schunke col., 1♀. ARGENTINA, Salta: San Martin, Pocitos, I.1960, A. Martinez leg., 5♀, 1♂; without locality, III. 1958, Martinez Pereira col., 3♀, 4♂. Misiones: Leandro N. Alem, XII.1961, A. Martinez leg., 1♀; Puerto Esperanza, II.1961, A. Martinez leg., 1♀, 1♂; Dos de Mayo, 350m, X.1971, 2♀, 3♂. BOLIVIA, Santa Cruz: Chapare, 400m, Dirings, 1♀, 1♂; Parapeti, X.1960, A. Martinez leg., 1♀; Provincia de Ichilo, Buenavista, II.1950, A. Martinez leg., 1♀, 3♂; Santa Cruz de La Sierra, 08.III.1954, Bruira col., 1♀. PARAGUAY, Presidente Hayes: Puerto Elsa [Puerto Elisa], XI.1936, 1♂; without locality, XII.1950, Dirings, 1♀, 1♂. All material is from MZSP.

Key for the immatures of Galeritini with known pupa

1 Third instar larva: antenna longer than head width; head length more than four times longer than the nasale. Pupa: lateral projections without setae at the apex ..... ***Galerita carbonaria***

– Third instar larva: antenna shorter than head width; head length less than three times longer than the nasale. Pupa: lateral projections with a pair of short setae at the apex ..... ***Trichognathus marginipennis***

Relationships

In his monograph, Reichardt (1967) included a pre-cladistic reconstructed phylogeny in which *Trichognathus* was proposed as the sister group of the Old World Tropical *Eunostus* Castelnau, 1835. According to Ball (1985) and Hunting (2008), however, *Trichognathus* is postulated to be sister group of *Galerita sensu lato* (*Galerita sensu stricto* + *Progaleritina*), together forming the sister group of *Ancystroglossus* Chaudoir, 1862. Detailed studies on immature characters may contribute to the resolution of phylogenetic relationships within the group.

Natural history notes

Adults and larvae of *Trichognathus* are fast running predators and go in search of their prey at night usually on sandy beaches along rivers and small streams in grassy areas, as well as in gallery forests (Arndt and Drechsel 1998). Adults and larvae are seen hunting together. No one knows for sure what kind of prey they eat, but based on detailed study of mouthparts, Ball (1985) postulated that the very specialized mouthparts play an important role in the capture and manipulation of food.

Larvae and adults were found together on sandy substrate along a river margin, where they were active from sunset until about two hours later; after this period I found no more carabid larvae and adults. Sharing the same environment, some carabid adults of the genus *Tetracha* Westwood (Fig. 7a) were observed hunting. Possibly the same fact was observed by Arndt and Drechsel (1998) that indicated a frequent association with individuals of the carabid *Megacephala* Latreille, but now the genus *Megacephala* is divided into seven genera and *Tetracha* includes only Neotropical species. The group currently accepted as *Megacephala* occurs only in sub-Saharan region (Naviaux 2007).

Gregarious behavior was observed (Fig. 7b), as well as cannibalism among adults of *T. marginipennis* in the laboratory. During the pre-pupal stage (about two days before the pupal stage), the larva, usually agile, stayed motionless, writhing only when prodded; the pupal period lasted about one week. After death, the darkening of the head and pronotum of adults was also noticed.

Comparisons

The description of the third instar larva of *T. marginipennis* made by Arndt and Drechsel (1998) is quite complete and a full redescription is not necessary. However, unlike the original description of the larva, I observed that the abdominal sternites are distinct (Fig. 8b) and not fused as previously described. Furthermore, four bristles were found on the right side of the ventral surface of the head (figure 8e) in one specimen; usually, three are present on each side.

Comparing the pupae of *T. marginipennis* with those of *Galerita carbonaria*, showed that they are quite similar, with the following differences: each lateral abdominal extension has a pair of setae at the apex and all thoracic segments with some short setae in *T. marginipennis*, whereas in *G. carbonaria* there are no such setae. Moreover, the eyes of the pupa of *T. marginipennis* are apparently a bit larger.

As noted by Reichardt (1964), there are no consistent geographical patterns among the described morphs noted above. The genitalia of some females were dissected and the fairly long spermathecal gland, considered a remarkable character by Hunting (2008), was not observed, appearing only slightly elongated (Figure 6c). The sexual dimorphism of dilated tarsi was observed more pronounced in some males than in others.

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RESEARCH ARTICLE

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Cucujus tulliae sp. n. – an endemic Mediterranean saproxylic beetle from genus *Cucujus* Fabricius, 1775 (Coleoptera, Cucujidae), and keys for identification of adults and larvae native to Europe

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Abstract

Cucujus tulliae **sp. n.** is described as a new member of genus *Cucujus* Fabricius, 1775 (Coleoptera, Cucujidae), which enumerates at present eleven species distributed in Eurasia and northern America. This saproxylic beetle is the first *Cucujus* species known only from Mediterranean and it is probably endemic to Calabria (Italy). The species was found especially in old–growth mountain forests of high conservation value (i.e. national parks) dominated by Calabrian pine (*Pinus laricio calabrica*). We hypothesize that *C. tulliae* sp. n. probably evolved from isolated populations of *C. haematodes* Erichson, 1845. The species is thus relictual and of high conservation value, corresponding at least to endangered (EN) category with respect to recent IUCN criterion. *C. tulliae* sp. n. is here compared with two species native to Europe – *C. haematodes* and *C. cinnaberinus* (Scopoli, 1763) and with the Caucasian *C. haematodes caucasicus* Motschulsky, 1845, which is confirmed as a valid subspecies. The male genitalia of this Caucasian form have been examined and illustrated for the first time. A comprehensive key to adults and larvae of European species is provided.

Keywords
Calabria, *Cucujus cinnaberinus*, *Cucujus haematodes caucasicus*, Italy, Sila National Park, old–growth forests, *Pinus laricio*, relict species, larval taxonomy

Introduction

The genus *Cucujus* F. enumerates at the moment 11 known species, distributed throughout the Holarctic region and highly concentrated in Asia, with many endemics especially in India, Nepal, Myanmar, China, Taiwan and Japan (Horák and Chobot 2009; Lee and Pütz 2008). Only two native species have been known from Europe, *C. cinnaberinus* (Scopoli, 1763), and *C. haematodes* Erichson, 1845. A third species was described as *C. siculus* by Pic (1894) from Sicily; Ratti (1986, 2000) later regarded this taxon as a synonym of the northern American *C. clavipes* (Fabricius 1781), the record being probably based on an accidental introduction into Sicily, or on a mislabeling of the beetle.

Cucujus cinnaberinus is an endemic taxon to Europe, distributed from Spain to Ukraine and Sweden, its populations are more densely diffused only in eastern Europe, from Austria and Bavaria eastwards (Horák and Chobot 2009). In Italy the beetle was thought extinct after 1960, but in the last decade it has been found in Piemonte and on the Alburni mountains in the Campania Region by Biscaccianti et al. (2009), and after 49 years absence in the Sila National Park in Calabria (Mazzei et al. 2011).

Cucujus haematodes is a palearctic species ranging from Bavaria and Southern Italy to Japan, it comprises at least one well differentiated subspecies, *C. h. opacus* Lewis, 1988, found in Japan and Taiwan, whereas the nominal form is known from Southern Italy (Calabria), Greece and Eastern Europe until the Primorskiy Region of far eastern Russia and China (Horák and Chobot 2009). Another form, *C. h. caucasicus* Motschulsky, 1845, is known from Armenia, Georgia and Russia, but the status of this subspecies was considered more dubious (Horák and Chobot 2009), although Mamaev et al. (1977) in a larval key considered the preimaginal characters as those of a separate species.

During a long term survey of the *Cucujus* populations of the Sila National Park, started 2009 as reported in Mazzei et al. (2011), a large amount of *Cucujus* larvae has been collected and reared until pupation and eclosion. Among large numbers of *C. cinnaberinus* and *C. haematodes* specimens, a third form has been recognized both by larval as well as by adult characteristics. We present here the description of this new *Cucujus* species, that is probably endemic to the Calabrian mountains.

Material and methods

All the adult specimens have been obtained by rearing the larval material collected in the Sila National Park under the bark of an endemic pine, *Pinus laricio* var. *calabrica*

and occasionally of silver fir, *Abies alba* fallen trees. Adult specimens are in our study area quite uneasy to collect in nature, probably because of their early appearance in spring and short reproductive season. On the contrary, the preimaginal stages are well known for their underbark life, in the literature they are sometimes defined as "scavengers", but also predators on pupae and small larvae of other insects (Mamaev et al. 1977) or even on other subcortical beetles (Rozhkov 1970; Burakowski et al. 1986). Palm (1941) observed that *C. cinnaberinus* larvae are able to feed on bast and cambium, and that cannibalism on younger conspecific larvae ceases in presence of longhorned beetle (Cerambycidae) larvae, that were vigorously accepted. Straka (2008) observed *C. cinnaberinus* adults feeding on various insects and was able to keep larval specimens alive with mealworms – darkling beetle larvae (Tenebrionidae). Horák et al. (2010) observed in far eastern Russia that the associated guild of *C. haematodes* was composed by springtails (Collembola), mites (Acari), ants (Formicidae), carabids (Carabidae) and subcortical histerids (Histeridae). Mazzei et al. (2011) reared *C. cinnaberinus* larvae with calliphorid maggots (Diptera), but especially with fresh beef meat, and this very simple method was adopted in this study.

