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A new *Muricea* species (Cnidaria, Anthozoa, Octocorallia) from the eastern tropical Pacific

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Abstract

The genus *Muricea* is considered abundant and widely distributed along the eastern Pacific. Its occurrence in shallow waters has been recognised; however species from deeper than 30 m have been rarely recorded. During the 2005 R/V Urracá expedition along the north and central Pacific coast of Costa Rica several octocoral specimens were collected by bottom trawling from 30 to 150 m yielding new species and new records. Herein we describe a new species of *Muricea* from deeper than 30 m. The morphological characters of the species were analysed and illustrated by optic and scanning electron microscopy. *Muricea subtilis* **sp. n.** can be distinguished from the other species in the genus by its thin spiny branches, non-imbricate calyces, white colony and sclerites, and the size and composition of sclerites. Comparative character tables are provided for the closest *Muricea* species-group. This new species increases the number in the genus to 26, and contributes to the knowledge on the diversity and distribution of mesophotic soft corals in the eastern Pacific.

Keywords

Alcyonacea, Cnidaria, eastern Pacific, mesophotic zone, *Muricea subtilis*, new species, plexaurid, soft corals, taxonomy

Introduction

The genus *Muricea* is considered abundant and widely distributed in shallow waters (< 30 m) along the eastern Pacific and was recently revised and updated to contain 25 valid species (Breedy and Guzman 2015, 2016). *Muricea* has been reported from Cape Hatteras, North Carolina to Brazil, including Bahamas, Greater and Lesser Antilles, and Caribbean islands (Bayer 1961); it also occurs in the eastern Pacific from southern California to Perú and presumably in Chile (Breedy and Guzman 2016).

Muricea midas Bayer, 1959 is the deepest record for the genus, at 201 m in the western Atlantic (Bayer 1959); and *Muricea fruticosa* Verrill, 1869, is known to 102 m in the eastern Pacific. *Muricea galapagensis* Deichmann, 1936, known from 94 m, was only once collected. Normally, the genus occurs shallower from one meter in intertidal zones to 30 m deep (Breedy and Guzman 2016). However, several species have been found in deeper mesophotic zones requiring further exploration and taxonomic work.

According to Breedy and Guzman (2016) boundaries among species of *Muricea* (as in many other octocorals) are difficult to draw. However, the morphological characters such as colony and sclerite shapes, sizes and colours still represent a valid approach to determine species together with field observation (e.g. habitat, bathymetry). The genus was divided in four groups according to the morphology of colonies and sclerites: the *Muricea squarrosa* species-group, *Muricea fruticosa* species-group, the *Muricea austera* species-group and the *Muricea plantaginea* species-group (Breedy and Guzman 2015, 2016).

Herein we describe a new mesophotic *Muricea* species collected during the 2005 R/V Urracá-STRI expedition to the Pacific coast of Costa Rica, that resulted in interesting material from deeper waters (see Vargas-Castillo 2008).

Material and methods

The specimens were collected by bottom trawling from unexplored habitats down to 70 m deep in the middle mesophotic zone (from 40 to 150 m), on board of the Smithsonian Tropical Research Institute R/V Urracá along the north and central Pacific coast, from Santa Elena Bay to the Nicoya Gulf.

The specimens were fixed in 70% ethanol or air-dried. For microscopic study, they were prepared according to the protocol described by Breedy and Guzman (2002), and observed using optic microscopy, Olympus LX 51 inverted microscope, and scanning electron microscopy, with a Hitachi 3700 at the Research Center of Microscopic Structures (CIEMIC) of the University of Costa Rica (UCR) and a Zeiss EVO 40 at the Electron Microscopy Laboratory (Tupper Research and Conference Center). The holotype and paratypes are deposited in the Museo de Zoología, Universidad de Costa Rica (MZUCR).

The taxonomic approach was by the evaluation of characters following Breedy and Guzman (2015, 2016). Morphological characters of colonies and sclerites are presented in Tables 1–2 and comparison with the type material of the related taxa in the genus. Measurements of branches are given taking in account the length of the calyces whether preserved in ethanol or dry. Terminology used in descriptions mostly follows Bayer et al. (1983) and Breedy and Guzman (2015, 2016).

Results

Class Anthozoa Ehrenberg, 1834
Subclass Octocorallia Haeckel, 1866
Order Alcyonacea Lamouroux, 1812
Family Plexauridae Gray, 1859

Genus *Muricea* Lamouroux, 1821

Muricea Lamouroux, (pars.) 1821: 36; Blainville (pars) 1834: 509; Ehrenberg (pars.) 1834: 134; Dana 1846: 673; Milne Edwards and Haime 1857: 142; Kölliker 1865: 135; Verrill 1868: 411; Verrill 1869: 418–419, 450; Studer 1887: 58; Wright and Studer 1889: 93; Gorzawsky 1908: 8; Nutting 1910: 9; Kükenthal 1919: 835; 1924: 141; Riess 1929: 383–384; Aurivillius 1931: 102–104; Deichmann 1936: 99; Bayer 1956: F210; 1959: 12; 1961: 179–180; 1981: 930 (in key); 1994: 23–24; Tixier-Durivault 1970: 154; Harden 1979: 140; Hardee and Wicksten 1996: 127–128; Marques and Castro 1995: 162; Castro et al. 2010: 779; Breedy and Guzman 2015: 6–7; 2016: 7–9.

Eumuricea (pars.) Verrill, 1869: 449; Riess 1929: 397; Breedy and Guzman 2015: 6–7.

Type species. *Muricea spicifera* Lamouroux, 1821, by subsequent designation (Milne Edwards and Haime 1857.)

Genus diagnosis (based on Breedy and Guzman 2016). Colonies planar or multiplanar, bushy, arborescent, laterally branched, pinnately branched, dichotomous or with long flexible branches, with some occasional branch anastomosis. Branches and branchlets upward bending almost parallel, and with about the same thickness all along, frequently with slightly enlarged tips. Coenenchyme moderately to very thick (compared to other plexaurids) with a circle of longitudinal canals surrounding the axis and dividing the coenenchyme into a thin inner layer or axial sheath, and a thicker outer layer. The outer and inner layer of coenenchyme indiscriminate, almost blended in species with thinner branches. In some species with a thin coenenchyme polyps fully retractile within prominent calyces longitudinally and closely placed all around branches and branchlets, or spaced in loose spirals around branches and branchlets. Calyces prominent, shelf-like or tubular, with prickly projecting spindles, longitudinally arranged. Base of anthocodia without sclerites or with flat rods arranged in weakly differentiated collaret and points below tentacles, or just transversely set along the neck zone of polyp. Sclerites of outer coenenchyme and of calyx mostly long, unilateral spinous spindles, often massive, sculptured on inner surface by crowded complex tubercles and on outer surface by simple spines or prickles, and in some species with a few more or less prominent coarse, prickly projections. Spindles with laterally placed spinous or leaf-like processes are the dominant type in some species. Axial sheath composed of capstans, spindles, or oval forms, and undeveloped sclerites. Sclerite colours are white, various hues of yellow, amber, orange, purple and red. Anthocodials with lower hues.

Muricea subtilis **sp. n.**
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Figures 1–3

Material. Holotype: UCR 2322 (URR 46), ethanol preserved, off Esterillos, Puntarenas, Central Pacific, Costa Rica, 09°20.940'N, 84°30.240'W–09°21.242'N, 84°30.043'W, 51.7–53 m, R. Vargas, R/V Urraca, 17 July 2016. UCR 2322A, fragment for molecular analysis in progress.

Paratypes: MZUCR-OCT 0082 (URR 44), ethanol preserved, off Punta Mala, Puntarenas, 09°22.085'N, 84°32.206'W–09°22.280'N, 84°32.037'W, 44.2–44 m, R. Vargas, 17 July 2005; MZUCR-OCT 0125 (URR 26–53), dry, off Carrillo Beach, Nicoya, Guanacaste, 09°51.264'N, 85°29.37'W–09°50.727'N, 85°29.37'W, 39–40 m, R. Vargas, R/V Urraca, 16 July 2005; MZUCR 0126 (TWL 27–36), dry, off Carrillo Beach, 09°50.013'N, 85°29.476'W–09°49.88'N, 85°29.40'W, 30–32 m, R. Vargas, R/V Urraca, 16 July 2005; MZUCR 0140 (URR 47), dry, off Esterillos, 09°20.212'N, 84°28.358'W–09°21.610'N, 84°28.275'W, 51.7–53 m, R. Vargas, R/V Urraca, 17 July 2016; UCR 2321 (URR 46), as the holotype.

Type locality. 09°20.940'N, 84°30.240'W (off Esterillos, Puntarenas), 53 m in depth.

Diagnosis. Colonies spiny and delicate in appearance, fan-like or lateral. Branching irregular, mostly dichotomous, in one or two planes. Branches and branchlets thin, 1.5–2 mm in diameter, in some cases thinner, about 1 mm. Some branch pseudo-anastomosis present. Polyps mostly close together. Calyces shelf-like, prominent, up to 1.2 mm. Calyces not imbricate. Coenenchyme thin. Coenenchymal and calycular sclerites mostly leaf-like spindles up to 0.95 mm long. Anthocodial sclerites mostly irregular warty rods and thin torches, translucent or whitish. Colony colour whitish to pale yellow.

Description. The holotype is a 14.5 cm tall and 23 cm wide colony. A 15 mm long stem, 6 mm in diameter, subdivide in two main branches, 4–5 mm diameter and arise from an irregular, 15 mm diameter holdfast (Figure 1A). The branches are about the same diameter at the bottom of the colony 3–4 mm producing thinner branchlets 2–3 mm diameter up to the ends. Branching is irregular, mostly dichotomous, branches and branchlets project at angles 45°–75°and separated up to 25 mm. They spread in one plane in a fan-like colony. The branchlets are straight or curved inwards, some are anastomosed. Unbranched terminal ends are about 2 mm in diameter and up to 40 mm long. The axis is amber. The calyces are shelf-like, 1–1.2

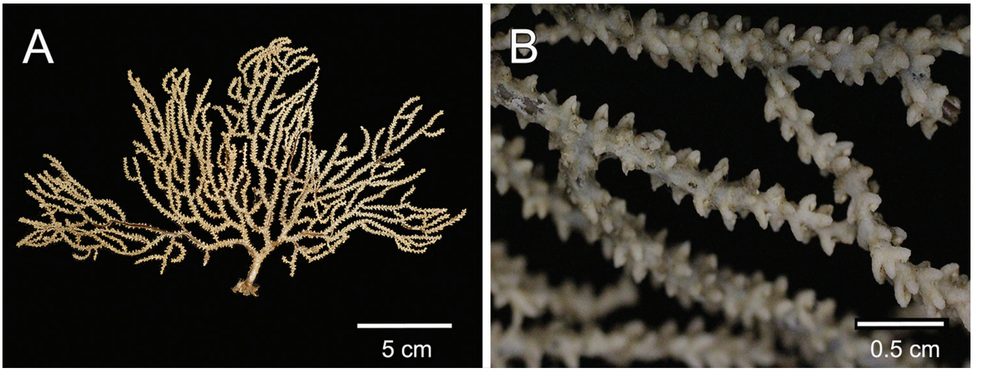

Figure 1. *Muricea subtilis* sp. n., UCR 2322 (holotype). **A** Colony **B** Detail of branches.

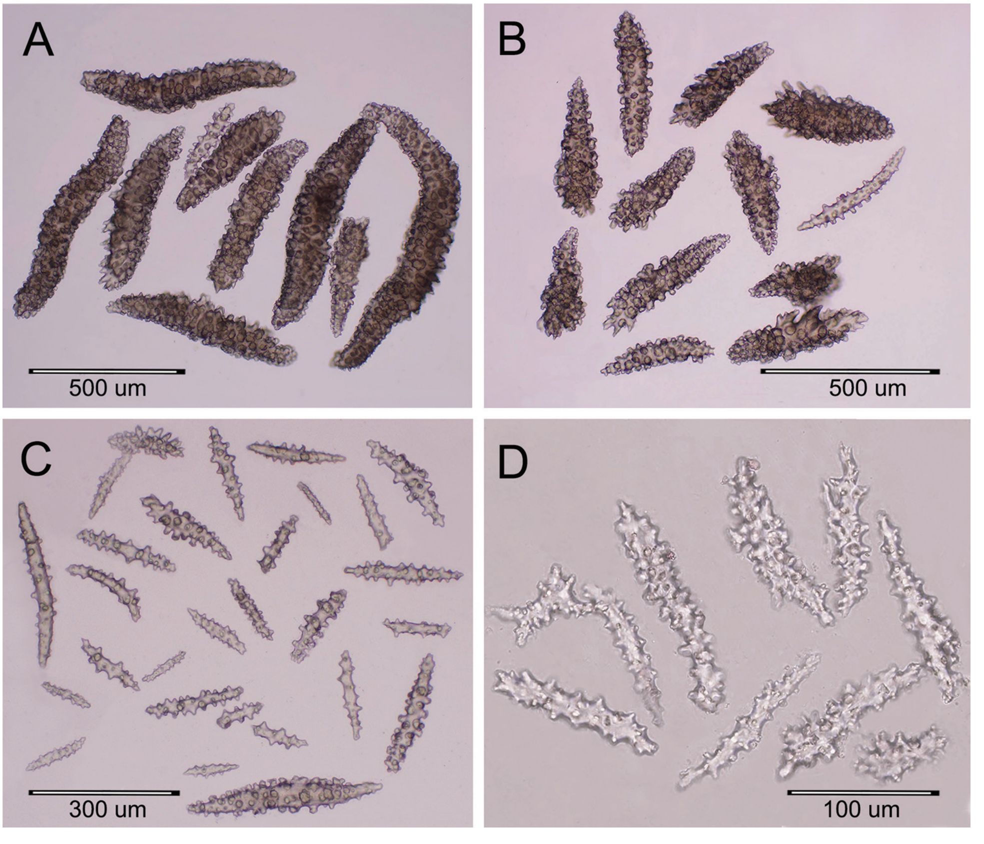

Figure 2. *Muricea subtilis* sp. n., UCR 2322 (holotype). **A–C** Coenenchymal sclerites **D** Anthocodial sclerites (optic micrographs).

mm long, giving a spiny appearance to the colony. They are close together, or only a few millimetres apart, 0.5–1.5 mm, and not imbricate (Figure 1B). Some branches are devoid of polyps, probably eaten by worms. Polyps are on the upper side of the

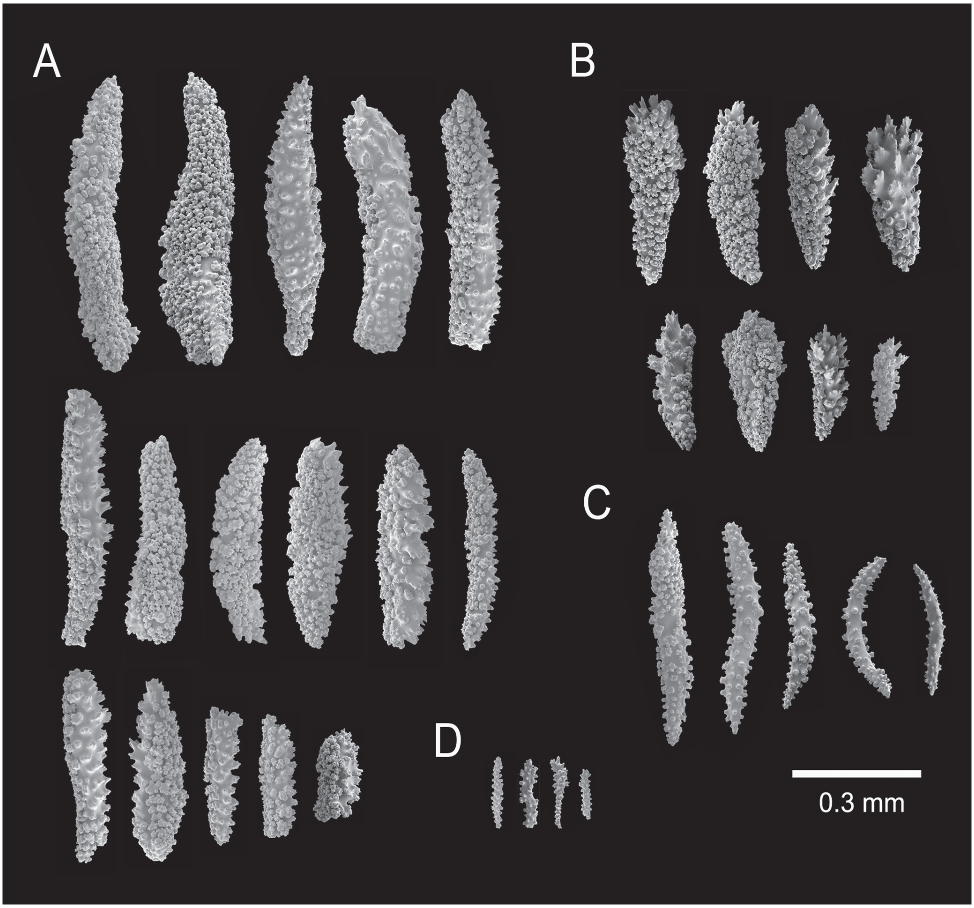

Figure 3. *Muricea subtilis* sp. n., UCR 2322. **A–B** Calycular and coenenchymal sclerites **C** Axial sheath **D** Anthocodial sclerites.

elongated calyces. The calyx size and spacing vary from the larger branches to the thinner, being larger and acute, and closer placed at the branchlets and shorter, and distant at the main branches and almost absent at the stem. The coenenchyme is thin, composed of whitish and translucent sclerites, mostly of various kinds of spindles (Figure 2A–C). The coenenchyme and the calycular sclerites are mostly leaf-like spindles, 0.25–0.93 mm long, and 0.09–0.20 mm wide and spindles, 0.40–0.60 mm long and 0.06–0.10 wide (Figure 3A–C). The axial sheath is composed of spindles, 0.25–0.45 mm long and 0.04–0.07 mm wide (Figure 3D). The anthocodial sclerites are translucent irregular warty rods, thin torches, irregular short spindles, 0.05–0.2 mm long, and 0.01–0.05 mm wide (Figures 2D, 3D). The colony is whitish to pale yellow (Figure 1A–B).

The paratypes agree in all characters with the holotype; however, some colonies have thinner branchlets, about 1 mm in diameter, and the leaf-like spindles can reach 0.95 mm long.

Etymology. The adjective *subtilis* (L) meaning fine, thin, delicately slender, of a cutting edge, is used here, in allusion to the thin and spiny branches characteristic of the species. The term *subtilis* in literature combines sharpness and acuteness that imply clarity which could also evoke the white colour of the colony.

Habitat and distribution. The species has been collected from muddy-sand bottoms, together with other octocoral species such as *Muricea fruticosa* Verrill, 1869; *Pacifigorgia senta* Breedy & Guzman, 2003, and other invertebrates from 30 to 54 m deep. A few species of gorgonians were the dominant component of the catches; some specimens were attached to debris or shells that probably hold the colonies on the mud-sandy substrate. *Muricea subtilis* sp. n. was collected along the outer part of Nicoya Gulf and central Pacific coast of Costa Rica.

Discussion

The species belongs to the *M. plantaginea* species-group together with *M. mortensenii* and *M. californica*. According to Breedy and Guzman (2016) this species-group is characterised by shelf-like calyces, thin coenenchyme, thin branches and the lack of unilateral spinous spindles (as defined for the genus). The new species' delicate spiny colony, almost immediately separates it from the others in the group. However, it is similar to *M. plantaginea* (Valenciennes, 1846), white variety and *M. mortensenii* Hickson, 1928 in the colour of the colony and sclerites. It differs from the latter in its thicker branches, shorter calyces and smaller spindles that are the dominant type of sclerites in *M. mortensenii* (Tables 1–2). *Muricea plantaginea* is distinguished from *Muricea subtilis* sp. n. in having thicker non-dichotomous branches, and mostly flabellate colonies with stronger structure that is evident also in small, young colonies of *M. plantaginea*. The imbricate calyces and larger leaf-like spindles, up to 1 mm or slightly more (Table 1–2) in *M. plantaginea* are also features that differentiate these two close species.