All the larval specimens were kept at a temperature of 20°C with fresh beef meat, their development lasted about 8 months and a maximum of six larval molts were observed before pupation.

The dissections of adult male specimens were normally performed after short KOH treatment of the terminalia and total abdomen removal. The male genitalia are in fact highly delicate and a less careful extraction may cause the loss of the typical long "flagellum", well described by Sharp and Muir (1912) and troubles in position of the sclerified structures of the internal sac. Thereafter, the male genital structures were prepared on small transparent labels and enclosed in euparal, finally the labels arranged on the same insect pin of the specimen. The photographs of the adult and larval material were made with a Zeiss Stemi SV11 Stereoscope with a Canon PowerShot G5 five MP digital camera. The male genitalia were photographed with a Zeiss Axioskop equipped with Nomarski optic (Differential Interference Contrast, DIC), using a Nikon Coolpix 4500 four MP digital camera. The male genitalia figures were merged with help of Adobe Photoshop software.

The terminology of adult genitalia follows Wilson (1930) and Thomas (1999), the larval morphology is based on Lawrence (1991).

Collections examined

Museo Civico di Storia Naturale, Verona, Italy (**MCV**); Department of Entomology the National Museum, Prague, Kunratice 1, Czech Republic (**NMP**); collection P. Brandmayr, conserved in the Department of Ecology of the University of Calabria (**PBC**). The larval material used for the taxonomic key is conserved in 70% alcohol in the "Tullia Zetto" larval collection (**TZC**) in the Department of Ecology of the University of Calabria.

Results

***Cucujus tulliae* sp. n.**
urn:lsid:zoobank.org:act:1CC7BB12-8520-4DD0-890F-BDEB5C0FBD82
http://species-id.net/wiki/Cucujus_tulliae

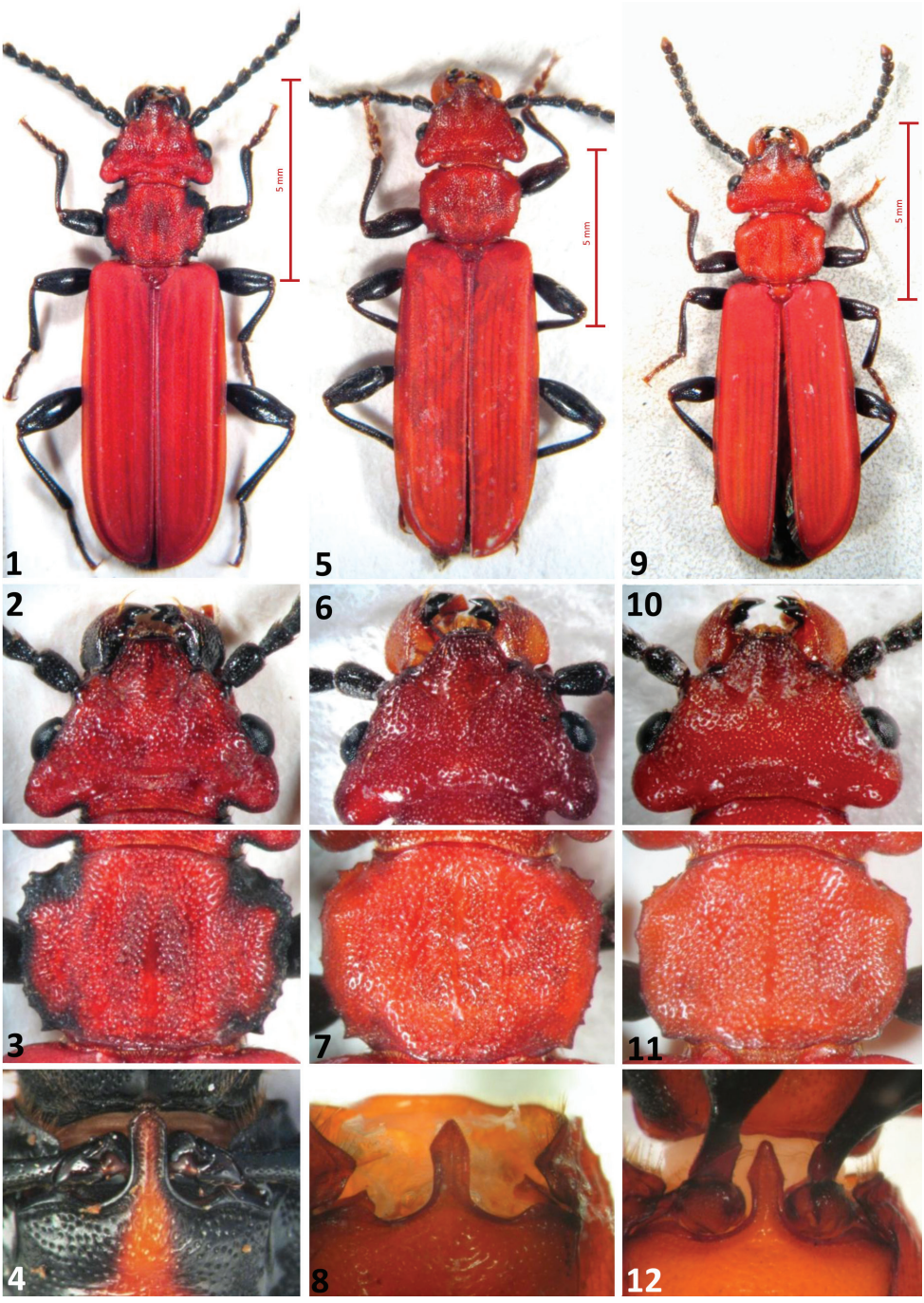
Type locality. Italy, Central Calabria, Sila National Park, mountains between the Cecita Lake and the Longobucco municipality, 1300–1600 m a. s. l., forests between 39°23'/25'N and 16°32'/35'E.

Type material. Holotype male: Sila National Park, Calabria, Italy, Vallone Freddo, Spezzano Sila (CS), 1300 m a. s. l., larva collected at instar five 18.10.2010, lg. Mazzei, adult emerged 28.12.10 in laboratory, prep. N. 3, **PBC**. Paratypes: one female, Vallone Freddo, reared from an aged larva collected 05.04.2011, lg. Mazzei, **PBC**. Larval specimens: 12 larvae (III–VI instar), Calabria, Sila, Vallone Freddo, Spezzano della Sila (CS), 1300 m a. s. l., lg. Mazzei, 05.05.2011; 2 larvae (V–VI), Calabria, Sila, Golia Corvo Natural Reserve, Spezzano della Sila (CS), 1300 m a. s. l., lg. Bonacci; 15.07.2011; 1 larva (V), Calabria, Aspromonte, Gambarie (RC), 1350 m a. s. l., lg. Mazzei, 07.06.2009.

Etymology. Tullia Zetto was an active zoologist and teacher of the Department of Ecology of the University of Calabria, who endeavoured for more than 20 years larval morphology and behaviour of carabids and other predatory beetles in Calabria and in several Mediterranean lands. She was born in Trieste 15.01.1949 and deceased in Cosenza 24.11.2010.

Diagnosis. *Cucujus tulliae* is clearly related to the *cinnaberinus–haematodes* species group, its distribution seems to be restricted to the mountains of Calabrian peninsula. The closest taxon could be *C. haematodes*, from which it can easily be distinguished by the less prominent postgenae, the arrow head shaped prosternal apophysis, the smaller and less spiny pronotum, the typical median lobe of the aedeagus and the larval morphology, that is apparently unique because of its slender body and occipital furrows.

Description. A bright red species, resembling a small–sized *haematodes* in colour, but with a less serrate pronotum. Length 11.2–12.5 mm. Colour light red, legs dark brown/black, tarsi brown. Prosternum of the same colour of pronotum. Antennae black, mandibles red/orange with black apex. Head distinctly wider than pronotum, with two longer setae after the posterior border of eyes. Postgenae less swollen than in *C. haematodes* (Figs 1, 5, 9). Occipital furrow deep and long as one third of the posterior head width. Frontoclypeus with a gentle longitudinal swelling. Pronotum less spiny than in *C. haematodes*, distinctly prolonged at the level of the neck as a short collar (Figs 3, 7, 11). Prosternal apophysis elongated as an arrow head, slender than in *C. haematodes* (Figs 4, 8, 12). Elytral sides distinctly carinate at its upper external margin, almost until the apex. Elytral surface opaque, density of punctures similar to that of *C. haematodes*. Apex of elytra broadly rounded and with short pubescence. Metathoracic wings well developed and robust. Sutural stria slightly convex. Median lobe distinctly wider than median strut, less restricted at its apex than in *haematodes*



Figures 1–12. The three European *Cucujus* species, adults. **1–4** *Cucujus cinnaberinus* **1** Total body, dorsal view **2** Head **3** Pronotum **4** Prosternal apophysis **5–8** *Cucujus haematodes* **5** Total body, dorsal view **6** Head **7** Pronotum **8** Prosternal apophysis **9–12** *Cucujus tulliae* **9** Total body, dorsal view **10** Head **11** Pronotum **12** Prosternal apophysis.

(Figs 13, 16, 19, 21). Apical process well protruding, more than in *haematodes*, and triangular at the tip, like in *C. cinnaberinus* (Figs 14, 17, 20, 22). Median strut 4.5 times longer than median lobe and particularly thin. Flagellum longer than the entire body, connected at its base with the male deferents, its more chitinized trait reaches the median lobe at the level of the two chitinous plates of the endophallus and bends backwards to the median strut. After bending the flagellum becomes transparent and runs across the endophallus, where, at the middle of its length, it rolls up in a sort of "ball", like a wire (Fig. 17). In figure 2 the "flagellum ball" is photographed in the median strut of *C. cinnaberinus* (Fig. 18).

Distribution and habitat. The larvae of this species have been collected under the bark of fallen pine trees of at least 25 cm diameter or on dead silver fir fallen trunks, but only on single locations of the National Park. The species seems to prefer cooler, northern exposed slopes and high air humidity at major elevations. In laboratory most larvae kept at 20°C died before pupation, a fact that could be explained by lower temperature preferences of the immature stages. The low number of larvae collected and the successful rearing of only two adults makes hypothesis much more difficult. Concerning geographic distribution, at the moment this taxon is known only from Calabria, in the highest part of the Sila plateau in the core of the Sila National Park, from two sites: Vallone Freddo and Serra Vurga. A single larva has been collected in the surroundings of Gambarie, in the Aspromonte National Park, at 07.06.2009, but this specimen died before pupation. There is little doubt that this new taxon may be an endemic saproxylic beetle of central and southern Calabria, with larval populations depending on the availability of high amounts of dead wood, especially of Calabrian pine, *Pinus laricio* var. *calabrica*.

***Cucujus cinnaberinus* (Scopoli, 1763)**
http://species-id.net/wiki/Cucujus_cinnaberinus

Note. We examined several specimens of this taxon, both from Italy as well as from the National Museum of Prague. This species is very abundant in the pine forest of the Sila National Park in Calabria.

Examined material. PBC: *C. cinnaberinus*: 1 ♂, Calabria, Sila, Vallone Freddo, Spezzano della Sila (CS), 1300 m a. s. l., lg. Mazzei, 05.04.2011, aedeagus slide n. 2. 1 ♀, Calabria, Sila, Vallone Freddo, Spezzano della Sila (CS), 1300 m a. s. l., lg. Mazzei, 06.05.2011, slide n. 6. 1 ♂, Calabria, Sila, Vallone Freddo, Spezzano della Sila (CS), 1300 m a. s. l., lg. Mazzei, 05.04.2011, slide n. 9. 2 ♂, Calabria, Sila, Monte Pettinascura, San Giovanni in Fiore (CS), 1650 m a. s. l., lg. Mazzei, 19.08.20092 ♀, Calabria, Sila, Monte Pettinascura, San Giovanni in Fiore (CS), 1650 m a. s. l., lg. Mazzei, 29.05.2009. 1♀, Calabria, Sila, Vallone Freddo, Spezzano della Sila (CS), 1300 m a. s. l., lg. Mazzei, 05.04.20113 ♂, Calabria, Sila, Vallone Freddo, Spezzano della Sila (CS), 1300 m a. s. l., lg. Mazzei, 05.04.2011. 1 ♂, Calabria, Sila, Arnocampo, San Giovanni in Fiore (CS), 1250 m a. s. l., lg. Maz-

Figures 13–22. Male genitalia of four *Cucujus* species/subspecies. **13–15** *C. cinnaberinus* (Sila N. Park) **13** Median lobe and median strut with flagellum, dorsal view **14** Median lobe **15** flagellum "ball" inside the endophallus **16–18** *C. haematodes* (Sila N. Park) **16** Median lobe and median strut with flagellum, dorsal view **17** Median lobe **18** Abdominal end of flagellum, with the basal part of the endophallus and genital duct **19–20** *C. tulliae* (Sila N. Park) **19** Median lobe and median strut with flagellum removed **20** Median lobe **21–22** *C. caucasicus* ("Caucasus") **21** Median lobe and median strut with flagellum, dorsal view **22** Median lobe.

zei, 06.07.2009. 1 ♀, Calabria, Sila, Cozzo del Principe, Spezzano della Sila (CS), 1350 m a. s. l., lg. Mazzei, 12.08.2009. 1 ♂, Calabria, Sila, Cozzo del Principe, Spezzano della Sila (CS), 1350 m a. s. l., lg. Mazzei, 12.08.2009. 4 ♂, Calabria, Sila, Golia Corvo Natural Reserve, Spezzano della Sila (CS), 1300 m a. s. l., lg. Mazzei, 07.07.2009. 4♀, Calabria, Sila, Golia Corvo Natural Reserve Spezzano della Sila (CS), 1300 m a. s. l., lg. Mazzei, 07.07.2009.

MCV: *C. cinnaberinus*, 1 ♀ ex coll. Brasavola, Sila, Bosco Gariglione, IX. 1 ♂, Calabria, Sila, Silvana Mansio, VIII–1960, det. Ratti, 1971.

NMP: about 120 specimens from many countries of Europe.

C. cinnaberinus larvae: 5 larvae (V–VI instar), Calabria, Sila, Vallone Freddo, Spezzano della Sila (CS), 1300 m a. s. l., 29.6.2009, lg. Mazzei; 18 larvae (IV–VI), Calabria, Sila, Monte Pettinascura, San Giovanni in Fiore (CS), 1650 m a. s. l., 12.09.2009, lg. Mazzei. 7 larvae (V–VI), Calabria, Sila, Golia Corvo Natural Reserve, Spezzano della Sila (CS), 1300 m a. s. l., 30.05.2009, lg. Mazzei.

Cucujus haematodes Erichson, 1845

http://species-id.net/wiki/Cucujus_haematodes

Note. This species is abundant in the Sila National Park, but less than *C. cinnaberinus*. We collected numerous larval stages also in the Aspromonte National Park.

Examined material. PBC: *C. haematodes*: 1 ♂, Calabria, Sila, Vallone Freddo, Spezzano della Sila (CS), 1300 m a. s. l., lg. Mazzei, 12.09.2009, slide n. 4. 1♂, Calabria, Sila, Vallone Freddo, Spezzano della Sila (CS), 1300 m a. s. l., lg. Mazzei, 05.04.2011, slide n. 1. 1 ♀, Calabria, Sila, Cozzo del Principe, Spezzano della Sila (CS), 1350 m a. s. l., lg. Bonacci, 12.08.2009, slide n. 7. 1 ♂, Calabria, Sila, Vallone Freddo, Spezzano della Sila (CS), 1300 m a. s. l., lg. Mazzei, 10.12.10, slide n. 8. 1 ♀, Calabria, Sila, Valle di Casu, Longobucco (CS), 1380 m a. s. l., lg. Brandmayr, 11.02.11. 1 ♂ Calabria, Sila, Valle di Casu, Longobucco (CS), 1380 m a. s. l., lg. Brandmayr, 11.02.11. 1 ♂, Calabria, Sila, Monte Pettinascura, San Giovanni in Fiore (CS), 1650 m a. s. l., lg. Bonacci, 29.05.2009. 1 ♀, Calabria, Sila, Cozzo del Principe, Spezzano della Sila (CS), 1350 m a. . l.s, lg. Bonacci, 18.08.2009. 2 ♂, Calabria, Aspromonte, Gambarie (RC), 1350 m a. s. l., lg. Mazzei, 07.06.2009. 3 ♀, Calabria, Aspromonte, Gambarie (RC), 1350 m a. s. l., lg. Mazzei, 07.06.2009. 3 ♂, Calabria, Sila, Colle Vurga, Longobucco (CS), 1550 m a. s. l., lg. Brandmayr, 04.07.2011.

MCV: *C. haematodes*: 1 ♀, Calabria, Sila, Bosco Gariglione, IX, coll. ex Brasavola. 1 ♂, Basilicata, Mt. Pollino, Piani del Pollino, VI ’51, lg. Ruffo. 1 ♂, Basilicata, Mt. Pollino, Piano Ruggio, VI–1953, lg. Ruffo.