Table 1. Diagnostic characters of sclerites in the *Muricea plantaginea* species-group. Measurements given are from the holotypes and lectotypes, in mm.

Species	Sclerite colours	Anthocodial sclerite colours	Dominant type of coenenchymal and calycular sclerites	Coenenchymal and calycular spindles maximum size	Anthocodial maximum size
M. plantaginea	rb, amb/w	lo, lb/w	ls	1×0.2	0.25×0.08
M. californica	ro, ly, amb	lo	ls	0.54×0.2	0.23×0.06
M. mortensenii	w	w	s	0.7×0.12	0.21×0.08
M. subtilis sp. n.	w	w	ls	0.93×0.14	0.20×0.05

Colours: amb, amber; lb, light brown; lo, light orange; rb, reddish brown; ro, reddish orange; w, white, colourless. Type of coenenchymal and calycular sclerites: ls, leaf-like spindle; s, spindles.

Table 2. Diagnostic characters of colony morphology in the *Muricea plantaginea* species-group. Measurements given are from holotypes and lectotypes, in mm.

Species	Colony colour	Colony shape	Branching pattern	Length of unbranched terminal branchlets	Diameter of end branchlets (mm)	Calyx height at branchlets	Calyx arrangement at branchlets
M. plantaginea	db/w	fla	irr, lat	10–50	2–3	0.7–1.2	c, imbr
M. californica	ro	bu	irr, lat	0.5–2.8	3–3.2	1.1–1.9	c, slightly imbr
M. mortensenii	py	fla	irr	2–4	2–3	0.7–1	c
M. subtilis sp. n.	py,w	lat, fla	irr, lat, dich	5–40	1.5–2	1–1.2	c

Colours: db, deep brown; py, pale yellow; ro, reddish orange; w, white, colourless.
Colony shape: bu, bushy; fla, fan-like, flabelliform.
Branching pattern: dich, irregularly dichotomous; irr, irregular; lat, lateral.
Calyx arrangement at branchlets: c, close, not imbricate; imbr, imbricate.

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RESEARCH ARTICLE

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Two new mite species of the genus *Zygoseius* Berlese from Mexico (Acari, Mesostigmata)

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Abstract

Two new species of mites of the genus *Zygoseius* Berlese, *Z. papaver* **sp. n.** and *Z. lindquisti* **sp. n.**, collected from moss and flood debris, respectively, in a creek in Chiapas State, Mexico, are described herein.

Keywords

Gamasina, Pachylaelapidae, taxonomy, Chiapas, North America

Introduction

The genus *Zygoseius* Berlese, 1916 is a moderately small genus of mesostigmatic mites, with 13 described species currently. It was first defined by Berlese (1916) as a subgenus of *Lasioseius* Berlese, 1916, with description of the species *Z. furciger*, collected from ants' nests in Argentina. The genus was variously reviewed by Halliday (1997), Karg (1998) and Karg and Schorlemmer (2009). *Zygoseius* species are found in soil, leaf litter, moss, compost, cow and chicken dung, and ants' nests (Halliday 1997, Karg 1998, Karg and Schorlemmer 2009). Some species were found in association with insects, namely dung beetles (e.g. *Z. furciger* (Costa 1963) and *Z. sarcinulus* Halliday, 1997

(Halliday 1997)). Feeding behavior has been observed for one species, *Z. furciger*, which fed readily on nematodes (Walter and Ikonen 1989).

The taxonomic placement of *Zygoseius* is still problematic and authors placed it in various families: Ascidae *sensu lato* or Blattisociidae (Evans 1958, Sheals 1962, Costa 1963, Hyatt 1964), Halolaelapidae (Karg 1998, Christian and Karg 2006, Karg and Schorlemmer 2009), Laelapidae (Vitzthum 1943) and Pachylaelapidae (Lindquist and Evans 1965, Hafez and Nasr 1982, Krantz and Ainscough 1990, Halliday 1997, Moraza and Peña 2005, Lindquist et al. 2009, Childers and Ueckermann 2015). Mašán and Halliday (2014) excluded the genus from Pachylaelapidae based on its leg chaetotaxy and the two dorsal shields of the deutonymphs. Recently, the molecular analyses of Sourassou et al. (2015) suggest that *Zygoseius* is related to members of the superfamily Rhodacaroidea.

Materials and methods

Mite specimens were collected from moss and debris in Chiapas State (officially the Free and Sovereign State of Chiapas), Mexico, in May 1969. All specimens had been extracted from samples using Berlese-Tullgren funnels, then cleared in lactophenol and mounted in Hoyer's medium on microscope slides. Specimens were examined using a Zeiss Axio Imager M2 and a Leica DM 2500 compound scopes, attached to cameras AxioCam ICc 5 and ICC50 HD, respectively. Images and morphological measurements were taken via ZEN 2012 software (version 8.0) and Leica Application Suite (LAS) software (version 4.2, Live and Interactive Measurements modules). More than 120 morphological characters were examined and measured for each species. All the measurements were given as ranges of minimum–maximum, in micrometers (μm). Lengths of shields were taken along their midlines from the anterior to posterior margins; widths were measured approximately at mid-level (at the widest point) for the dorsal shield, between mid-level of coxae II (at the narrowest point) for the female sternal shield, and from the posterior part of coxae IV (at the widest point) for the male holoventral shield. Epigynal shield lengths were measured along their midlines from anterior margin of hyaline extension to posterior shield margin and also from the level of setae *st5* to the posterior shield margin. Epigynal and ventrianal shield widths were measured at the widest point, past *st5* level, and near *ZV2* level, respectively. Leg lengths were measured ventromedially from the base of coxa to the apex of tarsus, excluding the ambulacrum (ambulacral stalk, claws and pulvillus); lengths of leg segments were taken dorsomedially. Ambulacra were measured ventromedially including pulvilli and claws. Setae lengths were measured from the bases of their insertions to their tips. Distances between setae were measured from the center of the setal alveolae. Corniculi were measured from the apex to the median section of posterior margins. Chelicera lengths were measured for: the first or basal segment, second segment (from base to apex of the fixed digit; width measured at the widest point), fixed digit (from dorsal poroid to apex) and movable digit (from base to apex). Length of peritreme was measured from the anterior margin of stigmata to the anterior end of peritreme. Length and width of anal opening were measured excluding the raised band of cuticle surrounding the anus. Idiosomal notation for setae used in this paper follows that of Lindquist and Evans (1965). The notations for leg and palp setae follow those of Evans (1963a, 1963b). Idiosomal and peritrematal shield notations for pore-like structures (gland pores and poroids/lyrifissures) follow the systems of Athias-Henriot (1971) for ventral idiosoma and Athias-Henriot (1975) for dorsal idiosoma. The notations of spermathecal structures are based on Athias-Henriot (1968) and Evans and Purvis (1987).

Results

Zygoseius papaver **sp. n.**
http://zoobank.org/0DFF7672-E02A-48B3-90D8-1CC9D5601100
Figures 1–14, 27–31, Plate 1

Diagnosis (female). Dorsal shield oval, well-reticulated throughout, except nearly smooth medially between setae *j6–J4*; shield with serrated lateral margins. Dorsal setae smooth, relatively short, all <35 long, some podonotal (*s3–5*, *z6*) and opisthonotal (*J1*, *J2*, *J4*, *Z1–4*) setae longer than other setae; setae *J5* strongly mesad, and slightly anterad *Z5*. Sternal shield irregularly and sparsely micropunctate, with a transverse, recurved linea posterad level of setae *st1*. Epigynal shield punctate, mostly anteriorly and laterally. Ventrianal shield wider than long, lineate except anterad anus, and punctate except in anterior fourth; setae *JV1–2* 1.5–2× as long as other setae on shield. Peritrematal shield micropunctate; punctae larger in poststigmatic region. Soft lateral and opisthogastric integument bearing nine pairs of short setae. Epistome bifurcate, distal haves of projections bipectinate. Hypostomal setae *h1* twice as long as *h2* and 1.5× as long as *h3*. Cheliceral movable digit with two subapical, unconspicuous teeth. Cheliceral fixed digit with two subapical teeth. Genua II–III with 10 and 8 setae, lacking setae *av* and *pv*, respectively. Spermathecal apparatus with globular spermatheca separated from small, ring-like sperm reservoir by a thick-walled, short duct; spermatic canal long, narrow.

Description. *Female* (n = 11). *Dorsal idiosoma* (Figs 1, 28). Dorsal shield ovoid, 340–374 long, 252–275 wide (length/width ratio: 1.26–1.44), completely covering idiosoma, slightly widened posteriorly. Shield margins serrated posterolaterally from level of setae *r3*. Shield well-reticulated throughout, except more or less smooth medially in *j5–6* region and in median narrow band between setae *j6–J4*. Reticulations in opisthonotal region densely covered with small punctae. Posterior region between pairs of setae *J4*, *Z4*, *J5* with large punctae, not reticulate. Dorsal shield bearing 37 pairs of setae, 23 and 14 pairs on podonotal and opisthonotal regions, respectively; setae *J3* missing. Dorsal setae less than 35 long (Table 1), all smooth, acuminate, slightly widened in basal halves, except *J5* pilose in basal half (Fig. 3A); setae *J4* slightly pilose

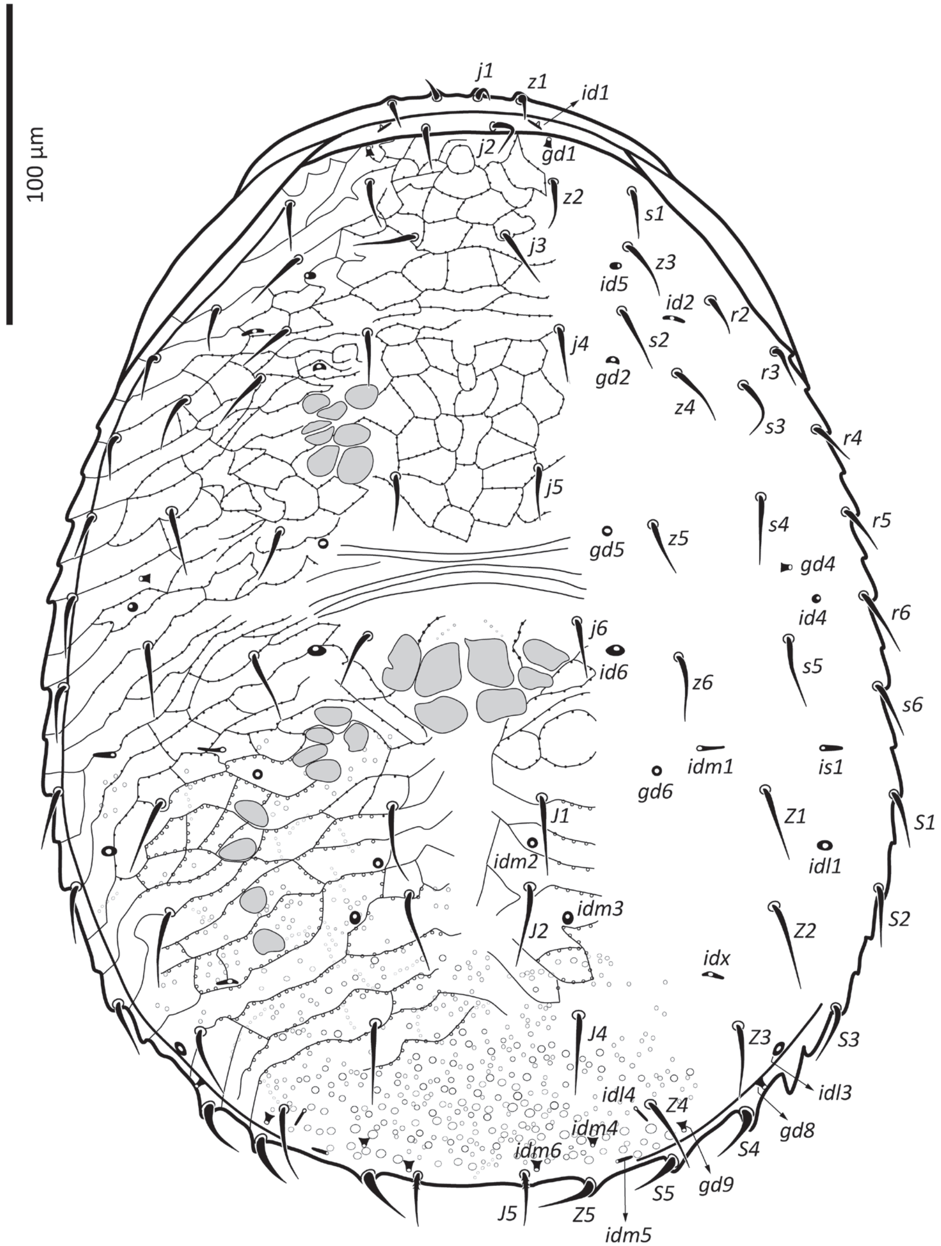


Figure 1. *Zygoseius papaver* sp. n., female, dorsal idiosoma.

basally in some specimens (Fig. 3B). Dorsal idiosoma with 23 pairs of pore-like structures, including seven gland openings and 16 poroids.

Ventral idiosoma (Figs 2, 29). Tritosternum with a trapezoidal base 22–27 long, 11–13 wide proximally, 4–6 wide apically, and a pair of laciniae, 76–83 long; laciniae

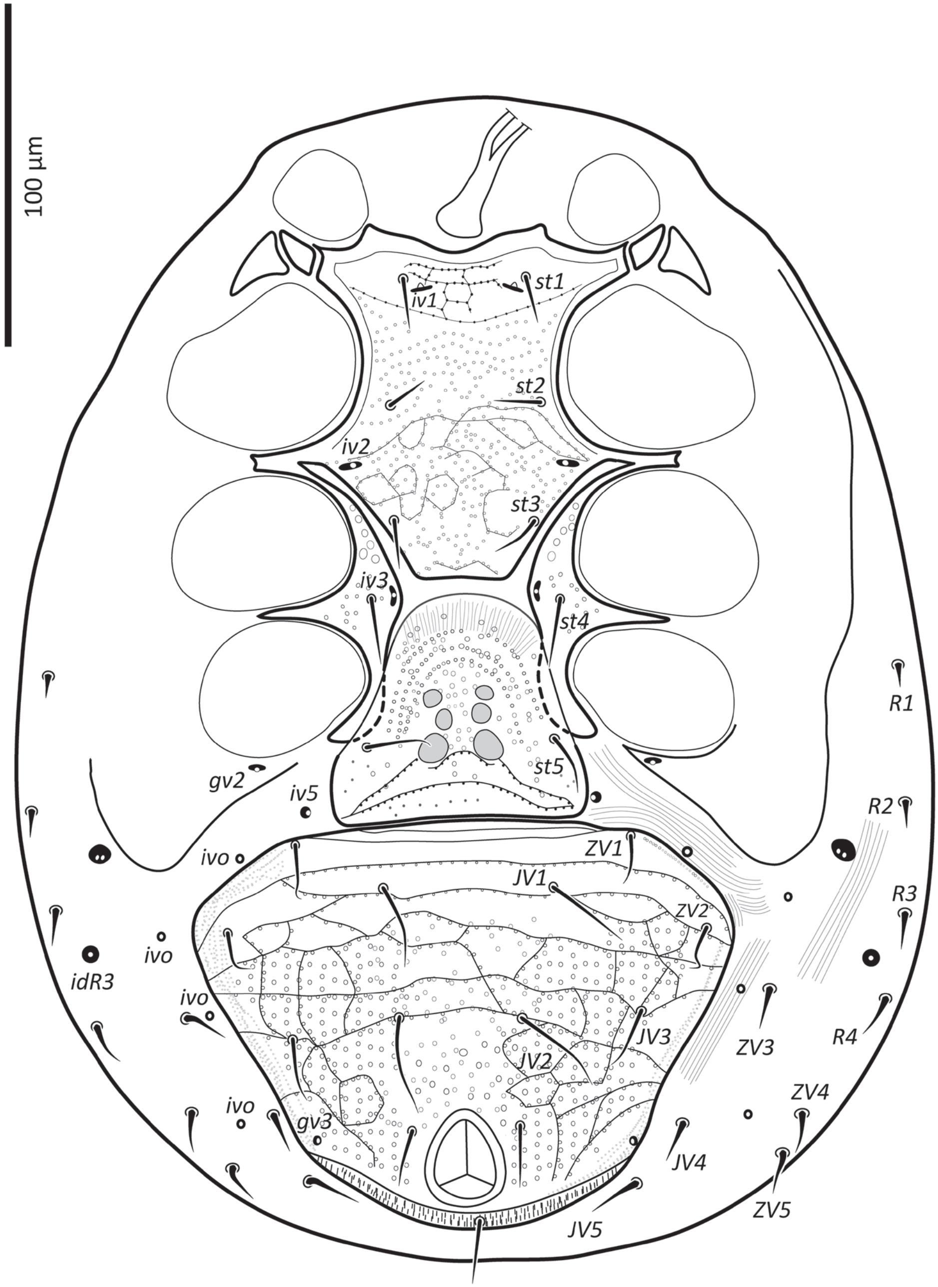


Figure 2. *Zygoseius papaver* sp. n., female, ventral idiosoma.

with barbs relatively short and blunt (Fig. 4). Sternal shield 93–105 long, 55–65 wide (length/width ratio: 1.50–1.78), bearing two pairs of poroids (*iv1–2*), and three pairs of smooth, subequal setae *st1–3* (Table 1); anterolateral arms of shield each insens-

Table 1. Lengths of most idiosomal setae of *Zygoseius papaver* sp. n. and *Z. lindquisti* sp. n.

Setae	*Z. papaver*		*Z. lindquisti*
	Female (n = 11)	**Male** (n = 1)	**Female** (n = 2)
j1	10–15	?	~ 5–7
j2	17–25	?	14–17
j3	19–27	24	15–17
j4	18–25	21	16–19
j5	16–20	~ 15	14–17
j6	16–20	17	16–20
J1	26–30	24	27–32
J2	24–32	26	28–34
J4	24–30	22–24	30–31
J5	16–22	17–19	19–21
z1	9–12	?	~ 5–7
z2	17–21	~ 12	13–18
z3	17–25	~ 20	17–19
z4	19–31	22	15–19
z5	16–23	16	15–19
z6	24–32	30	26–34
Z1	22–29	27	30–31
Z2	25–30	26	33–34
Z3	23–28	22	31–33
Z4	22–28	22	30–31
Z5	15–22	16	20–26
s1	12–17	~ 11	14–19
s2	19–26	?	17–22
s3	21–28	22	19–21
s4	22–27	25	18–21
s5	23–30	25	22–24
s6	19–22	18	28–29
S1	18–24	?	27–31
S2	17–23	18	29–32
S3	16–21	~ 16	26–30
S4	16–22	19	27–31
S5	16–21	17	28–31
r2	12–20	~ 16	19–20
r3	14–17	15	19–21
r4	18–20	21	20–21
r5	17–20	?	22–25
r6	19–20	~ 20	24–29
st1	16–21	18	16–20
st2	17–23	16	20–23
st3	17–22	18	18–21
st4	15–20	13	16–19
st5	18–24	14	18–19
JV1	25–32	25–27	19–23

Setae	***Z. papaver***		***Z. lindquisti***
	Female (n = 11)	**Male** (n = 1)	**Female** (n = 2)
JV2	26–34	28–30	22–25
JV3	16–22	17–18	16–19
JV4	13–17	13–14	20–21
JV5	14–18	14–15	18–19
ZV1	12–18	10–14	15–16
ZV2	11–17	12	18–21
ZV3	14–17	13–15	18–21
Para-anal setae (*pa*)	18–22	18	21–24
Post-anal seta (*po*)	17–23	16	20–22

? the seta was insufficiently clear to be measured.