NMP: About 100 specimens from the Czech Republic and to Far East. *C. haematodes* larvae: 3 larvae (V–VI instar), Calabria, Sila, Vallone Freddo, Spezzano della Sila (CS), 1300 m a. s. l., lg. Mazzei, 12.08.2009; 3 larvae (V–VI), Calabria, Sila, Monte

Pettinascura, San Giovanni in Fiore (CS), 1650 m a. s. l., lg. Mazzei, 12.08.2009; 1 larva (V instar) Calabria, Sila, Cozzo del Principe, Spezzano della Sila (CS), 1350 m a. s. l., lg. Mazzei, 10.07.2009.

***Cucujus haematodes caucasicus* Motschulsky, 1845, stat. n.**
http://species-id.net/wiki/Cucujus_haematodes_caucasicus

Note. At the beginning of this investigation we faced the possibility that the newly described taxon may belong to another already known form of the *haematodes* group. In Europe only a putative subspecies or relative of *haematodes* was known: *C. caucasicus* Motschulsky, 1845. Horák and Chobot (2009) are of the opinion that: "The state of *C. h. caucasicus* is more dubious, however, the main difference from the putative subspecies is the bright red color of the adult mandibles; also, the larval characters correspond with those of a separate species (Mamaev et al. 1977)". The original description of Motschulsky sounds as follows: "*Beaucup plus grand et plus allongé que le C. depressus, auquel il ressemble pour les couleurs et le fascies. Le corselet est plus transversal. J'ai pris cette belle espèce sur les Alpes du Caucase, sous l'écorce d'un hêtre*". There is no doubt that the "facies" of *C. caucasicus* was the same of a *C. haematodes*, but larger and with broader pronotum. Also the larval identification key of Mamaev et al. (1977) speaks for a separate species (or subspecies) status. Thus, we examined the male genitalia of three "*caucasicus*" individuals found in the National Museum of Prague.

Material examined. 1 ♂ and 1 ♀: Caucasus, "Reitter. Leder.", determined as: *Cucujus haematodes v. caucasicus* Motsch.". 1 ♂: Caucasus, "Reitter. Leder.", determined as: " *v. caucasicus* – Det. Dr. Obenberger". 1 ♂: Kaukasus, N. W. – Kuban – C. Rost, Berlin. – ex coll. J. Hlisnikowski. Determined as: "*Cucujus haematodes* Er.". 1 ♀: Caucasus – Krasnaja Poljana – R. Rous legit. 6.1967. All individuals are conserved in **NMP**.

Diagnosis. A larger *C. haematodes* with a broad pronotum, almost as wide as the head. Median lobe of the same general shape of *C. haematodes*, but the apical process of the inner sac vertical, paddle like in lateral view.

Description. Length 16.0–15.5 mm, colour light red, as in *C. tulliae* sp. n. or in *C. haematodes*, mandibles yellow with brownish/black apex. Head slightly wider than pronotum, postgenae less protrudent sidewards and more rounded (Fig. 23). Prothorax anteriorly not restricted, as it happens in true *C. haematodes*, and proportionally larger, the external borders with pronounced, evident teeth. Prosternal apophysis of the same shape of *C. haematodes*, at the end shortly triangular.

Aedeagus of the same general form of *C. haematodes*, but a little longer, (Figs 21–22), total length mm 5,2 – 5,3, median lobe ending with a vertically flattened apical process, in lateral view distinctly paddle shaped.

Distribution and habitat. This subspecies or allopatric species inhabits the Caucasian mountains – namely Georgia, Armenia and the three Russian regions – Republic of Adigeyia, Krasnodarskiy Kray and Stavropol'skiy Kray (Horák and Chobot 2009).

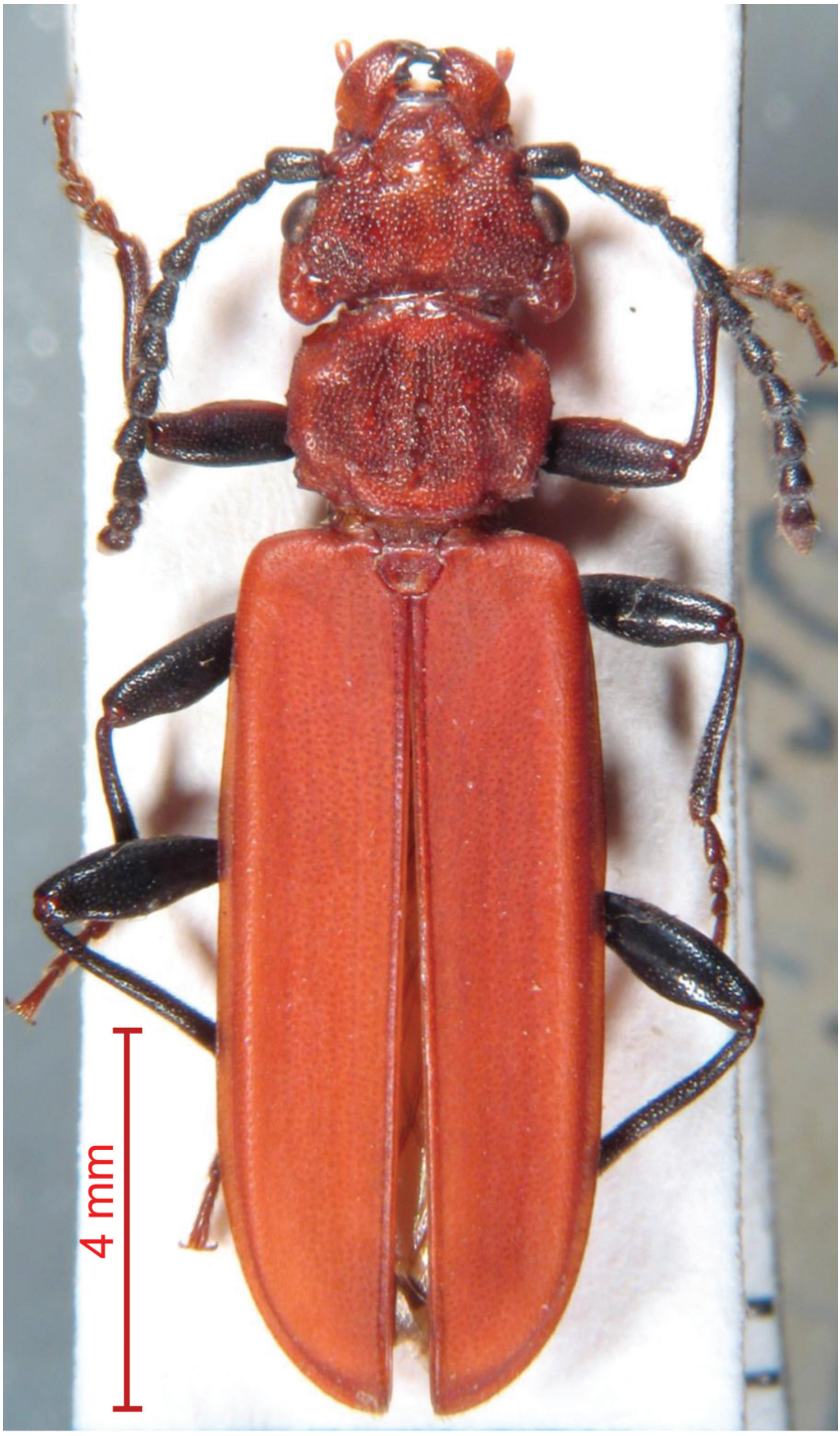


Figure 23. *Cucujus haematodes caucasicus* stat. nov.: dorsal view of male specimen. Locality: Kaukasus, N. W. – Kuban – lg. C. Rost, Berlin.

Key to the adults of the European species of genus *Cucujus* Fabricius, 1775

1 Body bright red on the dorsal side, with exception of the apex of the mandibles, that are often lighter, orange. Pronotum entirely reddish, always somewhat restricted at the front border, sides with more or less protruding red teeth **2**

– Sides of pronotum, inner side of postgenae and mandibles black, mandibles before the apex somewhat lighter coloured. Maximum width of the pronotum at the front border, ventral side of the same part black, with a median yellow stripe that prolonges onto the prosternal apophysis. Head triangular, postgenae obliquely protruding backwards, occipital groove well marked and reaching postgenae, nevertheless deeper in the middle, where the punctuation is well developed. Body length 12–15.5 mm, median lobe of the aedeagus evidently restricted at the basis (Fig. 14) ..... ***cinnaberinus* Scop.**

2 Pronotum robust, with distinct lateral spines, prosternal apophysis with parallel sides and short, triangular end (Fig. 8). Postgenae well developed, body length 13–16 mm **3**

– Pronotum more rounded, lateral borders with small, obtuse spines, on the head side restricted in a short neck. Pronotal apophysis ending with a prolonged, arrowhead like point (Fig. 12). Body length 11.5–12.5 mm .... ***tulliae* sp. n.**

3 Pronotum of normal size, distinctly narrower than the head, apical process of the median lobe tongue like, rounded at the tip (Fig. 17) .... ***haematodes* Er.**

– Body size 15.5–16 mm, pronotum broad and robust, little smaller than the head at its posterior end. Postgenae well developed, but less protruding laterally and more backwards oriented, not surpassing the head width at the level of the eyes. Apical process of the median lobe compressed, paddle like (Fig. 22) ..... ***haematodes caucasicus* Motsch.**

Larval morphology

Diagnosis of the genus *Cucujus* Fabricius, 1775

Larvae extremely flat bodied, length 7–8 mm in young stages, around 25–30 mm in aged ones. Colour from pale yellow to dark reddish brown. Head prognathous, always broader than pronotum, maximum width at the occiput (parietale), postgenae inflated. Epicranial suture sinuate, coronal suture short but distinct. Stemmata normally in number of six, located more or less at half of the length of head. Antennae of variable length; first antennomere robust, distal antennomere much slender and setose only at the apex. Second antennomere with a flat sensorium bordered by a chitinous ring. Fronto clypeal suture more less concave in the middle; front margin of the labrum with 4 macrochaetae; frontoclypeal suture absent. Mandibles asym-

metrical, broadly triangular and irregular bidentate, the teeth of the left one not at the same level (dorsal view). Two setae on the external side of each mandible; prostheca thin and hook like, broad based. Mola tuberculate, long, anteriorly with a penicillum formed by a dense brush of short setae.

The complex of mouth parts well protruding and occupying more or less one third of the head width. Maxillary and labial palps very short. Legs very short and robust, ending with one tarsungulus.

Notal sclerites distinctly bordered. Abdominal segment VIII longer than precedent, lateral margin with two processes bearing setae. Lateral portion of segment VIII with a stout protrusion below the spiraculum ("spiracular process"). Between segment VIII and IX there is a strong conical appendage with many apical setae. Tergum IX with one pair of strong urogomphi bearing a robust bifid spine at their base. Lateral ends of tergum IX with a strongly sclerotized thorn.

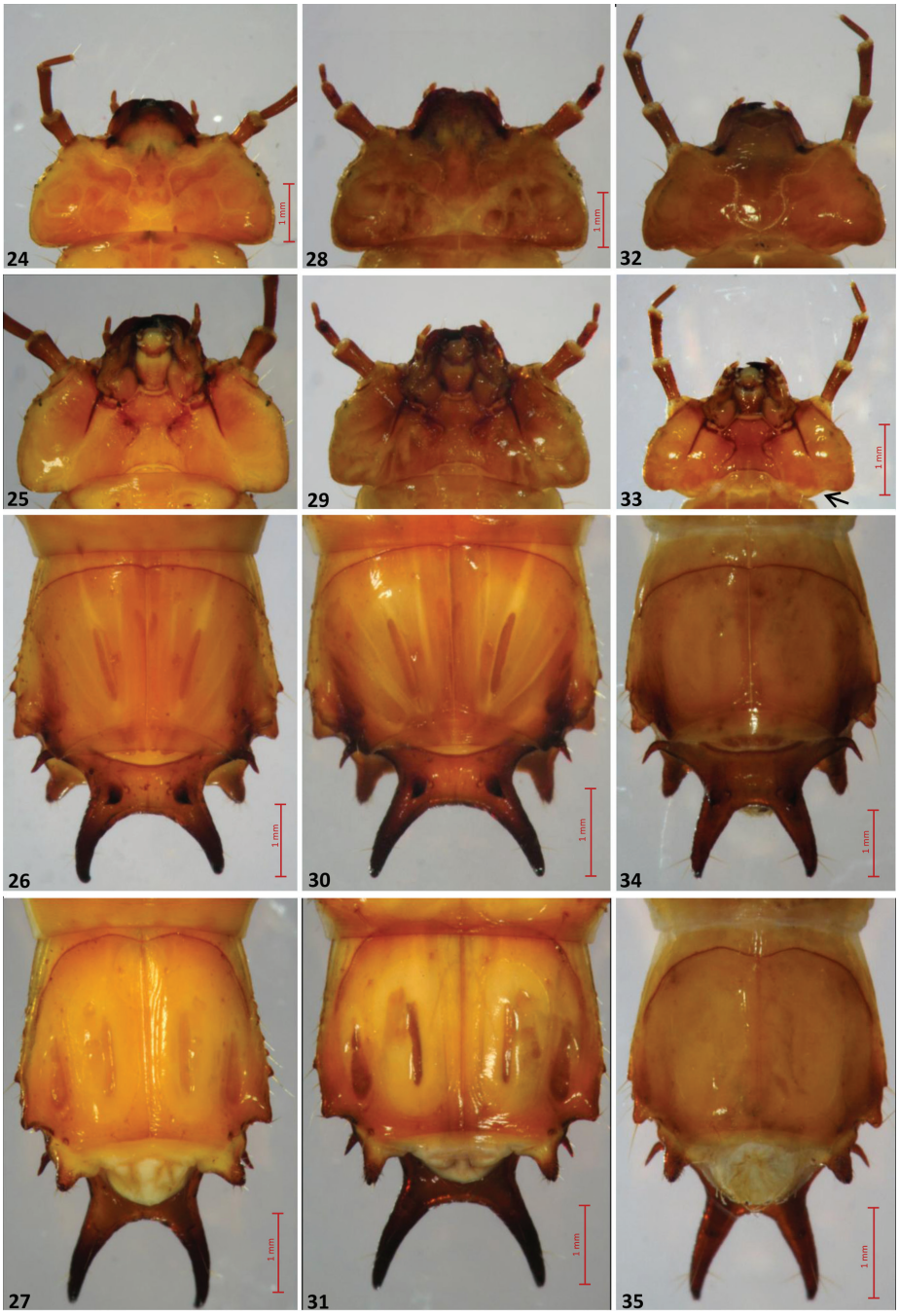
Key to the larvae of the European species of genus *Cucujus* Fabricius, 1775

1 Head very wide and flat, posterior margin of the head not excavate, without posterior furrows. Epistomal lateral edge not or less oblique from the antennal basis to the dorsal articulation of mandible. Mouthparts occupant more than a half of the front margin of the head. Antennae not longer than the head. Lateral chitinous thorns of tergum IX gently curved backwards..... **2**

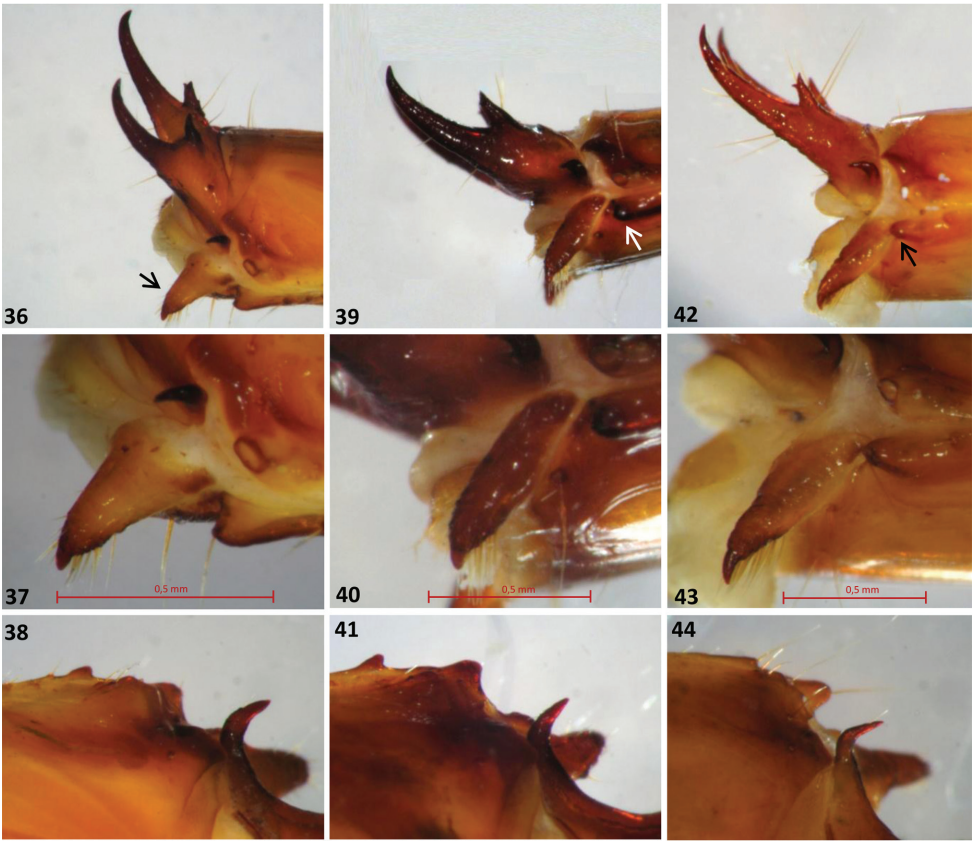
– Head wide and flat, with distinctly furrowed postgenae at the posterior margin, forming a separate swelling on the occipital part of the head. Mouthparts more protruding, lateral border of epistomal margin distinctly oblique from the antennal basis to the insertion of mandible. Mouthparts complex slender, antennae as long as the whole head. Lateral thorn of the tergum IX strongly bent backwards **3**