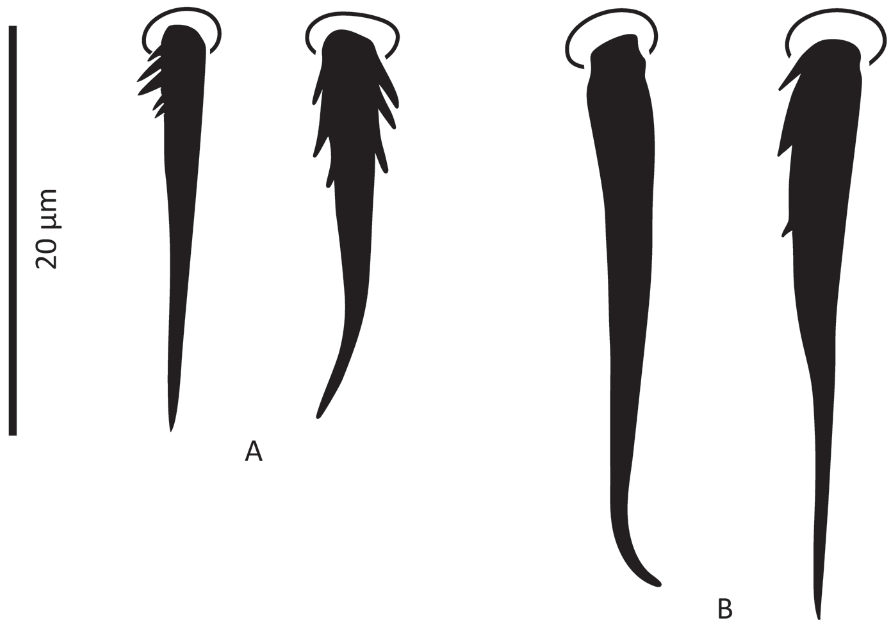


Figure 3. *Zygoseius papaver* sp. n., female, **A** seta *J5* **B** seta *J4*.

ibly fragmented apically into a platelet, itself abutting subtriangular exopodal plate between coxae I and II; shield anterior margin with a weak, wide median depression and two subtriangular projections; posterior margin narrow, truncate. Shield irregularly and sparsely micropuntate. A transverse, recurved linea posterad level of setae *st1*. Metasternal platelets fused to endopodal elements, arc-like in shape, punctate, bearing simple setae *st4* and poroids *iv3*. Epigynal shield trapezoidal, 72–79 long, 22–27 long from *st5* to posterior margin, 68–81 wide (length/width ratio: 0.91–1.03), with punctae most conspicuous in anterior and lateral portions; lineate posteriorly, three pairs of large subcircular sigillae centrally; anterior hyaline portion rounded, poorly sclerotized,

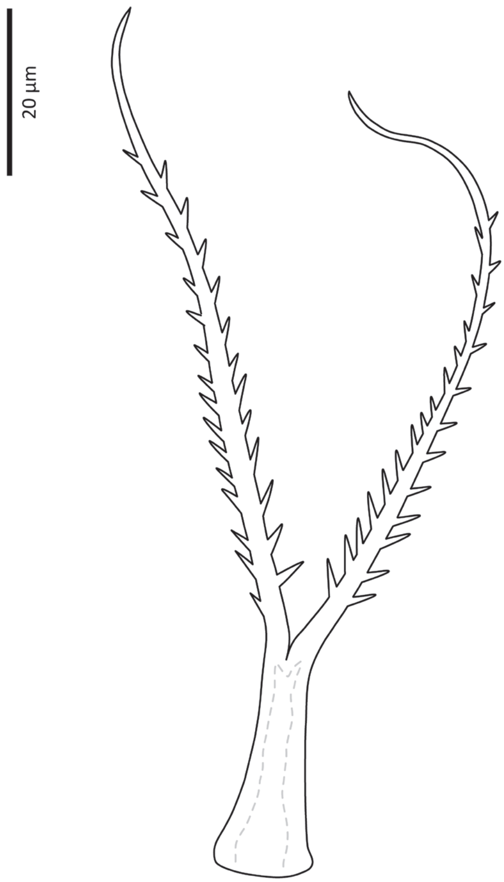


Figure 4. *Zygoseius papaver* sp. n., female, tritosternum.

indistinct; shield widest past level of *st5*, with posterior margin truncate; closely abutting ventrianal shield. Setae *st5* smooth, inserted near shield lateral margins; poroids *iv5* near posterolateral margins of shield. Ventrianal shield subpentagonal, expanded, wider than long, 113–121 long, 147–180 wide (length/width ratio: 0.70–0.80), straight anteriorly between setae *ZV1*. Shield distinctly lineate anteriorly, distinctly punctate posteriorly and medially, weakly lineate posterad *JV2* level, with small punctae in lateral margins; shield with five pairs of pre-anal and three circum-anal setae, all smooth. Setae *JV1–2* subequal, 1.5–2× as long as other setae (Table 1); para-anal setae inserted near level of anterior margin of anal opening; gland openings *gv3* on posterolateral margins of shield near mid-level of anus; cribrum well-developed, with a few narrow transversal strips of spicules; anal opening 20–25 long, 18–22 wide, subtriangular to ovoid, located in posterior fourth or third of shield. Peritreme 175–198 long, densely covered by aciculae, extending anteriorly almost to level of seta *z1*, with one gland pore (*gp*) located at mid-level of coxa II. Peritrematal shield wide, essentially in ventral position; completely fused to exopodal, parapodal and metapodal elements,

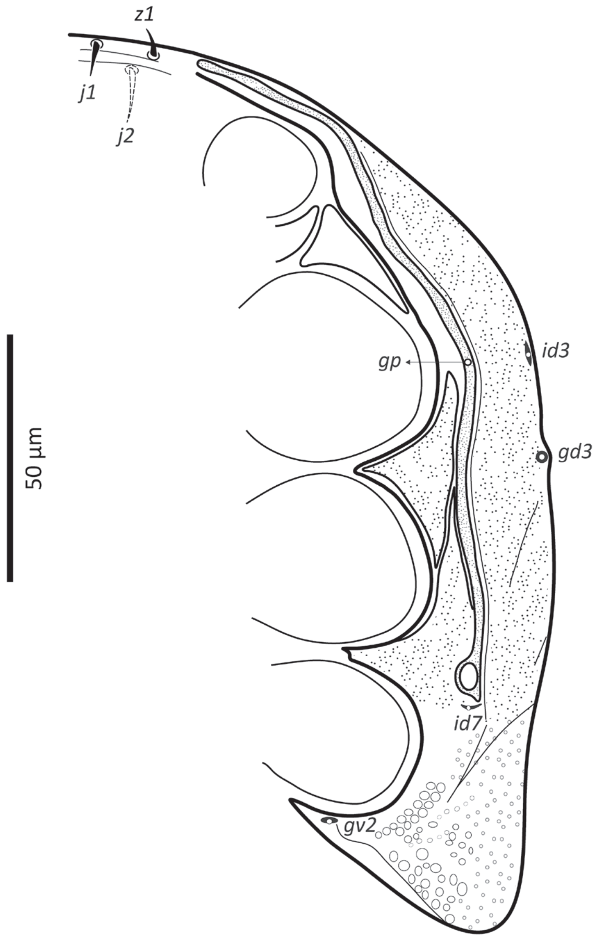


Figure 5. *Zygoseius papaver* sp. n., female, peritrematal shield.

extending well behind posterior level of coxae IV. Shield essentially micropunctate throughout, with larger punctae in poststigmatic region, bearing four pore-like structures (*id3*, *gd3*, *id7*), including *gv2*. Exopodal element between coxae II–III insensibly separated from posterior portion of more posterior exopodal-peritrematal elements (Fig. 5). Soft lateral and opisthogastric integument finely plicate, bearing nine pairs of short smooth setae, 11–20 long, most of which slightly thickened basally; soft cuticle with five pairs of poroids (4 *ivo*, *idR3*), and one subcircular platelet bearing two pore-like structures (putatively a gland pore, and an associated poroid), near posterolateral margin of peritrematal-metapodal shield.

Gnathosoma. Epistome (Fig. 6) bifurcate, with two long (12–20) and relatively thick projections, forming a U-shape at their bases (separated by 4–7); distal halves of projections deeply serrated on both inner and outer margins, margins proximally smooth; basal margins coarsely serrated laterally. Posteromedian ridge with

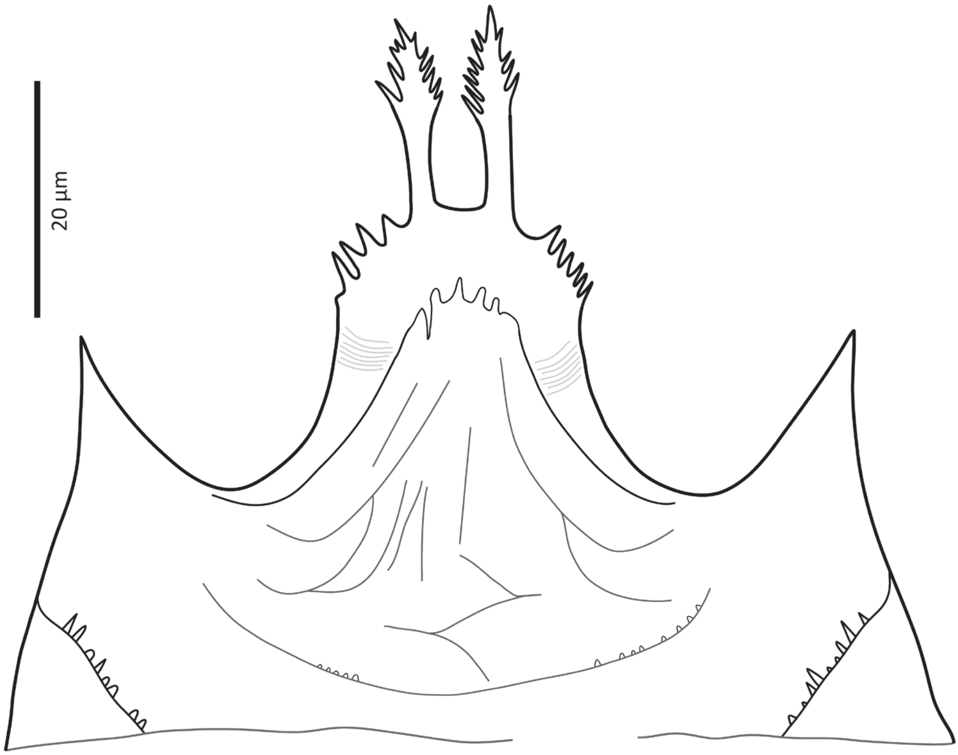


Figure 6. *Zygoseius papaver* sp. n., female, epistome.

denticles in lateral portions; larger denticles or tubercles on posterolateral ridges. Corniculi (Fig. 7) 28–31 long, horn-like. Internal malae (Fig. 7) with a pair of smooth lobes, apically blunt, membranous, almost reaching apex of corniculi; labrum longer than internal malae, fimbriate distally. Hypostomal and capitular setae (Fig. 7) smooth, needle-like, *h1* (39–45)>*h3* (24–31)>*pc* (17–24)≈*h2* (17–21). Deutosternum (Fig. 7) with seven transverse rows of denticles; rows broad, variable in width, 5th and 7th, or 5–7th rows usually broader, anteriormost (first) row with larger denticles; numbers of teeth in rows from anterior row (1st) to posterior row (7th), respectively: 7–9, 12, 10–12, 13–14, 14–15, 13–15, 13–15. Chelicera (Fig. 8) with movable digit with two subapical, inconspicuous teeth; fixed digit with two subapical teeth followed by a short, relatively thick pilus dentilis; dorsal cheliceral seta short, setiform; first cheliceral segment 34–55 long, second 103–110 (17–28 wide), fixed digit 29–33, movable digit 34–40. Palp (Fig. 9) 101–107 long, with dorsal surfaces of genu and especially femur with some sigillae; trochanter 11–14 long, femur 31–37, genu 27–30, tibia 19–22; apotele 3-tined. Palp chaetotaxy: from trochanter–tibia 2-5-6-14 setae; trochanter 0 0/1 0/1 0, femur 1 2/0 1/0 1, genu 2 2/0 1/0 1 and tibia as in Fig. 9; all palp setae smooth, tapered; *av* (*v2*, *sensu* Evans 1963b) on trochanter strongly bent inwards (Fig. 27); *al* on femur, *al1–2* on

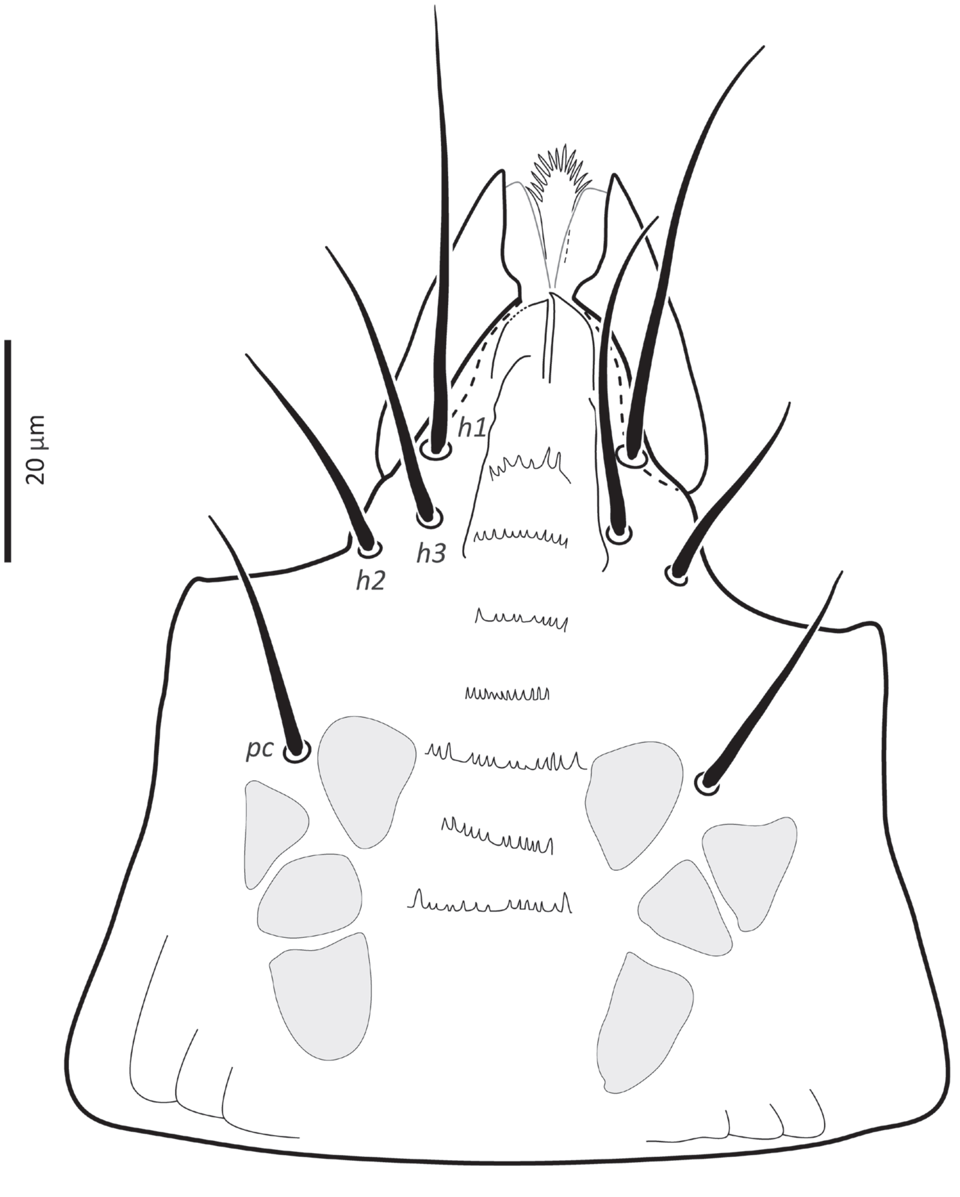


Figure 7. *Zygoseius papaver* sp. n., female, subcapitulum.

genu and one of *al* setae on tibia short and spatulate; genu with stout spur dorsodistally (see arrow, Fig. 9).

Legs (Figs 10–13). Lengths of legs: I 265–305, II 253–279, III 234–250, IV 271–300. Lengths of femora: I 56–64, II 42–58, III 45–53, IV 58–68; genua: I 45–49, II 36–41, III 25–30, IV 27–32; tibiae: I 40–46, II 29–36, III 27–29, IV 30–36; tarsi: I 57–65, II 73–85, III 67–73, IV 82–95; ambulacra: I 20–23, II 20–24, III 19–22, IV

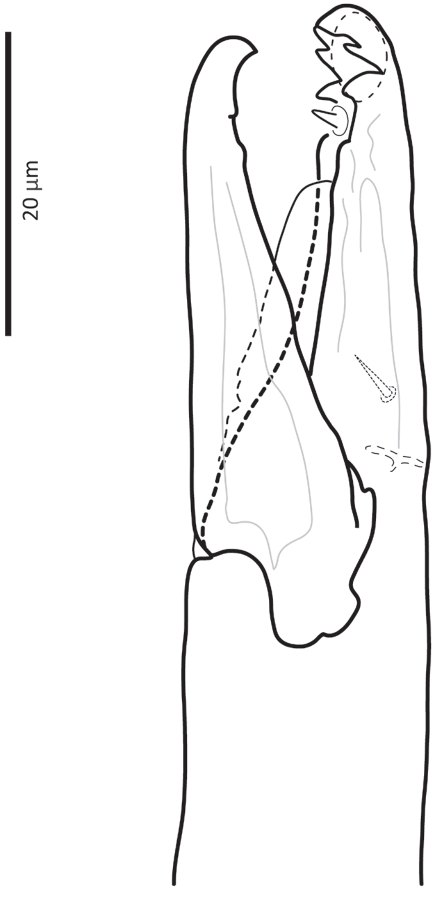


Figure 8. *Zygoseius papaver* sp. n., female, chelicera, ventro-paraxial view.

22–25. Chaetotaxy of leg segments I–IV normal for *Zygoseius* (*sensu* Halliday 1997) except for genu II and genu III: coxae 2-2-2-1, or I–III (0 0/1 0/1 0), IV (0 0/1 0/0 0); trochanters 6-5-5-5, or I (1 0/1 1/2 1), II (1 0/1 0/2 1), III–IV (1 1/1 0/2 0); femora 13-11-6-6, or I (2 3/1 2/3 2), II (2 3/1 2/2 1), III–IV (1 2/1 1/0 1); genua 13-10-8-9, or I (2 3/2 3/1 2), II (2 3/0 2/1 2), III (2 2/1 2/0 1), IV (2 2/1 3/0 1); tibiae 13-10-8-8, or I (2 3/2 3/1 2 in 10 females or 2 4/2 3/1 2 in one of the 11 females), II (2 2/1 2/1 2), III–IV (2 1/1 2/1 1); tarsi II–IV 18-18-18, all as 3 3/2 3/2 3 + *md* and *mv*. All setae on legs I–IV simple, relatively short and tapered, except: femur I with *pd1–2* thickened (lengths: *pd1* 12–13, *pd2* 10–11); tarsi II–IV with apical setae *al1*, *av1*, *pv1*, *pl1* and subapical setae *av2*, *pv2*, *md* and *mv* short, spur-like. Trochanter III with small cuticular spur posterolaterally, and trochanter IV with two cuticular spurs, posterolaterally and posterodorsally. Sigillae on ventral surfaces of coxae I–IV and trochanters I–II, and dorsal surfaces of femora, genua and tibiae I–IV, and basitarsi II–IV. All ambulacra with a pair of well-developed hooked claws. Pulvilli not discerned.