2 Antennae slender, second joint distinctly longer than the first one, apical joint thin five times longer than wide at the basis. Lateral border of parietale a little swollen in correspondence of the stemmata. Epistomal front margin moderately oblique towards the mandibular basis (Figs 24–25). Urogomphi well curved and apically a little converging to the median plane (Figs 26–27). Basal tooth with minor spine directed outwards and far from the apex. Spiracular process small and little pronounced (Figs 36–38). Conical appendage very large at the basis, distinctly setose around the apical part, chitinous apex short (Fig. 37)..... ***cinnaberinus* (Scop.)**

– Antennae very short, second joint longer like the first one. Apical antennomere four times as wide as at the basis. Head robust and not swollen in the stemmata area (Figs 28–29). Front epistomal margin straight from antennal basis to mandibular insertion. Maximum head width behind the stemmata. Urogomphi well curved but apically not converging to the median plane (Figs 30–31). Basal tooth with less distant apical spines. Conical appendage



Figures 24–35. The three European *Cucujus* species, larvae. **24–27** *C. cinnaberinus* **24** Head, dorsal view **25** Head, ventral view **26** Tergum IX and urogomphi, dorsal view **27** Tergum IX and urogomphi, ventral view **28–31** *C. haematodes* **28** Head, dorsal view **29** Head, ventral view **30** Tergum IX and urogomphi, dorsal view **31** Tergum IX and urogomphi, ventral view **32–35** *C. tulliae* **32** Head, dorsal view **33** Head, ventral view **34** Tergum IX and urogomphi, dorsal view **35** Tergum IX and urogomphi, ventral view.



Figures 36–44. The three European *Cucujus* species, larvae. **36–38** *C. cinnaberinus* **36** Urogomphi, lateral view and conical appendage (black arrow) **36** Conical appendage **38** Lateral end of tergum IX, sclerotized thorn **39–41** *C. haematodes* **39** Urogomphi, lateral view and conical appendage (white arrow) **40** Conical appendage **41** Lateral end of tergum IX, sclerotized thorn **42–44** *C. tulliae* **42** Urogomphi, lateral view and conical appendage (black arrow) **43** Conical appendage **44** Lateral end of tergum IX, sclerotized thorn.

slender and of different shape (Figs 39–41). Spiracular process inconspicuous ..... ***haematodes*** **Er.**

3 Head posteriorly sinuate and marked by very long antennae. Second antennomere a little longer than the first one. Apical antennomere six times longer than wide at the basis. Epistomal front margin strongly oblique towards the mandibular insertion. Frontal suture less sinuate than in previous species (Figs 32–33). Urogomphi strong and a little converging at the end, apex with three evident macrochaetae (Figs 34–35). Basal tooth of normal shape and slender. Spiracular process distinctly protrudent backwards (Figs 42–43). Lateral thorn of tergum IX strongly bent to the rear, forming an angle of ninety degrees (Fig. 44) ..... ***tulliae*** **sp. n.**

Conclusions

The new described taxon of saproxylic beetle, *Cucujus tulliae*, seems to be of limited distribution, at the moment the only two adult specimens, obtained by rearing, are known from Sila National Park, and a single larva has been captured in the Aspromonte National Park, always on dead Calabrian Pine trunks. It is not astounding that this very cryptic species escaped the capture by previous collectors, most of them were occasional visitors of the Sila plateau and this area has never been the object of a long term faunal survey. Moreover, in the older Italian reports (Ratti 1986, 2000) both *C. cinnaberinus* as well as *C. haematodes* were collected mainly on beech (*Fagus sylvatica*) or silver fir and normally in single specimens or very low numbers. The only exception that is known concerns *C. haematodes*, collected by Prof. Sandro Ruffo in more individuals on the Mt. Pollino (Calabria and Basilicata: Italy), in the year 1953, during a kind of "nuptial flight" (personal communication to the last author). Only after 2009 these saproxylic beetles seem to have expanded their habitat also into pure pine woods (Mazzei et al. 2011), perhaps as a consequence of changes in forest management – especially hands–off approach causing higher dead wood accumulations.

The new species seems to be also habitat restricted, in fact the larvae have been found only at three sites in Sila National Park, on northern exposures or at high elevations. Thus, further research is needed to assess the ecological requirements of the species.

The systematic position of *C. tulliae* sp. n. indicates an affinity with *C. haematodes* – body colour and male genital parts, especially the connection between median lobe and median strut (phallobase of other authors) are similar in both species. The new species may have evolved during a cold climate phase (glacial period?) from isolated *C. haematodes* populations. The smaller body size (if confirmed by new findings) speaks for less favorable conditions, as prey density or trunk sizes.

Concerning a first hypothesis on the conservation status of this southern Italian endemic, the evaluation as endangered (EN) in the IUCN categories seems appropriate – e.g. with respect to endemic *Osmoderma* spp. (Audisio et al. 2009). *C. tulliae* should be "ipso facto" included in the Italian red list of saproxylic beetles.

The second outstanding result of this study is that for the first time *C. haematodes caucasicus* Motsch. has been recognized as a valid subspecies, or perhaps as an allopatric species of the *haematodes* "species aggregate", the heterogeneity of which has been emphasized especially by Horák and Chobot (2009). Also Mamaev et al. (1977), basing on larval characters, considered *C. caucasicus* as a separate species, and a thorough reexamination of V. de Motschoulsky's diagnosis reveals that later authors severely underestimated his statements.

The *C. haematodes* group reveals to be not only extremely widespread in his Palaearctic distribution, but also highly influenced by isolation and tending to local speciation. A revision of this species aggregate could be of importance for conservation biology and for the relationships between saproxylic predators and history of palearctic forests.

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RESEARCH ARTICLE

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A new species of the genus *Microtendipes* Kieffer, 1915 (Diptera, Chironomidae) from Oriental China

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Abstract

A new species of the genus *Microtendipes* Kieffer, 1915, *M. zhejiangensis* **sp.n.**, is described, and its morphological description and illustrations are given. A catalogue of the genus in Oriental Region is provided and a key to the males of *Microtendipes* in the Oriental Region is given.

Keywords

Microtendipes, new species, key, catalogue, Oriental Region

Introduction

Microtendipes Kieffer, 1915 is a cosmopolitan genus, occurring in all zoogeographical regions. Immature stages of *Microtendipes* are found in littoral and sublittoral sediments of large water bodies, with a few species occurring in running water (Ashe et al. 1987; Cranston et al. 1989). So far, there are 61 species recorded around the word.

The Oriental Region includes all of Asia south and east of the Himalayan Mountains (India and South East Asia), as well as southern China and the Islands

of Southwestern Japan, Indonesia and Philippines. There was no catalogue of *Microtendipes* for the Oriental Region before this work, some previous records of Oriental *Microtendipes* are as follows: Kieffer (1921) recorded two new species based on the females, *M. stictopterus* Kieffer, 1921 from Philippines and *M. dimidiatus* Kieffer, 1921 from Taiwan Province (China), but Edwards (1929a) reviewed the Chironomidae from Philippines and recorded that the type specimen of *M. stictopterus* in Kieffer (1921) was too damaged for determination, *M. stictopterus* has been treated as nomen nudum; Reiss (1997) recorded *M. schuecki* Reiss, 1997 from Thailand; Chaudhuri et al. (2001) listed *M. callicomus* (Kieffer, 1911) from the Indian subcontinent, but *M. callicomus* ought to be treated as *Chironomus callicomus*; Wang (2000), Qi and Wang (2006) and Qi and Wang (2010) recorded 8 species of *Microtendipes* from Oriental China; Sasa and Suzuki (2000) recorded *M. iriocedeus* Sasa & Suzuki, 2000 from Southwestern Japan (Iriomote Island); Kikuchi and Sasa (1990) recorded *M. tobaquintus* Kikuchi & Sasa, 1990 from Indonesia (Toba Lake).

In this contribution, a new species of *Microtendipes* from Oriental China is described; the type localities map of the genus *Microtendipes* in Oriental China is given (Fig. 1); a catalogue and a key to the species of *Microtendipes* from the Oriental Region are presented.