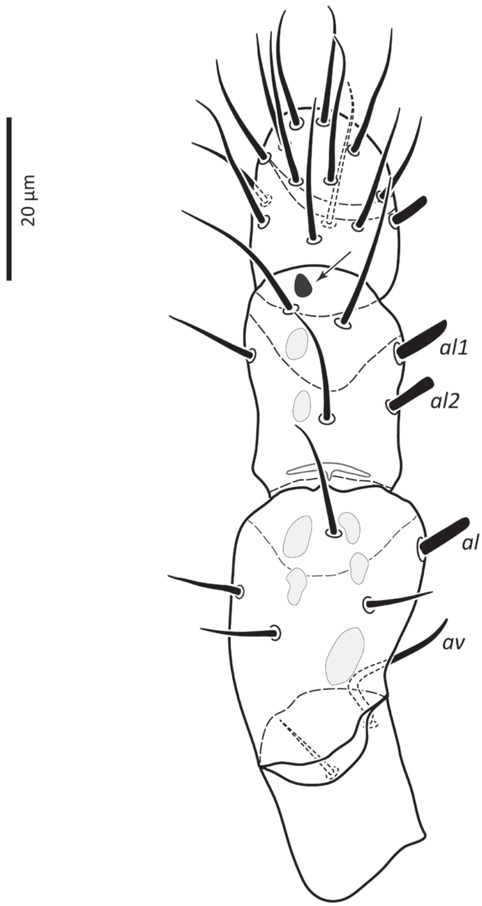


Figure 9. *Zygoseius papaver* sp. n., female, palp, excluding tarsus, dorsal view.

Spermathecal apparatus (Plate 1). Spermatheca (Plate 1C) globular, large (diameter 8–11), connected to a short, thick-walled duct (5–10 long), followed by a small ring-like sperm reservoir (diameter 5–6), and a narrow and long spermatic canal (16–24 long), sometimes widened basally (as in Plate 1B).

Male (n = 1). *Dorsal idiosoma* (Fig. 30). Dorsal shield oval, 338 long, 252 wide (length/width ratio: 1.34), completely covering idiosoma. Shield ornamentation and chaetotaxy similar to those of female, except reticulation in central region of idiosoma between setae *j6–j6* to *J2–J2* more distinct.

Ventral idiosoma (Fig. 31). Tritosternum as in female, 14 long, 11 wide proximally, 6 wide apically; laciniae 76 long. Gonopore diameter 20, discernible part of duct 50 long. Holoventral shield 271 long, 217 wide (length/width ratio: 1.25), reticulate nearly throughout except between setae *st5–JV1*, cells punctate inside and along margins; ventral region weakly lineate and punctate between setae *JV1* and *JV2*, with more distinct punctae laterally and especially posteriorly. Holoventral shield fused laterally to

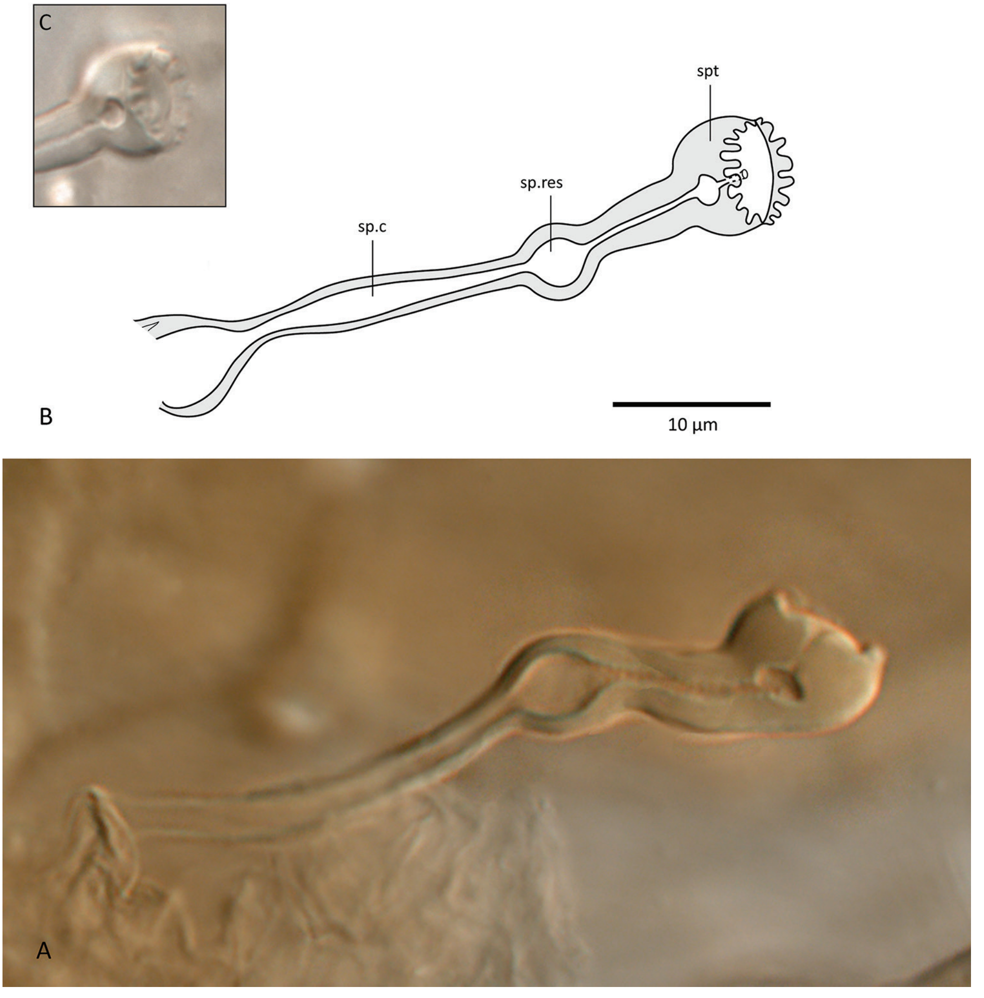
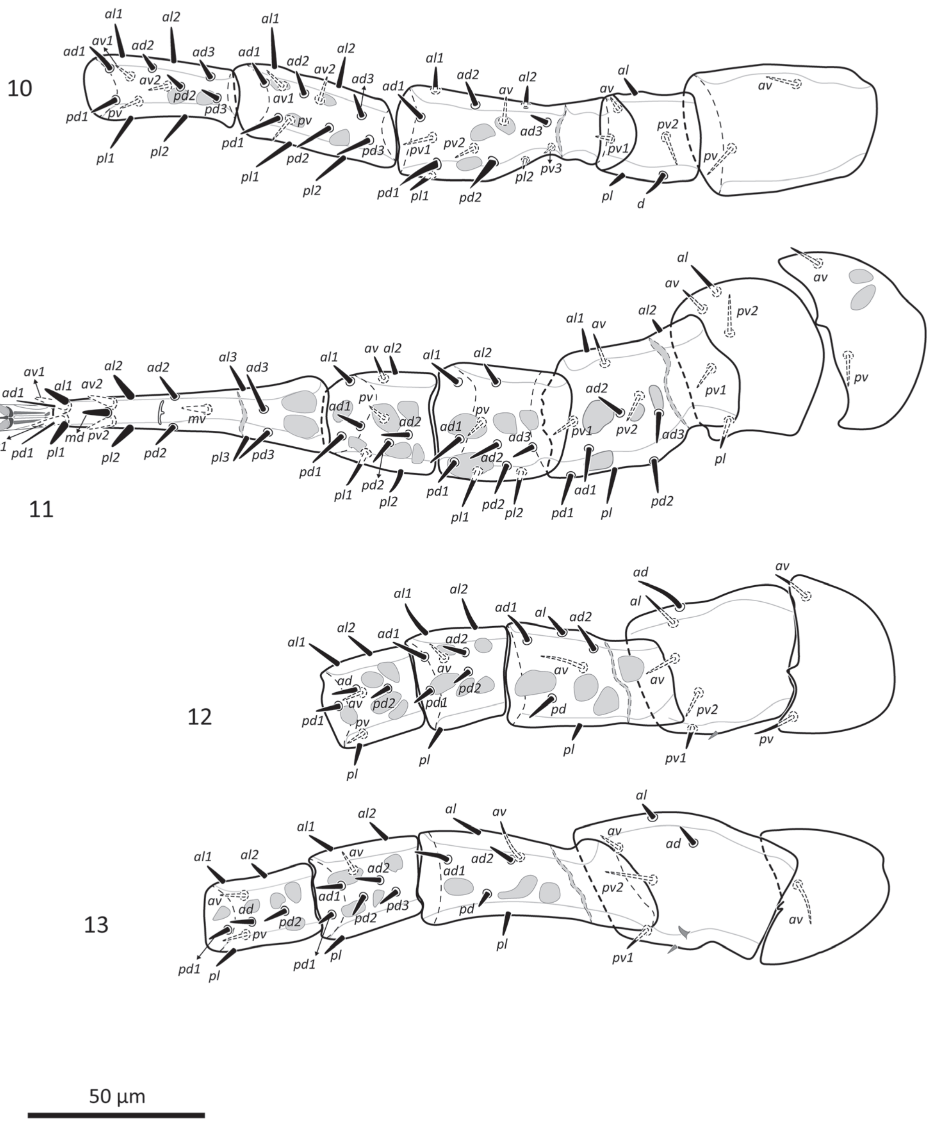


Plate 1. *Zygoseius papaver* sp. n., female, **A, B** spermathecal apparatus in two different females. Abbreviations: sp.c.= spermatic canal, sp.res.= sperm reservoir, spt.= spermatheca **C** spermatheca.

peritrematal, metapodal and exopodal elements, bearing 12 pairs of simple and smooth setae (five and seven pairs on sternogenital and ventrianal regions, respectively) (Table 1), and three smooth circum-anal setae; shield with nine pairs of pore-like structures (*iv1–3*, *iv5*, *gv2–3*, three pairs of *ivo*), excluding those on peritrematal-exopodal shields. Setae *JV1–2* longer than other ventral setae, including *JV3–5*, *ZV1–3* (Table 1). Peritreme 178 long. Soft lateral and opisthogastric integument with 6–7 pairs of short setae, 7–15 long, slightly thickened basally, and two or three pairs of pore-like structures. Anal opening subtriangular, 22 long and 19 wide. Other features of ventral idiosoma as in female.

Gnathosoma. Epistome as in female, with two projections, 19 long, distance between bases of projections 5. Corniculi (26 long) and deutosternum as in female. Lengths of hypostomal setae: *h1* 39, *h2* 14, *h3* 24, *pc* 19. Chelicera and spermatodactyl not avail-



Figures 10–13. *Zygoseius papaver* sp. n., female, legs I–IV, dorsal view.

able for study (broken off specimen). Palp 98 long, similar to that of female; trochanter 13 long, femur 40, genu 22, tibia about 21; palp setae and chaetotaxy as in female.

Legs. Lengths of legs: I 288, II 239, III 231, IV 288. Lengths of femora: I 61, II 44, III 55, IV 60; genua: I 45, II 37, III 26, IV 30; tibiae: I 44, II 32, III 25, IV 31; tarsi: I 61, II 71, III 68, IV 87, ambulacra: I 18, II 20, III 19, IV 24. Chaetotaxy of legs I–IV similar to that of female, except that the femur II has one conical spine-like projection ventrodistally (Fig. 14). Setae *pd1–2* on femur I thickened as in female, *pd1* 14–15, *pd2* 10–12. Sigillae locations similar to those of female.

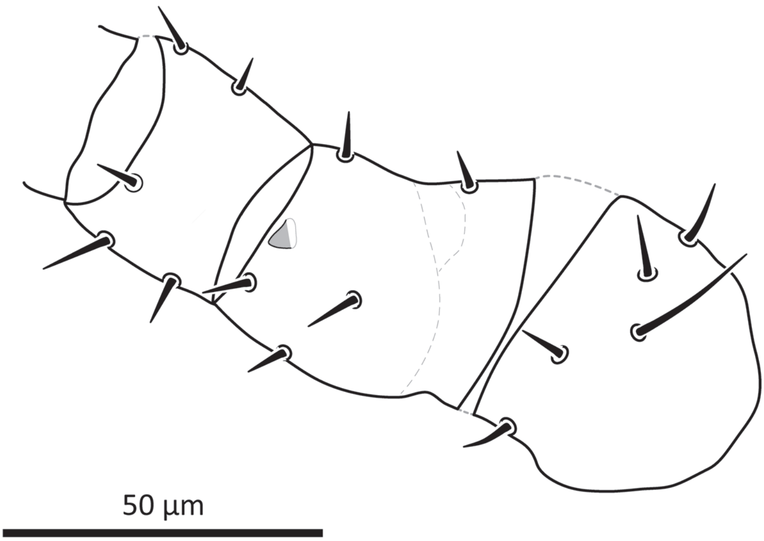


Figure 14. *Zygoseius papaver* sp. n., male, trochanter-genu II, ventral view.

Immature stages. Unknown.

Material examined. Holotype: Female. Mexico, Chiapas State, Volcan Tzontehuitz, 9000 ft. (= 2743.2 m. a.s.l.), 12 miles NE of San Cristóbal de Las Casas, from moss on log, 19 May 1969, coll. J. M. Campbell. Paratypes: 15 females, 1 male, same data as holotype. The holotype and 12 paratypes (females and male) are deposited at the Canadian National Collection of Insects, Arachnids and Nematodes (CNC) at the Agriculture and Agri-Food Canada, Ottawa, Canada, and four female paratypes are deposited at the Acarology Collection of the Department of Entomology (ACDE), College of Agriculture and Natural Resources, Science and Research Branch, Islamic Azad University, Tehran, Iran.

Etymology. The specific name refers to the shape of the spermatheca of the new species, which resembles the capsule of opium (*Papaver somniferum* L., 1753). It is considered as a noun in apposition.

Remarks. The spermathecal apparatus of *Z. papaver* sp. n. is distinct from that of any other *Zygoseius* species for which it was described: the spermetheca is globular and larger than any other sclerotized part of the apparatus, and ends in a flower-like pattern. The new species can also be distinguished by its long *J1–2* setae relative to the distance between *J1* and *J2* setae (ratio setal length/distance = 0.90 ± 0.06 st.dev., range 0.75–1.0). Based on their illustrations, a few species described from South America have long *J1–2* setae relative to the distance between them, such as *Z. alveolaris* Karg, 1998 and *Z. triramuli* Karg & Schorlemmer, 2009 (Karg 1998, Karg and Schorlemmer 2009), but these have a different arrangement of setae of the *j–J* series, including the presence of *J3*.

The epistome of *Zygoseius papaver* sp. n. is unique among described species, with relatively short but thick projections that are conspicuously barbed apically. The epistome of *Z. laticuspidis* Karg, 1998 is similar; however, it is even more swollen apically, and is slightly denticulate on the basal margin in-between the projections. *Zygoseius laticuspidis* also has *J5* setae inserted mesad of *Z5* (note, however, that the relative position of *J5* and *Z5* can vary, depending on how flattened is the dorsal shield on the slide). The new species can further be distinguished from *Z. laticuspidis* by its shorter dorsal setae (all are <30 long; most are 30–60 long in *Z. laticuspidis*), *J4* setae separated by 1.4–1.9× the distance between *J1* setae (*J4–J4* distance over twice that between *J1–J1* in *Z. laticuspidis*), and by the presence of nine pairs of setae on the opisthogastric soft cuticle (six pairs in *Z. laticuspidis*). Other *Zygoseius* species can be distinguished from *Z. papaver* sp. n. by some of the same characters mentioned above, as well as by (1) its epistome; (2) the length and width (and their ratios) of the dorsal, sternal and ventrianal shields; (3) relative length of dorsal setae, especially *Z5*; (4) the ornamentation of the dorsal and sternal shields; and (5) long *JV1–2* setae, 1.5–2× as long as other pre-anal setae on the ventrianal shield, and as long as about 2/3 of distance between *JV1* and *JV2. Zygoseius ampullus* Halliday, 1997 and *Z. foramenis* Karg, 1998 also have longer *JV1–2* setae but clearly differ by their epistomes, and by shorter *J1–2* setae and a ventrianal shield as long as wide. In the key to species of Karg and Schorlemmer (2009), *Z. papaver* sp. n. would reach couplet 3 (12), and can be distinguished from species in (3) and (12) by the characters mentioned above.

Another distinguishing feature of *Z. papaver* sp. n. is the distinctly serrated lateral margins of the dorsal shield. This also characterizes *Z. ovatus* Karg, 1998. The margins of the dorsal shield of other species may appear somewhat serrated (e.g. *Z. ampullus*, *Z. metoecus* Halliday, 1997 and *Z. separatoporus* Karg, 1998), although the serration matches with the insertion of setae in marginal positions (mostly *r* and *S* setae), whereas in the new species and at least in *Z. ovatus*, most serration are independent of setal insertions. Such serrated margins of the dorsal shield are reminiscent of the dorsal shield of many Zerconidae (Ujvári 2010, 2011) and some species of *Pachyseius* Berlese (Pachylaelapidae) (Mašán 2007, Ahadiyat et al. 2016). Note that the serration of dorsal shields in zerconid and *Pachyseius* species is largely correlated, although not entirely, with the insertion of marginal setae.

Zygoseius papaver sp. n. also differs from other *Zygoseius* species by its reduced chaetotaxy on genu II, lacking seta *av*, and genu III, lacking seta *pv*, instead of the usual complement of two ventral setae, including both *av* and *pv* as noted in the genus diagnosis of Halliday (1997). His diagnosis was based on four species (*Z. furciger*, *Z. ampullus*, *Z. metoecus*, *Z. sarcinulus*), so we can predict that other described (with unstudied leg chaetotaxy) and undescribed species have such genual chaetotaxy. However, because at least another species of *Zygoseius*, newly described herein (see below), sometimes lacks *pv* on genu III, we can suspect that other species also lacks such seta. Members of other non-parasitic dermanyssine families lack both of these setae (e.g. Phytoseiidae; Evans 1963a), or lacks either *av* on genu II (some *Pseudolaelaps* species, Pseudolaelapidae; Mašán 2014) or more commonly *pv* on genu III (e.g. some Eviphididae, Pachylaelapidae, Macrochelidae, Ascoidea, Blattisociidae; Evans 1963a, Lindquist and Evans 1965, Moraza and Johnston 1990, Mašán 2007, Mašán and Halliday 2010), showing plasticity of the development of those setae. Based on the studied chaetotaxy of *Z. furciger* and of other dermanyssines (Evans and Till 1965, Lindquist and Evans 1965, Halliday 1997), when present in the adults, ventral setae of genua II–III appear at the deutonymphal stage. Therefore, they are theoretically not as stable as (i.e. less likely to be retained in the adult stage than) setae appearing at an earlier developmental stage (Evans 1963a, Lindquist and Evans 1965, Rowell et al. 1978).

***Zygoseius lindquisti* sp. n.**
http://zoobank.org/50B0C71A-5F59-4852-B39E-C9D5E78895FB
Figures 15–26, 27, 32–33, Plate 2

Diagnosis. Dorsal shield oval, densely micropunctate, with relatively distinct reticulation and lineation, except more weakly reticulated medially between setae *j4–6*. Edges of lateral parts of dorsum smooth. Dorsal setae smooth, except *J4* and *J5* with a few barbs basally; all setae less than 35 long; setae *z6*, *s6*, and all opisthonotal setae (except *J5* and *Z5*) 1.5–2× as long as other setae. Sternal shield densely micropunctate, except in the regions of setal insertions. Epigynal shield conspicuously punctate in anterior 2/3, punctae lighter posteriorly. Ventrianal shield distinctly lineate in anterior half, reticulate laterally and posteriorly; setae *JV2* slightly longer than other setae on shield. Peritrematal shield micropunctate throughout, punctae larger in poststigmatic region. Soft lateral and opisthogastric cuticle with nine pairs of setae. Epistome bifurcate, thin projections slightly converging, about twice as long as distance between their bases, sparsely serrated in apical half. Hypostomal setae *h1* about twice as long as *h2*, and subequal to *h3*. Femur I with seta *pd2* thickened. Spermathecal apparatus with a small, kidney-shaped spermatheca directly connected to a globular, large sperm reservoir, followed by a long spermatic canal with diverging walls.