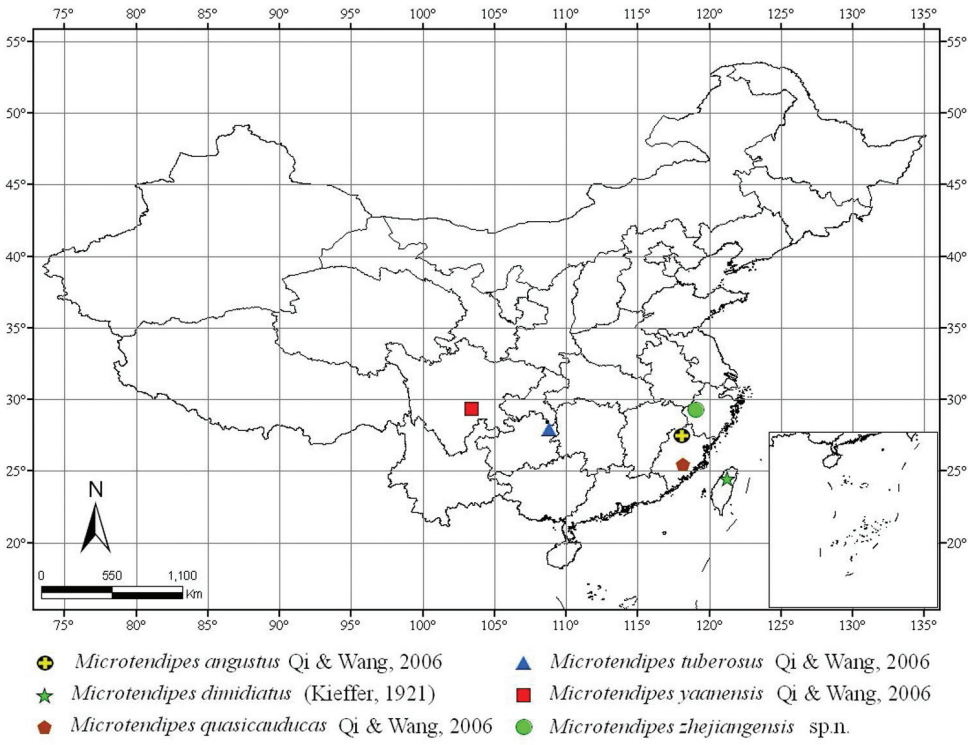


Figure 1. The type localities map of the genus *Microtendipes* in Oriental China.

Materials and methods

The morphological nomenclature follows Sæther (1980) and the abbreviations of parts measured follow Qi et al. (2012). The material examined was mounted on slides, following the procedure outlined by Sæther (1969). Specimens are deposited in the College of Life Science, Nankai University, China and College of Life Science, Taizhou University, China.

Taxonomy

Genus *Microtendipes* Kieffer, 1915
http://species-id.net/wiki/Microtendipes

Microtendipes Kieffer, 1915: 70; Pinder 1978: 128; Qi and Wang 2006: 37.

Type species. *Tendipes abbreviatus* Kieffer, 1913 [= *Chironomus chloris* (Meigen, 1818)]

Diagnosis. Most males of *Microtendipes* can be distinguished from all other Chironomini by one or two rows of stout, proximally directed setae on the fore femur. Additionally, the hypopygium of some species generally has a tubercle or wart-shaped median volsella often bearing a tuft of long setae. Species without the above characters require association with immature stages for correct placement in the genus; moreover, *Microtendipes* can be divisible into two species-groups (*pedellus* group and *rydalensis* group) with recourse to immature stages. The characters of larva are as follows: the body is large, red to orange coloured, up to 15 mm long; the antenna has 6 segments; the lauterborn organs alternate on apices of segments 2 and 3; the mandible has 3 inner teeth; the median trifid is either pale or as dark as remaining teeth with very small median tooth (maybe absent); the lateral and ventral tubules are absent.

Distribution. Palaearctic, Oriental, Nearctic, Neotropical and Australian regions.

A catalogue of *Microtendipes* in Oriental Region

***Microtendipes angustus* Qi & Wang, 2006**
Microtendipes angustus Qi & Wang, 2006: 38.
Oriental China (Fujian, Guizhou Province).

***Microtendipes britteni* (Edwards, 1929)**
Chironomus (*Microtendipes*) *britteni* Edwards, 1929b: 399.
Microtendipes britteni (Edwards): Pinder 1978: 128; Wang 2000: 645; Qi and Wang 2006: 40; Qi and Wang 2010: 497.
Oriental China (Guangdong, Guizhou, Zhejiang Province)

***Microtendipes chloris* (Meigen, 1818)**
Chironomus chloris Meigen, 1818: 28
Microtendipes chloris (Meigen): Pinder 1978: 128; Qi and Wang 2010: 497.
Oriental China (Zhejiang Province)
***Microtendipes dimidiatus* (Kieffer, 1921)**
Chironomus (*Microtendipes*) *dimidiatus* Kieffer, 1921: 581
Oriental China (Taiwan Province)
***Microtendipes iriocedeus* Sasa & Suzuki, 2000**
Microtendipes iriocedeus Sasa & Suzuki, 2000: 3, 12.
Southwestern Japan (Iriomote Island)
***Microtendipes pedellus* (De Geer, 1776)**
Tipula pedellus De Geer, 1776: 378
Chironomus aberrans Johannsen, 1905: 221
Microtendipes pedellus (De Geer): Edwards 1929b: 397 ; Wang 2000: 645; Qi and Wang 2006: 41.
Oriental China (Guizhou, Zhejiang Province); South India
***Microtendipes quasicauducas* Qi & Wang, 2006**
Microtendipes quasicauducas Qi & Wang, 2006: 41.
Oriental China (Fujian Province)
***Microtendipes schuecki* Reiss, 1997**
Microtendipes schuecki Reiss, 1997: 271.
Thailand (DoI Inthanon)
***Microtendipes tobaquintus* Kikuchi & Sasa, 1990**
Microtendipes tobaquintus Kikuchi & Sasa, 1990: 301.
Indonesia (Toba Lake)
***Microtendipes truncatus* Kawai & Sasa, 1985**
Microtendipes truncatus Kawai & Sasa, 1985: 18; Qi and Wang 2006: 43.
Oriental China (Zhejiang, Fujian, Guizhou, Yunnan Province)
***Microtendipes tuberosus* Qi & Wang, 2006**
Microtendipes tuberosus Qi & Wang, 2006: 43.
Oriental China (Guangdong, Guizhou, Hainan Province)
***Microtendipes yaanensis* Qi & Wang, 2006**
Microtendipes yaanensis Qi & Wang, 2006: 45; Qi and Wang 2010: 497.
Oriental China (Zhejiang, Sichuan Province)

Key to males of the genus *Microtendipes* in Oriental region[#]

1	Hypopygium with median volsella	**2**
–	Hypopygium without median volsella	**7**
2	Superior volsella with lateral lobe	**3**
–	Superior volsella without lateral lobe	**5**
3	Wing with dark markings	***M. schuecki***
–	Wing transparent, without markings	**4**

4 Front femur with small tubercle ..... ***M. tuberosus***
– Front femur without small tubercle ..... ***M. yaanensis***
5 Anal point subtriangular ..... ***M. pedellus***
– Anal point parallel sided **6**
6 Superior volsella hook-like ..... ***M. chloris***
– Superior volsella broad, rounded apically ..... ***M. truncatus***
7 Inferior volsella abruptly narrowed in apical half **8**
– Inferior volsella digitiform **9**
8 Anal point apically slightly swollen and rounded; superior volsella with 4 dorsal setae, 2 basal setae ..... ***M. angustus***
– Anal point parallel-sided, slender, apex rounded; superior volsella with 7–10 dorsal setae, 4 long basal setae ..... ***M. zhejiangensis* sp.n.**
9 Wing with dark markings ..... ***M. quasicauducas***
– Wing transparent, without markings **10**
10 Abdominal tergite VIII narrowed at base, as inverted V-shaped .... ***M. iriocedeus***
– Abdominal tergite VIII not narrowed at base **11**
11 Anal point parallel-sided, slender, apex rounded ..... ***M. tobaquintus***
– Anal point subtriangular, with pointed apex ..... ***M. britteni***

The record of *M. dimidiatus* was only based on female, so the key does not include it.