Description. *Female* (n = 2). *Dorsal idiosoma* (Figs 15, 32). Dorsal shield oval, 396–413 long, 278–283 wide (length/width ratio: 1.40–1.48), completely covering idiosoma; edges of lateral parts of dorsum smooth, with no marginal serration; shield densely micropunctate throughout, distinctly reticulate-lineate, more weakly reticulate medially, especially between setae *j4–j6* and posterad setae *Z3–4* and around and posterad *J5*. Dorsal shield with 37 pairs of setae, 23 and 14 pairs on podonotal and opisthonotal regions, respectively; lacking setae *J3*. Dorsal setae less than 35 long, all smooth, acuminate, slightly swollen basally, except *J4–5* finely pilose basally (Fig. 17A, B). Opisthonotal setae about twice as long as podonotal setae (Table 1). Dorsal idiosoma with 23 pairs of pore-like structures, including seven gland openings and 16 poroids.

Ventral idiosoma (Figs 16, 33). Tritosternum with a trapezoidal base, 23–28 long, 12–14 wide proximally, 4–6 wide apically, and a pair of laciniae (61–64 long). Laciniae with barbs relatively short and blunt (Fig. 18). Sternal shield 98–102 long, 66–71 wide (length/width ratio: 1.44–1.48), bearing two pairs of poroids and three pairs of smooth, subequal setae *st1–3* (Table 1); shield anterolateral arms long, contiguous to subtriangular exopodal plate between coxae I and II; anterior margin with

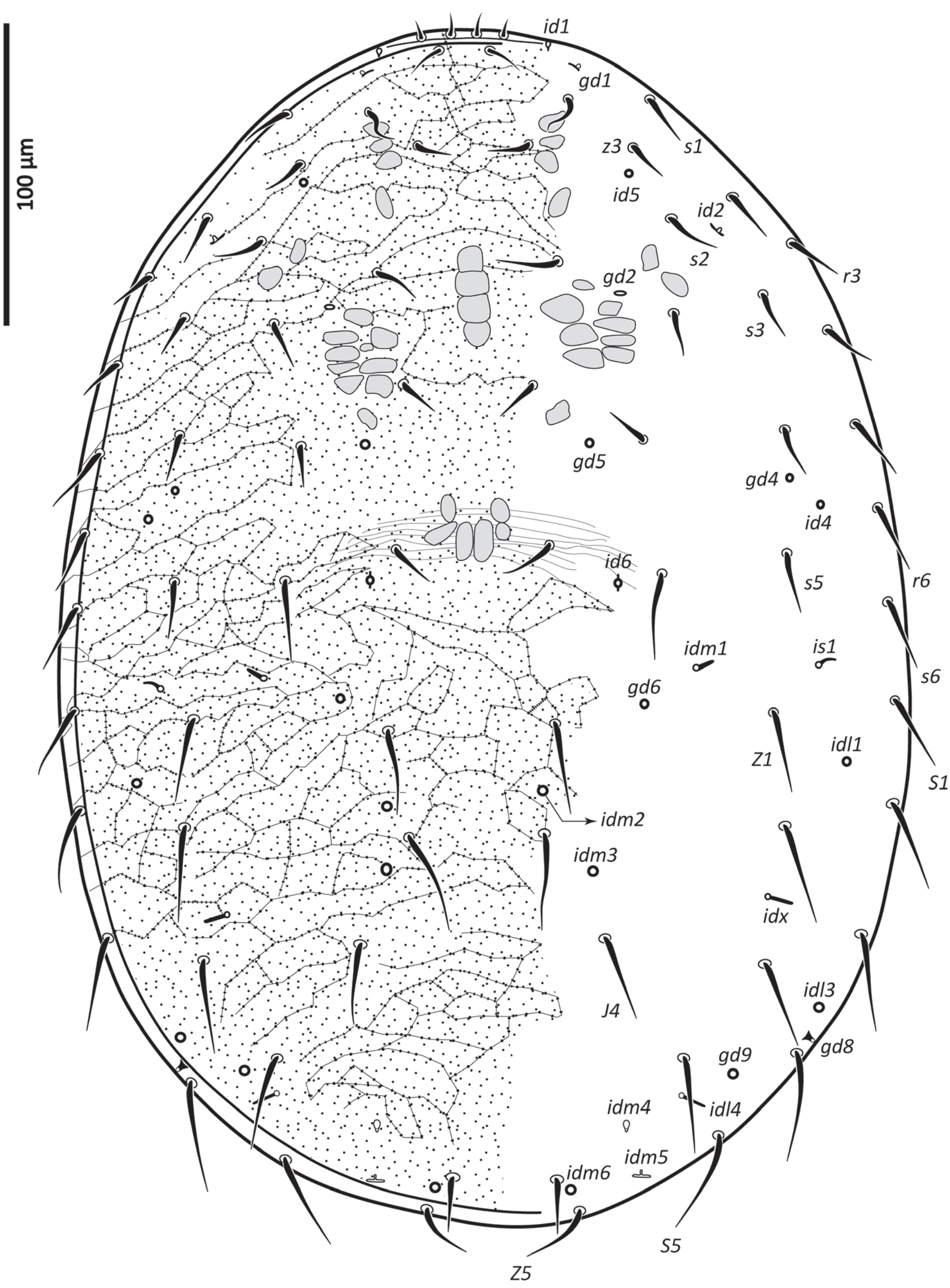


Figure 15. *Zygoseius lindquisti* sp. n., female, dorsal idiosoma.

distinct median notch and two subtriangular projections; posterior margin truncate; shield densely micropunctate throughout, except smooth around sternal setae. Complex of metasternal and endopodal elements arc-shaped, mostly smooth, punctate in

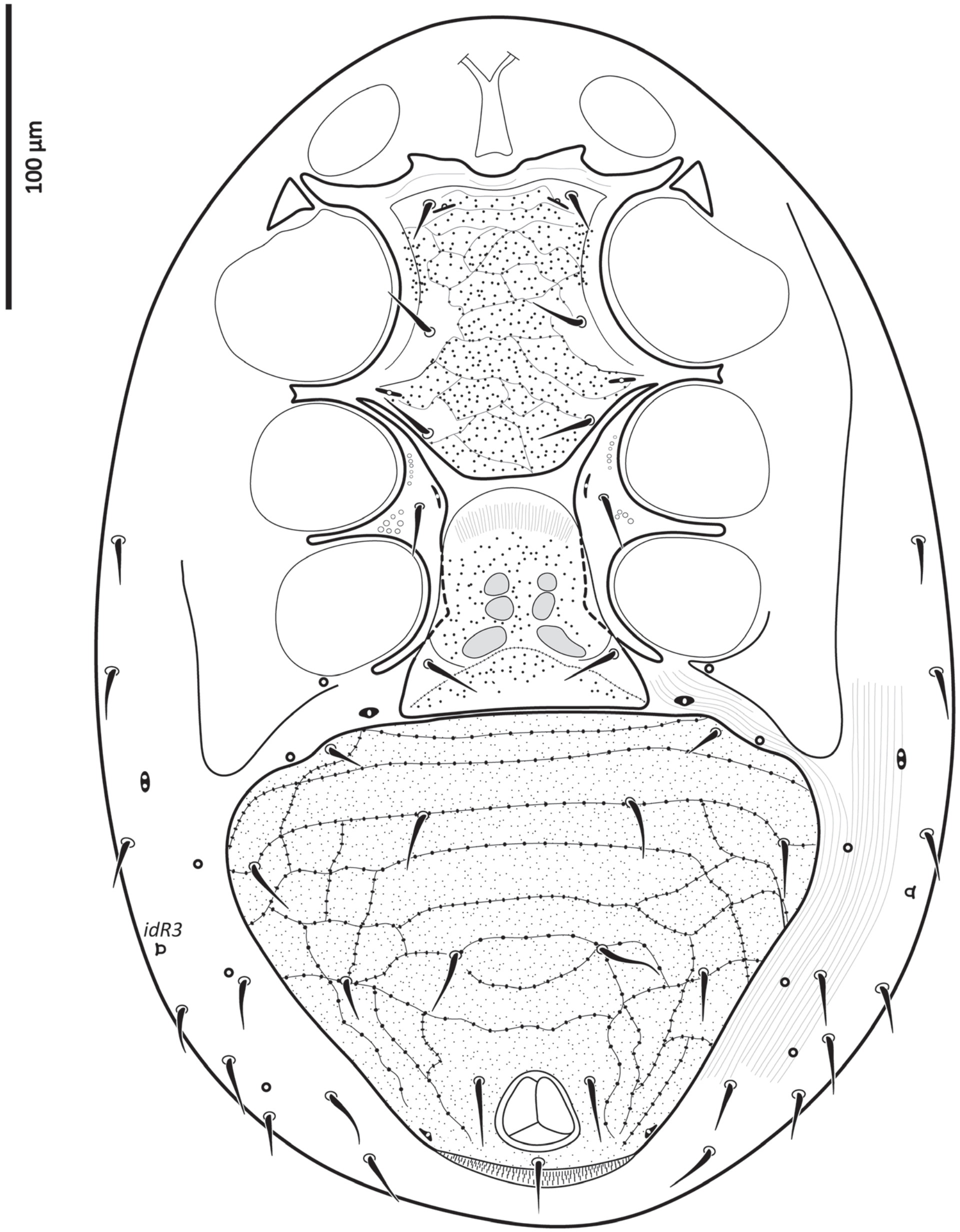


Figure 16. *Zygoseius lindquisti* sp. n., female, ventral idiosoma.

restricted areas, bearing simple setae *st4* and poroids *iv3*. Epigynal shield trapezoidal, 85–87 long, 22–24 long from *st5* to posterior margin, 81–84 wide (length/width ratio: 1.03–1.07), conspicuously punctate in anterior 2/3, punctae lighter posteriorly; shield with transverse convex line passing behind setae *st5*; anterior hyaline

Table 2. Distances between pairs of some dorsal and ventral idiosomal setae of *Zygoseius papaver* sp. n. and *Z. lindquisti* sp. n.

Characters	*Z. papaver*		*Z. lindquisti*
	Female	Male	Female
st1–st1	31–41	37	41–48
st2–st2	43–47	41	50–53
st3–st3	39–45	45	50–54
st4–st4	51–57	37	61–63
st5–st5	55–62	39	62–65
J1–J1	37–49	31	52–58
J4–J4	63–80	61	81–83
J4–J4/J1–J1	1.38–1.72	1.96	1.42–1.57
J2–J2	34–47	38	45–47
J1–J2	26–35	31	36–41

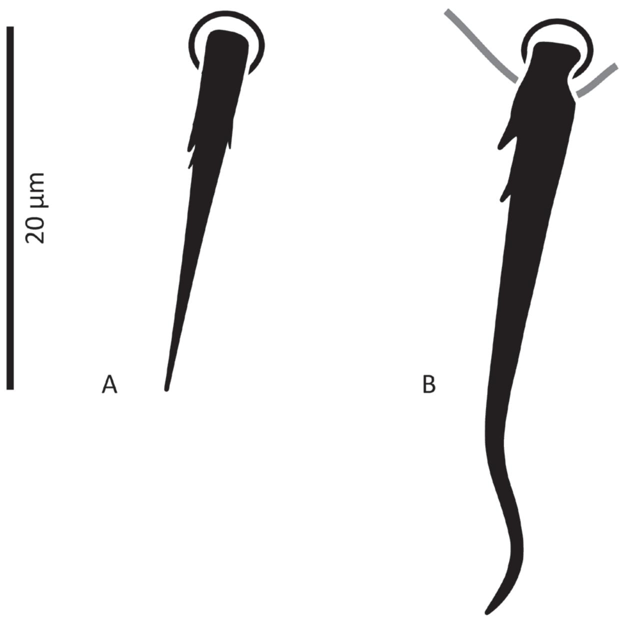


Figure 17. *Zygoseius lindquisti* sp. n., female, **A** seta *J5* **B** seta *J4*.

portion rounded, indistinct; shield closely abutting ventrianal shield; three pairs of suboval to subcircular sigillae medially, posterior ones larger, oval. Setae *st5* smooth, inserted near shield lateral margins. Poroids *iv5* near posterolateral margins of epigynal shield. Ventrianal shield subpentagonal, broad, 153–154 long, 189–196 wide (length/width ratio: 0.79–0.81), with straight anterior margin; distinctly lineate in anterior half, reticulate laterally and posteriorly; cells micropunctate inside and along cell margins; shield bearing five pairs of pre-anal and three circum-anal setae, all

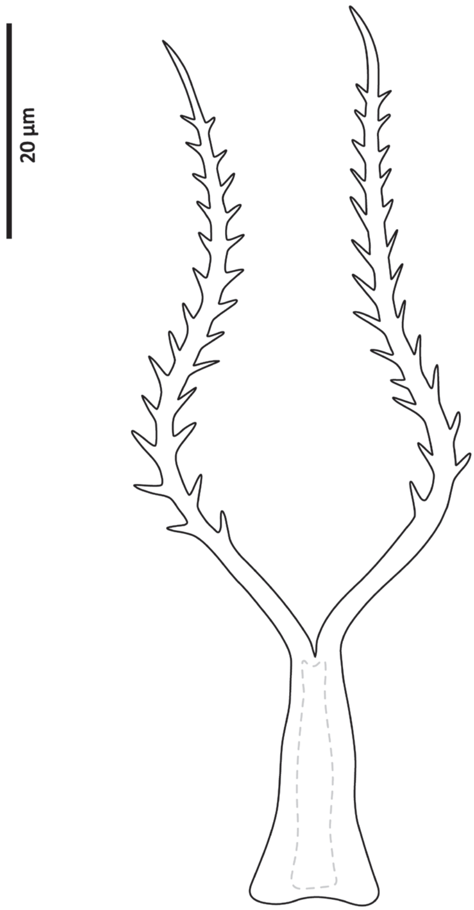


Figure 18. *Zygoseius lindquisti* sp. n., female, tritosternum.

smooth; setae *JV2* slightly longer than other setae; other setae subequal, except *ZV1* shorter (Table 1); para-anal setae inserted at level of anterior margin of anal opening; gland openings *gv3* on posterolateral margins of shield at level of posterior margin of anus; cribrum well-developed, 2–3 rows of spicules, extending along posterior shield margin between *gv3* openings; anal opening 25–26 long, 21–22 wide, subtriangular to subcircular, located in posterior fifth or fourth of shield. Peritreme 191–198 long, densely covered with aciculae, extending anteriorly near seta *z1*, with one gland pore (*gp*) at mid-level of coxa II. Peritrematal shield wide, fused to exopodal, parapodal and metapodal elements, extending well behind posterior level of coxae IV; shield micropunctate, with larger punctae in poststigmatic region, with four pore-like structures (*id3*, *gd3*, *id7*, *gv2*). Exopodal element between coxae II–III fused with other exopodal-peritrematal elements (Fig. 19). Soft lateral and opisthogastric integument plicate, bearing nine pairs of setae, 15–30 long, slightly thickened basally, marginal setae as the longest. Soft cuticle with five pairs of poroids, including four *ivo*, *idR3*,

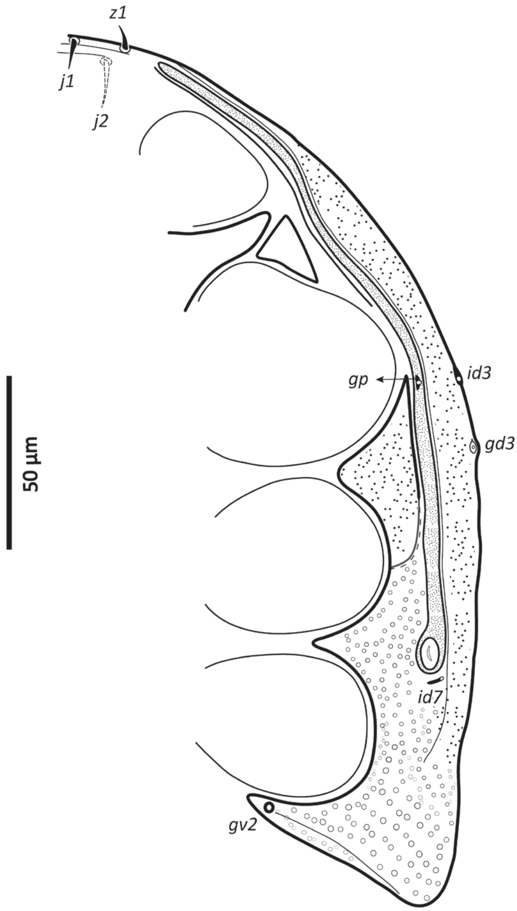


Figure 19. *Zygoseius lindquisti* sp. n., female, peritrematal shield.

and an oval platelet bearing two pore-like structures, at level of posterior margin of peritrematal shield.

Gnathosoma. Epistome (Fig. 20) bifurcate, with two slender projections (16–20 long), forming a U shape at their bases (separated by 8–10), slightly converging; distal halves of projections sparsely serrated on inner margin (in one specimen) or both inner and outer margins (in other specimen), margins proximally smooth; basal margin finely serrated laterally; a transverse series of blunt to sharp tubercles posteromedially, and fewer series laterally. Corniculi (Fig. 21) short, 24–26, horn-like. Internal malae (Fig. 21) finely developed, reaching slightly beyond corniculi; anterolateral margins fimbriate, inner margins smooth; labrum fine, shorter than internal malae, finely fimbriate distally. Hypostomal and capitular setae (Fig. 21) smooth, needle-like, *h3* (21–about 28) and *h1* (21–25)>*pc* (about 13–17)>*h2* (8–9). Deutosternum (Fig. 21) with 6–7

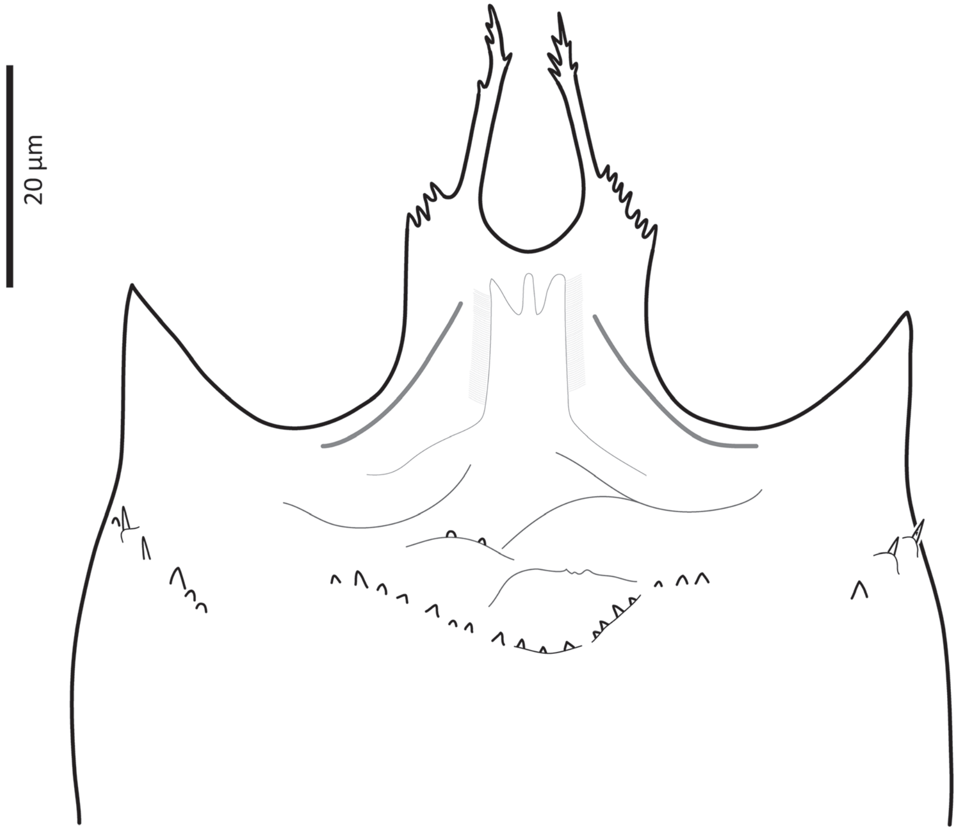


Figure 20. *Zygoseius lindquisti* sp. n., female, epistome.

transverse rows of denticles, followed posteriorly by a smooth ridge; posteriormost row of denticles widest; two anteriormost (1st and 2nd) and posterior-most (5th and/or 6th) rows with larger denticles; numbers of denticles from anterior to posterior rows: 8–10, ~ 9, 10–11, ~ 10–11, 12–14, 15–18. Cheliceral teeth not clearly discernable (digits oriented dorsoventrally); first cheliceral segment 35–44 long, second segment and fixed digit unclear; movable digit 27–29; width of second segment 17–21. Palp (Fig. 22) 105–113 long, dorsal surfaces of femur and genu with some sigillae; trochanter 13–18 long, femur 34–36, genu 27–29, tibia 23–26; apotele 3-tined. Palp chaetotaxy: from trochanter–tibia 2-5-6-14 setae; trochanter 0 0/1 0/1 0, femur 1 2/0 1/0 1, genu 2 2/0 1/0 1; tibia as in Fig. 22. All palpal setae smooth, tapered; *av* (*v2*, *sensu* Evans 1963b) on trochanter strongly bent inwards (Fig. 27); *al* on femur, *al1–2* on genu and one of *al* setae on tibia short and spatulate; genu with stout spur dorsodistally (see arrow, Fig. 22).

Legs (Figs 23–26). Lengths of legs: I 295–307, II 257–261, III 233–241, IV 307–309. Lengths of femora: I 60–63, II 49–52, III 48–53, IV 64–66; genua: I 44–45, II

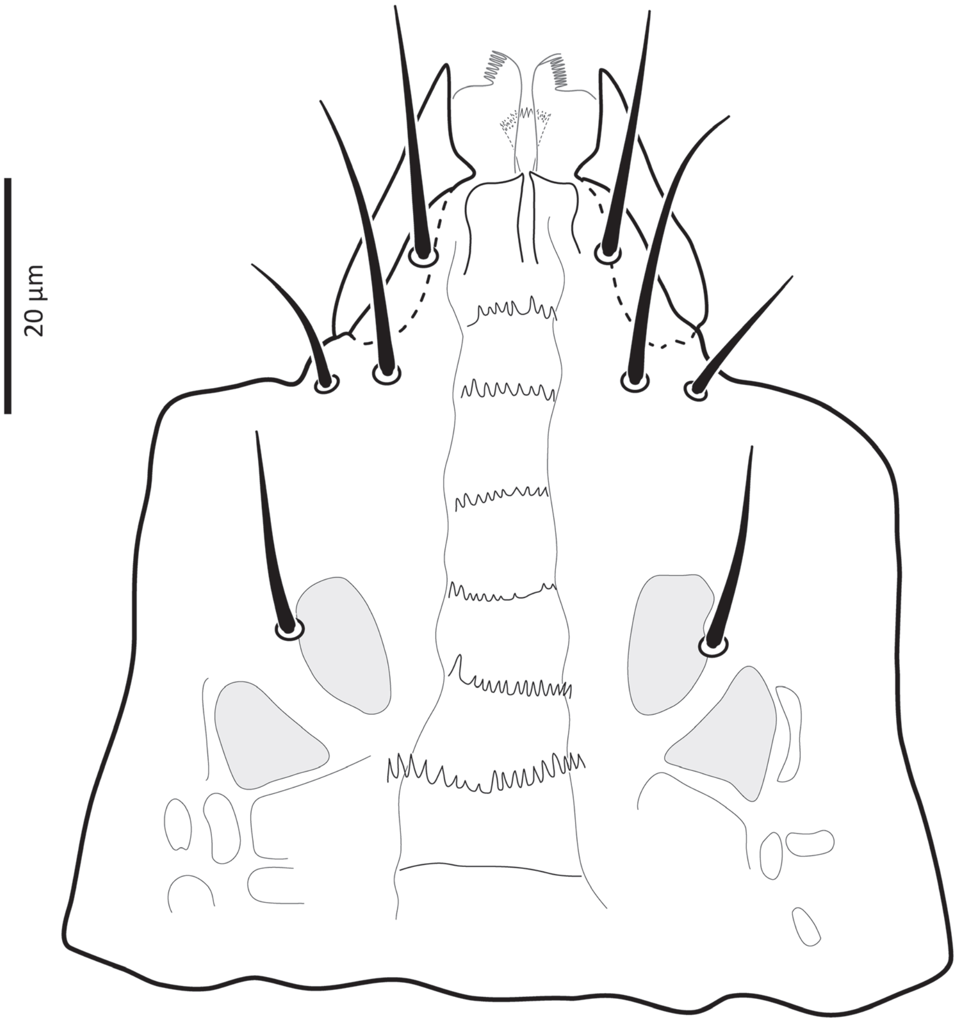


Figure 21. *Zygoseius lindquisti* sp. n., female, subcapitulum.

42–44, III 24–27, IV 31–34; tibiae: I 42–45, II 33–36, III 28–29, IV 36–38; tarsi: I 66–72, II 68–73, III 63–65, IV 88–91; ambulacra: I 21–25, II 21–22, III 19–20, IV 20–22. Chaetotaxy of leg segments I–IV normal for *Zygoseius* (*sensu* Halliday 1997): coxae 2-2-2-1, or I–III (0 0/1 0/1 0), IV (0 0/1 0/0 0); trochanters 6-5-5-5, or I (1 0/1 1/2 1); II (1 0/1 0/2 1), III–IV (1 1/1 0/2 0); femora 13-11-6-6, or I (2 3/1 2/3 2), II (2 3/1 2/2 1), III–IV (1 2/1 1/0 1); genua 13-11-8 or 9-9, or I (2 3/2 3/1 2), II (2 3/1 2/1 2), III (2 2/1 2/0 1 in one specimen, or 2 2/1 2/1 1 in another specimen), IV (2 2/1 3/0 1); tibiae 13-10-8-8, or I (2 3/2 3/1 2), II (2 2/1 2/1 2), III–IV (2 1/1 2/1 1); tarsi II–IV 18-18-18, all as 3 3/2 3/2 3 + *md* and *mv*. All setae on legs I–IV simple, relatively short and tapered, except: femur I with *pd1–2* thickened, *pd2* thicker

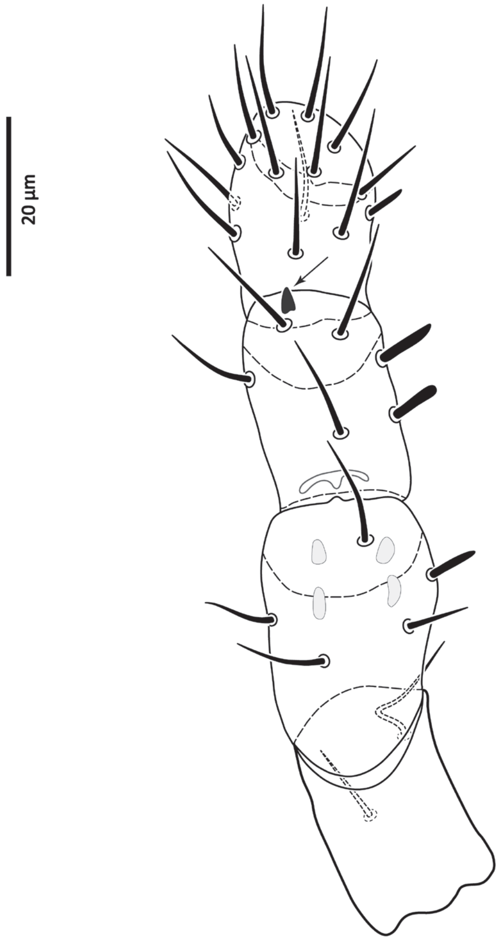
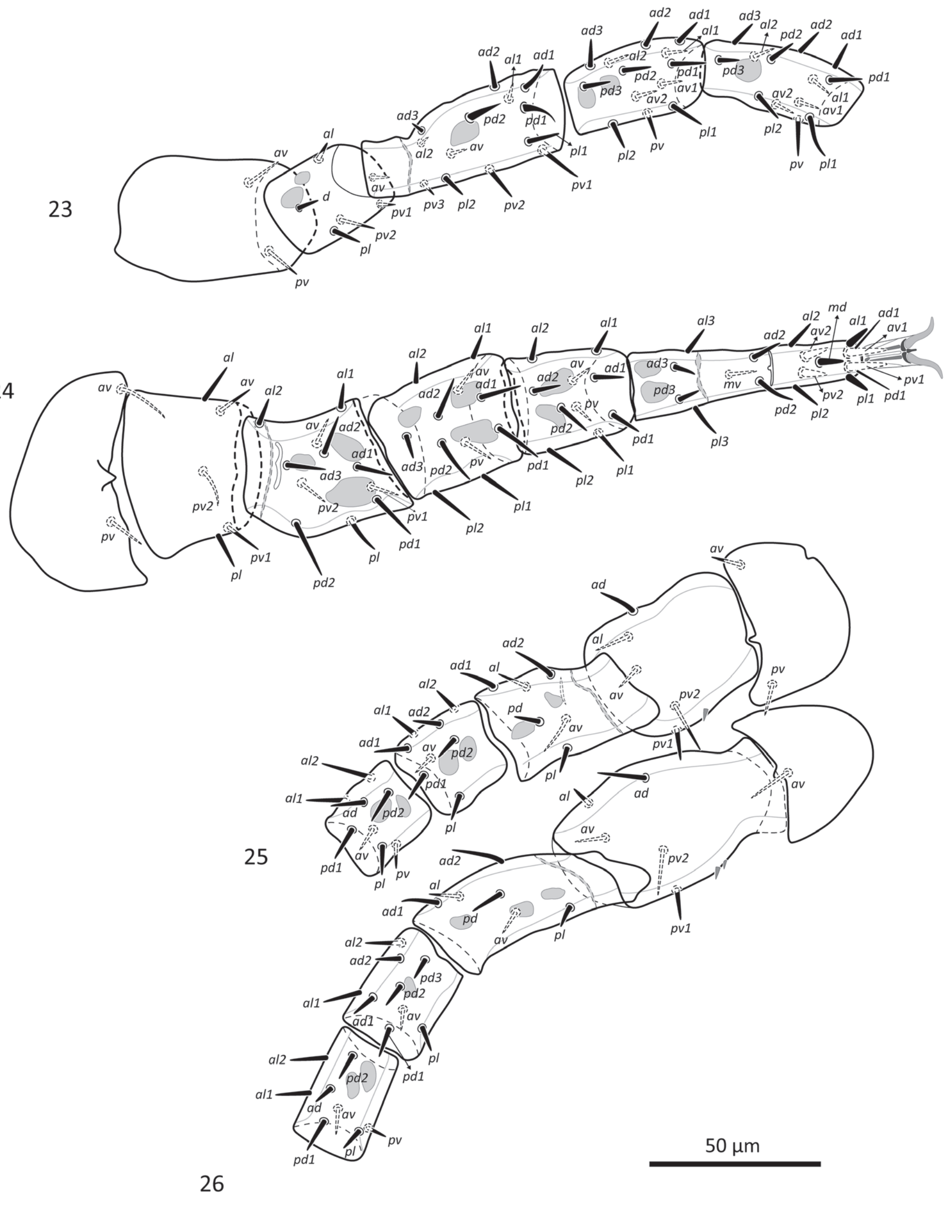


Figure 22. *Zygoseius lindquisti* sp. n., female, palp, excluding tarsus, dorsal view.

(lengths: *pd1* 10–12, *pd2* 11–12); tarsi II–III with apical setae *al1*, *av1*, *pv1*, *pl1* and subapical setae *av2*, *pv2* and *md* short, spur-like; tarsus IV with setae *al1*, *av1*, *pv1*, *pl1* and *md* short, spur-like; tarsi II–IV with *mv* longer and slightly slender. Trochanter III with small cuticular spur posterolaterally, and trochanter IV with two cuticular spur posterolaterally. Ventral surfaces of coxae II–IV and trochanters I–II, anterolateral surface of trochanter IV, and dorsal surfaces of femora and tibiae I–IV, genua and basitarsi II–IV with some sigillae. All ambulacra with a pair of well-developed hooked claws. Pulvilli not discerned.

Spermathecal apparatus (Plate 2). Spermatheca small, 6–8 wide, somewhat kidney-shaped, with no stalk, directly connected to a globular, large sperm reservoir (diameter 17–21), followed by a long spermatic canal (27–34 long). Sperm reservoir presenting a narrow central duct; spermatic canal with distinct walls, diverging basally.

Male and immature stages. Unknown.



Figures 23–26. *Zygoseius lindquisti* sp. n., female, legs I–IV, dorsal view.

Material examined. Holotype: Female. Mexico, Chiapas State, 6 miles NE of San Cristóbal de Las Casas, from flood debris in creek, 15 May 1969, coll. Evert E. Lindquist. Paratype: Female, same data as holotype. The holotype and paratype are deposited at the Canadian National Collection of Insects, Arachnids and Nematodes (CNC), Agriculture and Agri-Food Canada, Ottawa, Canada.

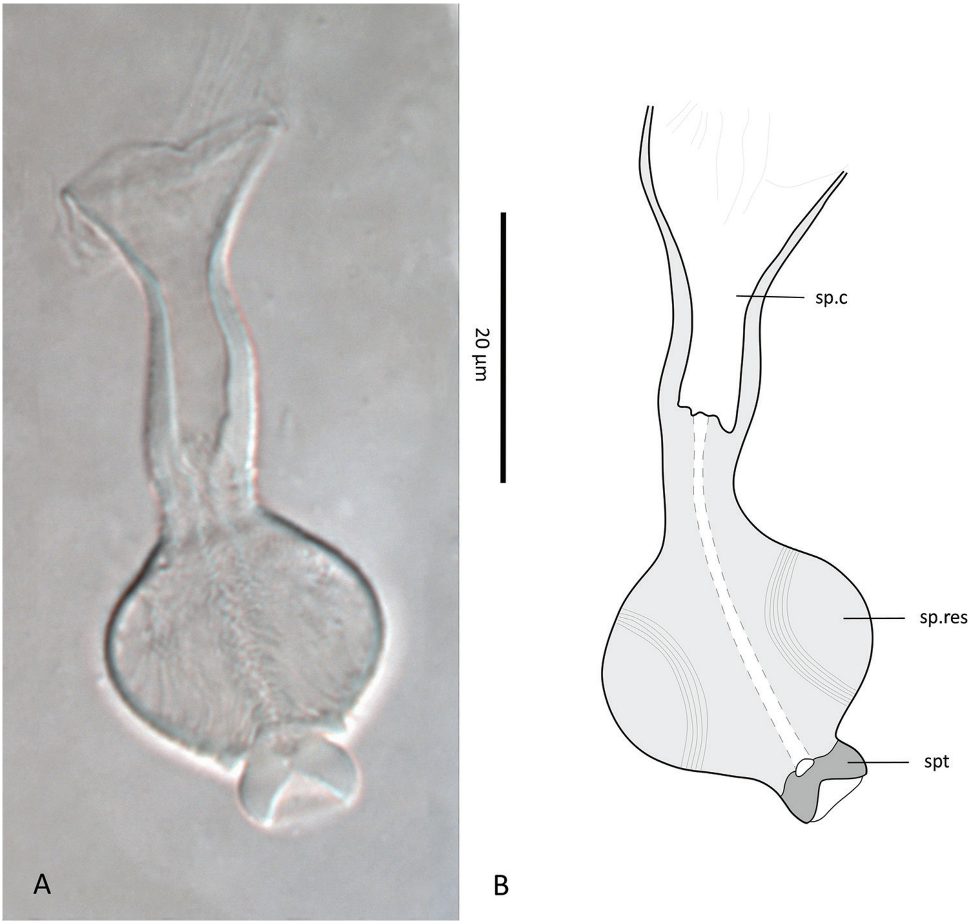


Plate 2. *Zygoseius lindquisti* sp. n., female, **A, B** spermathecal apparatus in two different females (Abbreviations as mentioned in Plate 1).

Figure 27. Seta *av* on palp trochanter of *Zygoseius papaver* sp. n., *Z. lindquisti* sp. n. and *Z. furciger*.

Etymology. The species is named in honor of Evert E. Lindquist, for his invaluable endeavors on the systematics of Mesostigmata over the years. The specimens of this new species were collected by him.

Remarks. The dorsal seta of trochanter I in *Z. papaver* and *Z. lindquisti* is inserted in a posterior position. We herein call this seta *d* (Figs 10, 23), although in the chaeto-

Figure 28. *Zygoseius papaver* sp. n., female, dorsal idiosoma.

tactic formula, we indicated it as posterodorsal, given its clear posterior position, as in Halliday (1997). Evans (1963a, fig. 1i) indicated '*ad*' for this dorsal seta, as illustrated for *Pergamasus* (Parasitidae). In the text, however, he called it '*d*', for *Pergamasus* and

Figure 29. *Zygoseius papaver* sp. n., female, ventral idiosoma.

for other gamasines. We have examined adult specimens of other *Zygoseius* spp., as well as of *Pachylaelaps* (Pachylaelapidae), *Gaeolaelaps* (Laelapidae), *Asca* (Ascidae), *Proctolaelaps* (Melicharidae), *Parasitus* and *Pergamasus* (Parasitidae), and the dorsal seta of trochanter I was usually inserted in a slightly to moderately posterior position, and rarely on the mediodorsal line or in a (slightly) anterior position.

Figure 30. *Zygoseius papaver* sp. n., male, dorsal idiosoma.

In his diagnosis of the genus *Zygoseius*, Halliday (1997) indicated one *pv* and one *pl* setae on trochanter IV, whereas Evans (1963a) indicated two *pv* and no *pl* (as we did, herein). Indeed, *pv1* is inserted much more posteriorly than *pv2* (although not

Figure 31. *Zygoseius papaver* sp. n., male, ventral idiosoma.

necessarily posterolaterally), and this situation is similar to that of *pv1–2* of trochanters II–III (Evans 1963a; Figs 11–13, 24–26).

In addition to poroid *idR3*, between setae *R3* and *R4*, the soft opisthogastric cuticle has a sclerotized complex of two pore-like structures, posterolaterad the peritre-

Figure 32. *Zygoseius lindquisti* sp. n., female, dorsal idiosoma.

matal-metapodal shield. These structures may be two openings of the same underlying gland complex; alternatively, they may be a gland opening and an associated poroid (note that both of these structures are sometimes visible in lateral view when the soft cuticle is folded, instead of the normal ventral view). It is unclear whether this gland

Figure 33. *Zygoseius lindquisti* sp. n., female, ventral idiosoma.

opening is homologous to the one (*gp*) typically found in the poststigmatic region of peritrematal shields in many Mesostigmata (e.g. Lindquist and Moraza 2016). This double pore-like structure also occurs in *Z. papaver* sp. n., as well as in *Z. ampullus* and *Z. metoecus* (Halliday 1997), and *Z. sarcinulus* (AA, personal observations).