***Microtendipes zhejiangensis* sp.n.**
urn:lsid:zoobank.org:act:96DD36A0-80C8-4175-9F46-33AC31F7E6B4
http://species-id.net/wiki/Microtendipes_zhejiangensis
Figs 2–5

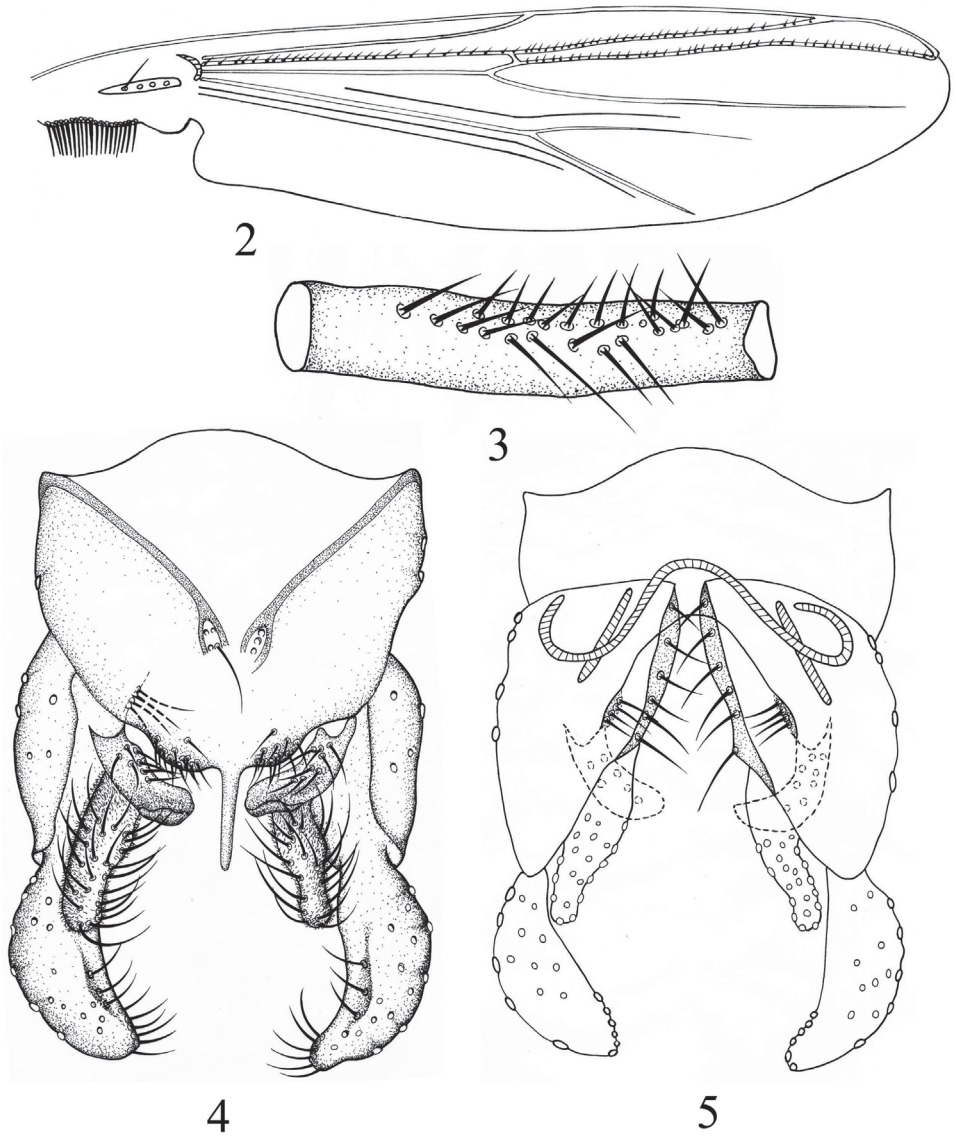
Diagnosis. The male imago can be distinguished from known species of the genus by the following combination of characters: superior volsella hook-like, apex obtuse, with 7–8 dorsal setae and 4 long basal setae; median volsella absent; absence of pigment marks in wing; acrostichals 2–3.

Description. Male imago (n = 3). Total length 5.75–6.05 mm. Wing length 3.38–3.48 mm. Total length/wing length 1.65–1.79. Wing length/length of profemur 2.25–3.71.

Coloration. Head yellow. Thorax greenish yellow with scutum and postnotum brown. Abdomen greenish yellow, Abdominal tergites I–VI pale green, tergites VII–IX and hypopygium brown. Legs: apical 1/3 of fore femur, basal 1/2 of fore tibia and apical 1/10 of tibiae brown; remaining parts greenish yellow.

Head. AR 1.82–2.48. Temporal setae 16–19 including 6–8 inner verticals, 6–10 outer verticals, and 2–3 postorbitals. Clypeus with 37–38 setae. Tentorium 205–240 mm long, 55–70 mm wide. Palpomere lengths (in mm): 60–65, 63–73, 310–330, 330–350, 460–480. L: $5^{th}/3^{rd}$ 1.39–1.54.

Wing (Fig. 2). VR 1.07–1.13. B with 4 setae; R with 27–28, R_1 with 24–32, R_{4+5} with 31–49 setae. Squama with 18–20 setae.



Figures 2–5. *M. zhejiangensis* sp.n., male. **2** wing **3** two rows of directed setae in front femur **4** hypopygium (dorsal view) **5** hypopygium (ventral view).

Thorax. Dorsocentrals 17, acrostichals 2–3, prealars 4. Scutellum with 10–25 setae.

Legs (Fig. 3). Distal half of front femur with 23–25 proximally directed setae in 2 rows, 180–200 mm long. Spur on median tibiae 25–33 mm long including 28–30 mm long comb, unspurred comb 25–33 mm long; spur on posterior tibia 33–40 mm long including 25–33 mm long comb, unspurred comb 28–30 mm long. Width at apex of front tibia 80–87 mm, of middle tibia 83–85 mm, of hind tibia 90–95 mm. Lengths (in mm) and proportions of legs in Table 1.

Table 1. Lengths (in μm) and proportions of legs of *Microtendipes zhejiangensis* sp.n. (n = 3).

	P_1	P_2	P_3
fe	1375–1500	1625–1700	1875–1875
ti	1550–1700	1525–1575	1700–1800
ta_1	1900–2075	1025–1100	1250–1300
ta_2	875–975	525–550	750–825
ta_3	875–950	420–450	575–600
ta_4	775–825	275–290	350–360
ta_5	325–350	150–150	150–160
LR	1.21–1.22	0.68–0.72	0.71–0.72
BV	1.70–1.72	3.00–3.04	2.52–2.64
SV	1.54–1.55	2.93–3.05	2.83–2.90
BR	2.21–2.50	3.40–3.75	2.67–4.75

Hypopygium (Figs 4–5). Anal point 78–90 mm long, parallel-sided, slender, apex rounded. Tergite IX with 6–9 long setae medially and 22–36 setae along posterior margin. Phallapodeme 90–113 mm long; transverse sternapodeme 50–70 mm long. Gonocoxite 223–238 mm long. Superior volsella 105–125 mm long, hook-like, apex obtuse, with 7–10 dorsal setae and 4 long basal setae. Inferior volsella digitiform, 110–140 mm long, narrowed in apical 1/2, with 29–32 setae. Gonostylus 143–148 mm long, with 9–10 setae along inner margin in distal 1/2. HR 1.51–1.64, HV 4.08–4.32.

Female, pupa and larva are unknown.

Type materials. Holotype: 1♂, China, Zhejiang: Kaihua County, Gutian Mountain, 29°14.27'N, 118°07.13'E, 7.iv.2011, Lin XL, sweeping method. Paratype: 2♂♂, same as holotype.

Etymology. The species is named after the type locality, using the Latin suffix *–ensis*, denoting place of origin.

Remarks. The new species is similar to *M. pedellus* (De Geer), but can be separated from *M. pedellus* (De Geer) on the basis of the following: (1) presence of median volsella in *M. pedellus* (De Geer), with 3 long setae in the median volsella; whereas absence of median volsella in *M. zhejiangensis* sp.n.; (2) the inferior volsella of *M. pedellus* (De Geer) digitiform, with 20 setae, whereas the inferior volsella of *M. zhejiangensis* sp.n. narrowed in apical 1/2, with 29–32 setae; (3) HV of *M. pedellus* (De Geer) 2.98–3.36, whereas HV of *M. zhejiangensis* sp.n. 4.08–4.32.

The new species is also similar to *M. nitidus* (Meigen, 1818). The superior volsella of *M. nitidus* (Meigen) has a basal expansion bearing more than 5 long setae mesally, but the superior volsella of *M. zhejiangensis* sp.n. is not expanded basally, with 4 long basal setae separated from each other.

This new species can be separated from *M. quasicaducas* Qi & Wang on the basis of the following characters: (1) the anal point of *M. quasicaducas* Qi & Wang slender, tapering from base, and apically pointed; whereas the anal point of *M. zhejiangensis* sp.n. parallel–sided, slender, apex rounded; (2) the wing with pigment marks in *M. quasicaducas* Qi & Wang, but the wing without marks in *M. zhejiangensis* sp.n.; (3) the

acrostichals 2–3 in *M. zhejiangensis* sp.n., whereas the acrostichals of *M. quasicaducas* Qi & Wang lacking.

This new species can also be separated from *M. zhamensis* Qi & Wang, 2006 on the basis of the following characters: (1) the anal point of *M. zhamensis* Qi & Wang slender, pointed; whereas the anal point of *M. zhejiangensis* sp.n. parallel-sided, slender, apex rounded; (2) presence of median volsella in *M. zhamensis* Qi & Wang, with 2 setae in median volsella; absence of median volsella in *M. zhejiangensis* sp.n.; (3) the inferior volsella of *M. zhamensis* Qi & Wang digitiform, with 24 setae; whereas the inferior volsella of *M. zhejiangensis* sp.n. narrowed in apical 1/2, with 29–32 setae; (4) the acrostichals 2–3 in *M. zhejiangensis* sp.n., whereas the acrostichals of *M. zhamensis* Qi & Wang lacking.

Distribution. The species is known from Zhejiang Province of China.

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