Zygoseius lindquisti sp. n. shares certain morphological features with *Z. incisus* Karg, 1998 and *Z. margaritatus* Karg & Schorlemmer, 2009, including: (1) an epistome with two thin projections, about twice as long as distance between their bases, sparsely serrated, mostly in apical half; (2) the ratio *J4* setae inserted well farther apart from each other than *J1* setae (ratio of distance *J4–J4*/*J1–J1*= 1.42–1.57 in *Z. lindquisti* sp. n.); (3) *J1–2* setae slightly shorter than distance between insertions of *J1* and *J2* (length *J1–2* setae/*J1–2* distance= 0.8–0.9 in *Z. lindquisti* sp. n.); (4) ventrianal shield with short setae, including *JV1–2*; (5) the length of seta *Z5* (20–26 in *Z. lindquisti* sp. n.). It also has a spermathecal apparatus similar to *Z. margaritatus*, although the latter has a more elongate, egg-shaped spermatic reservoir followed by a spermatic canal more constricted distally. The spermathecal apparatus of *Z. incisus* is distinct, with a narrow elongate spermatic canal. The species *Zygoseius lindquisti* sp. n. can further be distinguished from the two species by (1) the dense micropunctation on its dorsal, sternal and genital shields, and its ventrianal shield lineate anteriorly and reticulate laterally and posteriorly; (2) its relatively broad dorsal shield (396–413 long, 278–283 wide; vs 430 long, 260 wide in *Z. incisus*, 336–392 long, 231–256 wide in *Z. margaritatus*); (3) its relatively wide ventrianal shield (153–154 long, 189–196 wide; vs. 160 long, 170 wide in *Z. incisus*, 140 long, 182 wide in *Z. margaritatus*); (4) many longer setae in the opisthonotal region (e.g. *J1*, *J4*, *S5*).

The new species also has a spermathecal apparatus similar to *Z. furciger*. Based on the two females examined, however, *Z. lindquisti* sp. n. has a sperm reservoir globular with enlarged spermatic canal throughout, whereas the sperm reservoir of *Z. furciger* ranges from globular to oval with spermatic canal constricted distally (in proximity to sperm reservoir). The detailed description of Halliday (1997) allows to easily distinguish the new species from *Z. furciger*, by (1) its sternal shield faintly lineate and densely micropunctate (reticulate and with punctae along cell margins in *Z. furciger*); (2) smaller dorsal shield (396–413 long; vs 418–518 in *Z. furciger*); (3) some setae in opisthonotal region slightly longer (e.g. *J1*, *J4*); (4) hypostomal setae *h1* and *h3* subequal in length (*h3* about 1.5× as long as *h1* in Halliday, 1997); (5) deutosternum with 6–7 rows of denticles (eight rows in *Z. furciger*).

Discussion

The record of a "*Zygoseius* sp." by Palacios-Vargas (1983) probably represents from the first mention of the genus in Mexico. Among the now 15 described species, 12 are found in South America, including one (*Z. furciger*) that is also found elsewhere (USA, Africa, Israel); two (described herein) occur in Mexico, and one (*Z. sarcinulus*) is widespread in Australia.

Some morphological characters are of particular interest for the diagnosis of *Zygoseius* species and possibly also for classifying them into species groups. Perhaps the most useful character to distinguish *Zygoseius* species is the spermatheca itself varying in size relative to the rest of the apparatus, and the sperm reservoir varying in shape, ranging from oval to globular (Halliday 1997, Karg 1998). More detailed studies of the spermathecal apparatus will probably help further the systematics of *Zygoseius*, analogously as to its use for other Mesostigmata, such as the Phytoseiidae (Chant and McMurtry 1994, Beard 2001) and Pachylaelapidae (Mašán 2007).

The dorsal idiosomal chaetotaxy is moderately useful, with some setae varying markedly in position between species, such as *J5* relative to *Z5*, and with the atypical presence of seta *J3* in some species (in *Z. triramuli* and *Z. alveolaris*; Karg 1998). Although Halliday (1997) stressed the difficulty in using shield ornamentation (e.g. sternal shield) for species discrimination because of intraspecific variation, it is useful in some cases, including for the dorsal, sternal and ventrianal shields (compare *Z. papaver* and *Z. lindquisti*, Figs 1–2, 28–29, 15–16, 32–33; Halliday 1997).

The epistome and the male chelicerae appear as the most studied (or most often illustrated) gnathosomal characters in *Zygoseius*. There is some interspecific variation in the epistome, including the number (usually 2, rarely 3 or 4) and length of projections, and the extent of barbs on the margins. These variations are overall only moderate, although overall represent useful diagnostic features. Male chelicerae may be useful, with some apparent variation in dentition and in the lengths of spermatodactyls (e.g. *Z. furciger* has a longer spermatodactyl relative to cheliceral digits; Halliday 1997, Karg 1998, Karg and Schorlemmer 2009). The dentition of the female chelicerae has been illustrated for a few species only (*Z. incisus*, *Z. alveolaris*, *Z. furciger* (in Halliday 1997), *Z. papaver* sp. n.), and may differ in some species (e.g. *Z. incisus* has stronger teeth). The deutosternum has a variable numbers of transversal rows of denticles; e.g. that of *Z. papaver*, *Z. lindquisti* and *Z. furciger* have 7, 6–7 and 8 rows of denticles, respectively. The relative lengths of hypostomal setae (*h1–h3*, *pc*) also vary significantly, with some species having a particularly long *h1* seta (e.g. in *Z. papaver* sp. n.), whereas in other species (e.g. *Z. lindquisti* sp. n., *Z. furciger*), *h3* tends to be the longest.

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RESEARCH ARTICLE

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A multivariate study of differentiating characters between three European species of the genus *Lasiochernes* Beier, 1932 (Pseudoscorpiones, Chernetidae)

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Abstract

Morphological variation in three rarely collected European species of the genus *Lasiochernes* Beier, 1932 is thoroughly examined in the present study. Detailed descriptions of previously ignored morphological characters of *L. cretonatus* Henderickx, 1998, *L. jonicus* (Beier, 1929) and *L. pilosus* (Ellingsen, 1910) are presented. The female of *L. cretonatus* and the nymphs of *L. pilosus* are described for the first time. Multivariate morphometric techniques (principal coordinate analysis and discriminant analyses) were employed to confirm morphological differentiation of the three *Lasiochernes* species and to identify the most reliable characters for their separation. The usefulness of particular body parts for species identification was evaluated. An identification key for the females of the *Lasiochernes* species studied is provided. Geographic distribution and habitat preferences of the three species are summarized.

Keywords

Caves, mole nests, morphology, morphometric analysis, pseudoscorpion, taxonomy

Introduction

The genus *Lasiochernes* Beier, 1932 belongs to the subfamily Lamprochernetinae, as defined by Harvey (1994). Until now, ten species of the genus have been discovered (Harvey 2013). They are rarely collected, usually being found in the nests of small mammals or in caves. The genus is characterized by the presence of a long tactile seta on pedal tarsus IV, a pair of long tactile setae on tergite XI, five setae on the hand of the chelicera, secondary sexual dimorphism of the setation of the palps, with male palps bearing a long, dense setation, and a T-shaped spermatheca in females. Most of the known species are recorded from only one or two countries: *L. anatolicus* Beier, 1963 and *L. villosus* Beier, 1957 from Turkey; *L. turcicus* Beier, 1949 from Turkey and Israel; *L. congicus* Beier, 1959 and *L. punctiger* Beier, 1959 from the Democratic Republic of Congo; *L. jonicus* (Beier, 1929) and *L. cretonatus* Henderickx, 1998 from Greece; *L. graecus* Beier, 1963 from Albania and Greece and *L. siculus* from Italy (Harvey 2013). Only *L. pilosus* (Ellingsen, 1910) occurs in several European countries (Harvey 2013).

Detailed morphological descriptions of European pseudoscorpion species are rare. This holds true for both the adults and nymphal stages. These descriptions of adults and all nymphal stages are available mainly for the families Chthoniidae, Neobisiidae and Cheliferidae (e.g. Gabbutt and Vachon 1963, 1965, 1967, 1968, Gabbutt 1970), rarely for the family Chernetidae (Sezek and Özkan 2007, Christophoryová et al. 2012).

Material of three *Lasiochernes* species was obtained during our study: *L. cretonatus*, *L. jonicus* and *L. pilosus*. *L. cretonatus* was described from a single male collected in a cave in Crete (Greece) (Henderickx 1998). *L. jonicus* was briefly described by Beier (1929), based on several adult specimens from Corfu, Greece. *L. pilosus* is distributed in several European countries (Harvey 2013) and it shows a degree of host-specificity, since it is almost exclusively found in subterranean mole-nests with a particular content of dead leaves. Many adults and nymphal stages of the latter species had been collected, but there had been no detailed description of nymphs and some characters of the adults remained unknown.

Morphological differences between species of pseudoscorpions, as reported in taxonomic descriptions, are often based on quantitative traits. Multivariate morphometric methods are an effective tool to compare the role of numerous quantitative and qualitative characters and allow in-depth examination of morphological variation of phenetically similar taxa. In recent years, many papers have successfully employed multivariate morphometrics in the taxonomy of invertebrates, such as mites (Klimov et al. 2004, Stekolnikov et al. 2010, Jagersbacher-Baumann 2014), flies (Castañeda et al. 2015, Van Cann et al. 2015), beetles (Sha et al. 2016) and spiders (Hamilton et al. 2016). The applicability of these methods for differentiation of pseudoscorpion species has been studied on the family of Chthoniidae. Muster et al. (2004) used multivariate analyses to separate two European species of the genus *Chthonius*.

The aims of this study are to (1) assemble detailed morphological descriptions of the adults of the three investigated *Lasiochernes* species, (2) describe all the nymphal stages of *L. pilosus*, (3) assess the extent of morphological differentiation between adults of the three species, (4) identify the morphological characters that are most relevant for the differentiation of the three species and (5) provide an identification key for the females of the three species.

Material and methods

Lasiochernes cretonatus: Greece, Crete, Azogires (Fig. 1), collected in Cave of 99 Holy Fathers/Souré Cave (35°16'22"N, 23°42'39"E; 500 m a.s.l.), 8 October 2000, one male, four females, leg. H. Henderickx.

L. jonicus: Greece, Pelion, Mouresi (Fig. 1), collected in Tsouka cave (39°23'52"N, 23°10'12"E; 200 m a.s.l.), 3 November 2012, one male, one female, leg. H. Henderickx.

L. pilosus: Slovakia, Malé Karpaty Mts., Borinka (Fig. 1), collected in nest of mole *Talpa europaea* Linnaeus, 1758 (48°15'44"N, 17°05'10"E; 300 m a.s.l.), 20 January 1990, three males, four females, 15 tritonymphs, 15 deutonymphs, 15 protonymphs, leg. Oto Majzlan. Belgium, Namur, Hastière (Fig. 1), collected in a *Talpa europaea* nest (50°13'10"N, 04°50'12"E; 200 m a.s.l.), 11 May 2001, two males, three females, leg. H. Henderickx.

Populations of *Lasiochernes* collected from mole nests in Belgium and Slovakia were identified as *L. pilosus* (Beier 1963, Christophoryová et al. 2011) based on the setation on male palps and the habitat preference of this species. The taxonomic assignment of these two populations to *L. pilosus* is also in agreement with the known geographic distribution of this species (Harvey 2013). The studied population of *Lasiochernes* from Crete is from the type locality of *L. cretonatus*, a single cave at Azogires. The identification of this population as *L. cretonatus* is supported by morphological characters mentioned in the original description of this species, namely the setation of the male palp and the position of the tactile seta on the tarsus of leg IV (Henderickx 1998). The fourth *Lasiochernes* population was found in Pelion in Greece. It was identified as *L. jonicus* (Beier 1929, Mahnert 1978), due to the pedipalpal setation of the male specimens, which provides the main character distinguishing *L. jonicus* from *L. cretonatus*.

The chelicera, palp, leg I and leg IV were removed from the left side of the body of all specimens examined. In the case of *L. pilosus*, these appendages were mounted as permanent slide mounts using Swann's fluid as the medium. The rest of the body was studied as a temporary slide mount using lactic acid, after which it was returned to 70% ethanol. The body and the dissected appendages of *L. cretonatus* and *L. jonicus* were studied as temporary slide mounts using lactic acid, after which they were returned to 70% ethanol.

Measurements were taken from photographs using the Zeiss AxioVision 40LE application (v. 4.6). These photographs were made using the Canon EOS Utility software and a digital camera (Canon EOS 1100D) connected to a Zeiss Stemi 2000-C stereomicroscope or a Leica ICC50 camera connected to a Leica DM1000 stereomicroscope using Leica LAS EZ 1.8.0 software. Figures 4, 5 and 6 were drawn using a

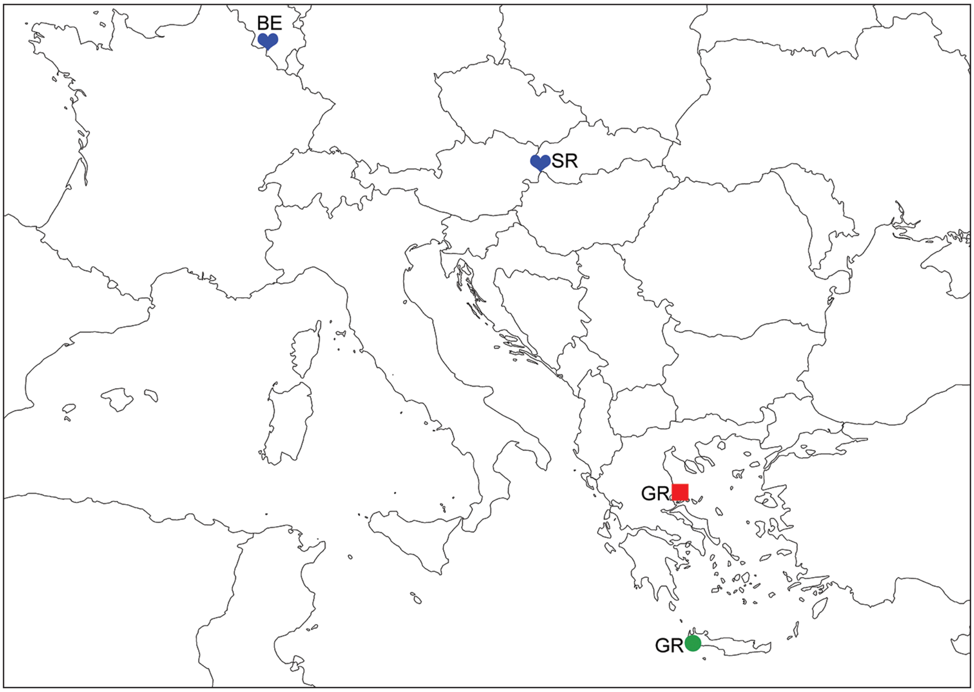

Figure 1. Collection localities of the studied material: *Lasiochernes cretonatus* (green circle), *L. jonicus* (red square) and *L. pilosus* (blue hearts).

Leica drawing tube. Figure 2A was made with an FEI Quanta 200 scanning electron microscope at the Royal Belgian Institute of Natural Sciences, Brussels; ESEM scanning was performed in low pressure/low temperature water vapor (100% saturation, 4°C). Figures 2B, C and 2D are photographs of living specimens, taken on a glass plate with flash illumination, using a Canon Eos 5D mark III with a Canon MP-E 65 mm f2.8 lens. Nomenclature for all taxa follows Harvey (2013). The material is deposited in the zoological collections of Comenius University, Bratislava.

Methods of multivariate morphometrics (Marhold 2011) were used to examine the differentiation of 19 adult specimens assigned to three *Lasiochernes* species (five specimens of *L. cretonatus*, two specimens of *L. jonicus* and 12 specimens of *L. pilosus*) and to evaluate the importance of particular morphological characters. The morphological characters measured or scored included those reported as taxonomically relevant within the genus in identification keys and other treatments. The distribution of long and dense setation on the palps of males, the main character used for taxonomic identification of the studied samples, was omitted from the statistical analyses to avoid circular reasoning. Altogether, 92 quantitative characters were measured or scored (Table 1), of which 51 were continuous (see Table 1 in Results) and 34 were discrete (see Morphological descriptions in Results). Out of these, seven characters were invariable between measured specimens (number of blades in cheliceral rallum, number of setae on hand and movable finger of chelicera, number of trichobothria on both chelal fingers, presence of a pair of long tactile setae on tergite XI and sternite XI) and only the remaining 85 characters were used for further statistical analyses.

The statistical analyses were performed as follows:

(1) As the first step, the Shapiro-Wilk statistic for the test of normality of distribution was computed for each character.
(2) Principal coordinate analysis, PCoA (Podani 2000, 2001), based on 85 characters, was used to obtain possible groupings of the 19 studied specimens. The data were standardized by a standard deviation of variables, and Euclidean distance was used to compute the secondary matrix. PCoA, unlike the better known PCA method (principal component analysis), can be also used for qualitative and mixed characters, as well as in cases when p>n (p = number of characters, n = number of objects).
(3) Correlation between the principal coordinate axes of PCoA and original quantitative characters was computed using Pearson correlation coefficient (Zar 1999) in order to identify the characters that are the most responsible for the groupings of specimens along the first three principal coordinate axes.
(4) Discriminant analyses (Klecka 1980, Marhold 2011) were employed to assess the morphological differentiation between the three *Lasiochernes* species. The discriminant analyses applied included canonical discriminant analysis (CDA) and classificatory discriminant analysis (classificatory DA). In CDA, the discriminant functions were derived to express the extent of morphological differentiation between the predefined groups (the three *Lasiochernes* species) and to identify the most important differentiating characters. Nonparametric *k*-nearest neighbors classificatory discriminant analyses were performed to estimate the percentage of specimens correctly assigned to the predefined groups. A cross-validation procedure was used, in which the classification criterion was based on $n-1$ individuals and then applied to the individual left out. Discriminant analyses generally require a multivariate normal distribution of the characters; nevertheless, they have been shown to be quite robust against deviations in this respect (Thorpe 1976, Klecka 1980). Due to the limited number of available specimens (19) and the chosen number of predefined groups (three), we had to lower the number of characters in primary matrices to 15 (or less) in order to satisfy the requirements for number of objects (n), number of predefined groups (g) and number of variables (p) in discriminant analyses [$p < (n-g)$]. Therefore, the original dataset of all measured characters was divided into eight partial matrices corresponding to eight parts of the body. Each partial dataset contained no more than 15 characters and each was analyzed in a separate CDA and classificatory DA. The following eight body parts were selected: carapace (six characters), chelicera (six characters), palp (nine characters), chela (11 characters), leg I (15 characters), leg IV (12 characters), tergites (ten characters) and sternites (12 characters). As a result, eight CDAs (CDA 1–CDA 8) and eight classificatory DAs (DA 1–DA 8) were performed to identify both the body parts and the characters that are most important for the differentiation of the three species. Altogether, 81 characters (out of the original 85) were included in these analy-

ses. Four characters were omitted. The character "length of the whole body" was inapplicable for the parts of the body and three other characters (posterior width of carapace, length of palpal hand with pedicel, length of patella of leg I), were excluded because they were invariable within one or more predefined groups (species) and might have distorted the discriminant analyses. Based on the results of the eight CDAs (CDA 1–8), the 15 most important characters were selected and a final matrix, combining all body parts, was assembled. This total-body matrix was analyzed in CDA 9 and classificatory DA 9. Prior to the discriminant analyses of all the datasets mentioned above, the Pearson and nonparametric Spearman correlation coefficients (Zar 1999) were computed to reveal correlation structure among the selected characters and to ensure that no very high correlations (> 0.95) were present (potentially distorting the analyses). The discriminant analyses were performed using SAS 9.1.3 software SAS/STAT v.9.2 (SAS Institute, 2009).

(5) Finally, descriptive statistics were computed for adults of the three *Lasiochernes* species, and for nymphs of *L. pilosus*. Variations in the morphological characters that differentiate between them are shown as box-and-whisker plots. The minimum and maximum values for the measured characters are reported in identification key and morphological descriptions. The analyses were performed using SAS 9.1.3 software SAS/STAT v.9.2 (SAS Institute, 2009).

Results

Morphological descriptions. Adults of the studied *Lasiochernes* species share the following characteristic. Setae on body relatively short and clavate. Carapace approximately as long as broad, granulate and rectangular, epistome absent, anterior margin straight, eyes or eyespots absent, anterior and posterior transverse furrows distinct (Figs 2A, 3). Chelicerae small, slightly sclerotized, five setae on hand, one on movable finger; movable finger with slender, well-developed galea; rallum of three blades; small, largely unsclerotized teeth situated on both movable and fixed fingers. Palps (Fig. 4): chelal fingers with twelve trichobothria (eight on fixed and four on movable chelal finger), venom apparatus developed only in movable chelal finger. Legs: tarsus IV with long tactile seta (Fig. 2). Abdominal tergites divided, tergite XI with a pair of long tactile setae (Fig. 2). Body measurements are given in Table 1.

Lasiochernes cretonatus Henderickx, 1998

Figs 2B, 3; Table 1

Description. Female (4 specimens analyzed) (Table 1). Chaetotaxy of carapace: 71–74 setae, 31–38 of them situated in front of anterior transverse furrow, 21–26 on medial disk, posterior margin with 13–14 setae. Cheliceral galea with 5–6 short terminal rami, serrula exterior with 19–21 blades. Palps: fixed chelal finger with 44–48 and movable

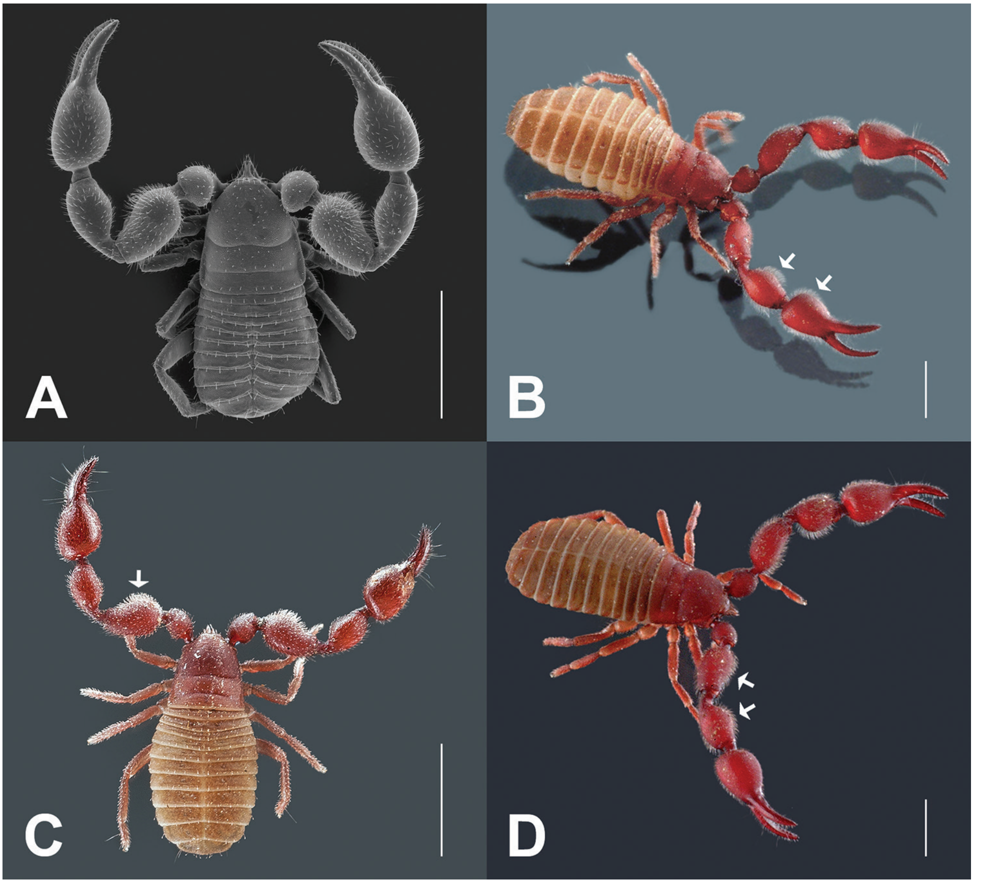

Figure 2. Males of *Lasiochernes* species. **A** *L. jonicus* (scanning electron micrograph) **B** *L. cretonatus* **C** *L. jonicus* **D** *L. pilosus*. Arrows point to long, dense setation on palps. Scales lines: 1 mm.

chelal finger with 48–50 marginal teeth; fixed chelal finger with 9–13 antiaxial accessory teeth and movable chelal finger with 8–9 antiaxial accessory teeth; fixed and movable chelal fingers with four paraxial accessory teeth. Palpal parts without long, dense setation (Fig. 3). Legs: tarsus IV with long tactile seta situated one third from the joint with the tibia, meaning 0.15–0.19 mm from the tarsal base. Chaetotaxy of tergites I–X: 14–16 (left hemitergite 6–8 + right hemitergite 7–8): 14–17 (7–8 + 7–9): 13–18 (7–9 + 6–9): 19–24 (9–11 + 9–13): 21–25 (11–13 + 10–12): 18–27 (9–15 + 9–12): 19–23 (10–11 + 9–12): 21–22 (10–12 + 10–11): 19–22 (10–12 + 9–12): 14–18 (7–9 + 7–9); tergite XI with 10 setae (5 + 5) plus a pair of long tactile setae. Chaetotaxy of sternites IV–X: 8–13 (left hemisternite 4–6 + right hemisternite 4–8): 18–22 (9–11 + 9–11): 20–25 (10–12 + 10–13): 19–23 (9–11 + 9–12): 19–26 (10–12 + 9–14): 22–24 (10–12 + 11–13): 18–22 (9–11 + 9–12); sternite XI with 9–10 setae (4–5 + 5) plus a pair of long tactile setae. Female spermatheca unpaired, T-shaped; anterior genital operculum with 29–31 setae and two lyrifissures, posterior operculum with 10–12 setae and 4–6 lyrifissures (Fig. 6A).

Table 1. Descriptive statistics of the measured morphological characters of the studied *Lasiochernes* species. Abbreviations: n: number of measured specimens. Mean values of the measured characters ± standard deviation (Mean ± SD) are given in upper rows; minimum and maximum (Min–Max) are in lower rows. Values of all the measured characters are in mm.

Characters/Species Mean ± SD Min–Max	*Lasiochernes cretonatus*	*Lasiochernes jonicus*	*Lasiochernes pilosus*			
	Adults	Adults	Adults	Tritonymphs	Deutonymphs	Protonymphs
	n = 5	n = 2	n = 12	n = 15	n = 15	n = 15
Body length	4.23±0.20 4.03–4.51	2.98±1.00 2.27–3.69	3.92±0.65 3.12–4.98	2.73±0.36 2.18–3.38	2.50±0.20 2.11–2.78	1.59±0.13 1.41–1.80
Carapace length	1.01±0.02 0.99–1.03	1.03±0.03 1.01–1.05	1.22±0.08 1.12–1.36	0.97±0.05 0.91–1.09	0.77±0.05 0.69–0.89	0.58±0.04 0.54–0.67
Carapace posterior width	1.00±0.00 0.99–1.00	1.09±0.01 1.08–1.09	1.28±0.13 1.12–1.55	1.04±0.06 0.92–1.13	0.85±0.06 0.73–0.95	0.66±0.04 0.60–0.75
Carapace length/posterior width ratio	1.02±0.02 0.99–1.03	0.95±0.03 0.93–0.97	0.96±0.05 0.88–1.05	0.94±0.03 0.88–0.99	0.91±0.05 0.84–0.99	0.88±0.03 0.83–0.95
Chelicera length	0.35±0.01 0.35–0.36	0.36±0.00 0.36–0.36	0.37±0.04 0.33–0.45	0.28±0.02 0.26–0.31	0.22±0.01 0.21–0.23	0.16±0.01 0.15–017
Chelicera width	0.18±0.01 0.17–0.18	0.17±0.01 0.16–0.18	0.23±0.02 0.20–0.27	0.18±0.01 0.16–0.19	0.13±0.01 0.12–0.14	0.10±0.01 0.09–0.11
Chelicera length/width ratio	2.01±0.07 1.94–2.12	2.13±0.18 2.00–2.25	1.67±0.09 1.54–1.86	1.61±0.07 1.44–1.72	1.72±0.08 1.57–1.83	1.63±0.07 1.55–1.78
Cheliceral movable finger length	0.26±0.01 0.26–0.27	0.21±0.01 0.20–0.21	0.30±0.03 0.25–0.34	0.22±0.07 0.21–0.23	0.17±0.00 0.17–0.18	0.13±0.01 0.12–0.15
Palpal trochanter length	0.52±0.01 0.50–0.53	0.53±0.01 0.52–0.53	0.63±0.06 0.53–0.69	0.42±0.02 0.39–0.45	0.30±0.03 0.27–0.33	0.20±0.01 0.18–0.24
Palpal trochanter width	0.38±0.00 0.38–0.38	0.42±0.02 0.40–0.43	0.43±0.05 0.34–0.51	0.30±0.02 0.27–0.33	0.21±0.01 0.18–0.23	0.14±0.01 0.13–0.15
Palpal trochanter length/width ratio	1.33±0.05 1.27–1.39	1.27±0.05 1.23–1.30	1.46±0.11 1.30–1.63	1.40±0.06 1.29–1.48	1.44±0.11 1.23–1.68	1.42±0.07 1.33–1.60
Palpal femur length	0.95±0.03 0.93–0.99	0.97±0.05 0.93–1.00	1.11±0.09 0.91–1.26	0.72±0.04 0.66–0.79	0.50±0.02 0.47–0.55	0.31±0.02 0.28–0.35
Palpal femur width	0.38±0.01 0.37–0.39	0.50±0.12 0.41–0.58	0.44±0.05 0.38–0.53	0.32±0.02 0.29–0.34	0.22±0.01 0.19–0.25	0.14±0.01 0.12–0.15

Characters/Species Mean ± SD Min–Max	*Lasiochernes cretonatus*	*Lasiochernes jonicus*	*Lasiochernes pilosus*			
	Adults	**Adults**	**Adults**	**Tritonymphs**	**Deutonymphs**	**Protonymphs**
	n = 5	**n = 2**	**n = 12**	**n = 15**	**n = 15**	**n = 15**
Palpal femur length/width ratio	2.50±0.05 2.44–2.54	2.02±0.59 1.60–2.44	2.51±0.19 2.19–2.80	2.29±0.12 2.09–2.48	2.28±0.11 2.17–2.47	2.29±0.14 2.07–2.62
Palpal patella length	0.96±0.03 0.93–0.99	1.02±0.01 1.01–1.02	1.04±0.10 0.82–1.18	0.67±0.04 0.62–0.72	0.46±0.02 0.43–0.48	0.29±0.01 0.27–0.30
Palpal patella width	0.44±0.01 0.42–0.45	0.43±0.01 0.42–0.44	0.49±0.06 0.41–0.60	0.35±0.02 0.32–0.40	0.24±0.01 0.23–0.27	0.15±0.00 0.15–0.16
Palpal patella length/width ratio	2.21±0.06 2.15–2.30	2.36±0.06 2.32–2.40	2.14±0.16 1.90–2.41	1.91±0.08 1.79–2.06	1.87±0.06 1.74–1.96	1.88±0.04 1.80–2.00
Palpal hand with pedicel length	0.89±0.01 0.88–0.91	0.94±0.08 0.88–0.99	1.06±0.10 0.81–1.18	0.77±0.05 0.68–0.83	0.54±0.03 0.51–0.59	0.36±0.02 0.33–0.39
Palpal hand without pedicel length	0.77±0.03 0.74–0.81	0.80±0.06 0.75–0.84	0.93±0.09 0.74–1.05	0.69±0.04 0.60–0.76	0.49±0.03 0.45–0.55	0.32±0.02 0.31–0.37
Palpal hand width	0.58±0.02 0.57–0.61	0.59±0.00 0.59–0.59	0.65±0.06 0.54–0.74	0.47±0.03 0.42–0.52	0.31±0.02 0.28–0.34	0.19±0.01 0.17–0.20
Palpal hand with pedicel length/width ratio	1.53±0.05 1.44–1.58	1.58±0.13 1.49–1.68	1.64±0.08 1.50–1.72	1.53±0.08 1.36–1.65	1.74±0.06 1.64–1.84	1.89±0.14 1.70–2.18
Palpal fixed finger length	0.84±0.06 0.80–0.95	0.74±0.04 0.71–0.77	0.93±0.05 0.83–1.01	0.62±0.04 0.54–0.68	0.43±0.02 0.41–0.48	0.30±0.02 0.27–0.33
Palpal chela length	1.66±0.09 1.58–1.78	1.61±0.07 1.56–1.66	1.93±0.15 1.55–2.12	1.34±0.09 1.20–1.47	0.93±0.03 0.88–0.98	0.63±0.02 0.60–0.69
Palpal chela length/palpal hand width	2.86±0.09 2.77–2.96	2.73±0.12 2.64–2.81	3.00±0.19 2.69–3.36	2.88±0.11 2.71–3.13	2.96±0.13 2.79–3.21	3.35±0.17 3.15–3.65
Leg I trochanter length	0.23±0.02 0.21–0.24	0.22±0.02 0.20–0.23	0.27±0.03 0.23–0.31	0.20±0.01 0.17–0.24	0.13±0.01 0.12–0.15	0.09±0.01 0.08–0.10
Leg I trochanter width	0.17±0.01 0.17–0.18	0.18±0.00 0.18–0.18	0.21±0.02 0.19–0.24	0.16±0.01 0.15–0.19	0.12±0.01 0.11–0.14	0.08±0.01 0.07–0.09
Leg I trochanter length/width ratio	1.31±0.08 1.23–1.41	1.19±0.12 1.11–1.28	1.27±0.08 1.14–1.41	1.24±0.09 1.13–1.40	1.13±0.05 1.07–1.18	1.07±0.06 1.00–1.14
Leg I femur length	0.27±0.01 0.27–0.28	0.26±0.03 0.24–0.28	0.31±0.03 0.25–0.35	0.20±0.02 0.17–0.23	0.13±0.01 0.12–0.15	0.10±0.01 0.09–0.12

Characters/Species Mean ± SD Min–Max	*Lasiochernes cretonatus*	*Lasiochernes jonicus*	*Lasiochernes pilosus*			
	Adults	Adults	Adults	Tritonymphs	Deutonymphs	Protonymphs
	n = 5	n = 2	n = 12	n = 15	n = 15	n = 15
Leg I femur width	0.17±0.01 0.17–0.18	0.19±0.01 0.18–0.20	0.23±0.02 0.20–0.25	0.16±0.01 0.14–0.20	0.11±0.01 0.10–0.13	0.08±0.01 0.07–0.11
Leg I femur length/width	1.58±0.07 1.50–1.65	1.37±0.05 1.33–1.40	1.37±0.08 1.24–1.50	1.23±0.08 1.13–1.43	1.17±0.11 1.00–1.40	1.19±0.08 1.00–1.29
Leg I patella length	0.50±0.06 0.44–0.58	0.48±0.01 0.47–0.48	0.55±0.04 0.46–0.61	0.38±0.02 0.34–0.41	0.27±0.02 0.25–0.30	0.18±0.01 0.16–0.19
Leg I patella width	0.17±0.02 0.15–0.19	0.16±0.00 0.16–0.16	0.20±0.02 0.17–0.22	0.15±0.01 0.13–0.17	0.11±0.01 0.10–0.12	0.08±0.01 0.07–0.09
Leg I patella length/width ratio	3.03±0.20 2.75–3.22	2.97±0.04 2.94–3.00	2.78±0.19 2.42–3.06	2.57±0.12 2.33–2.67	2.57±0.14 2.36–2.80	2.26±0.13 2.11–2.57
Leg I tibia length	0.52±0.06 0.46–0.60	0.47±0.04 0.44–0.49	0.55±0.05 0.46–0.62	0.36±0.02 0.33–0.41	0.24±0.01 0.23–0.26	0.16±0.01 0.15–0.17
Leg I tibia width	0.13±0.01 0.12–0.15	0.12±0.01 0.11–0.12	0.15±0.01 0.13–0.16	0.11±0.02 0.10–0.13	0.08±0.00 0.08–0.09	0.06±0.00 0.06–0.07
Leg I tibia length/width	3.97±0.21 3.73–4.29	4.04±0.06 4.00–4.08	3.81±0.29 3.44–4.21	3.23±0.15 3.00–3.50	2.88±0.10 2.67–3.00	2.55±0.15 2.29–2.83
Leg I tarsus length	0.42±0.05 0.38–0.47	0.33±0.03 0.31–0.35	0.49±0.04 0.42–0.56	0.35±0.02 0.31–0.38	0.25±0.01 0.23–0.26	0.17±0.01 0.15–0.19
Leg I tarsus width	0.11±0.01 0.10–0.12	0.09±0.01 0.08–0.09	0.11±0.01 0.09–0.12	0.09±0.01 0.08–0.09	0.07±0.01 0.06–0.07	0.05±0.00 0.05–0.06
Leg I tarsus length/width ratio	3.88±0.52 3.25–4.70	3.91±0.66 3.44–4.38	4.48±0.40 3.83–5.11	4.02±0.19 3.67–4.38	3.77±0.20 3.57–4.17	3.33±0.21 3.00–3.60
Leg IV trochanter length	0.39±0.02 0.37–0.42	0.33±0.04 0.30–0.35	0.43±0.06 0.34–0.53	0.33±0.01 0.30–0.35	0.21±0.02 0.20–0.24	0.13±0.01 0.10–0.15
Leg IV trochanter width	0.20±0.01 0.19–0.21	0.18±0.01 0.17–0.19	0.26±0.03 0.21–0.29	0.21±0.01 0.19–0.22	0.14±0.01 0.12–0.16	0.09±0.01 0.08–0.11
Leg IV trochanter length/width ratio	1.91±0.12 1.81–2.10	1.80±0.05 1.76–1.84	1.69±0.13 1.48–1.91	1.61±0.06 1.55–1.75	1.59±0.10 1.40–1.71	1.48±0.15 1.11–1.67
Leg IV femoropatella length	0.81±0.05 0.74–0.85	0.91±0.09 0.84–0.97	1.04±0.09 0.88–1.18	0.71±0.04 0.63–0.76	0.51±0.02 0.48–0.54	0.33±0.02 0.30–0.35

Characters/Species Mean ± SD Min–Max	*Lasiochernes cretonatus*	*Lasiochernes jonicus*	*Lasiochernes pilosus*			
	Adults	**Adults**	**Adults**	**Tritonymphs**	**Deutonymphs**	**Protonymphs**
	n = 5	**n = 2**	**n = 12**	**n = 15**	**n = 15**	**n = 15**
Leg IV femoropatella width	0.19±0.02 0.17–0.21	0.19±0.01 0.18–0.19	0.23±0.03 0.19–0.27	0.20±0.01 0.18–0.23	0.15±0.01 0.13–0.16	0.10±0.01 0.09–0.11
Leg IV femoropatella length/width ratio	4.26±0.34 3.76–4.72	4.89±0.31 4.67–5.11	4.51±0.33 4.00–4.95	3.67±0.18 3.30–3.89	3.51±0.14 3.27–3.77	3.39±0.13 3.10–3.56
Leg IV tibia length	0.76±0.03 0.74–0.80	0.72±0.03 0.70–0.74	0.84±0.08 0.71–0.96	0.56±0.03 0.50–0.60	0.37±0.02 0.35–0.40	0.23±0.01 0.21–0.25
Leg IV tibia width	0.13±0.00 0.12–0.13	0.14±0.00 0.14–0.14	0.15±0.02 0.12–0.17	0.13±0.01 0.12–0.15	0.11±0.01 0.10–0.11	0.08±0.01 0.07–0.08
Leg IV tibia length/width	5.97±0.28 5.69–6.33	5.14±0.20 5.00–5.29	5.57±0.45 4.44–6.33	4.29±0.32 3.79–4.75	3.53±0.09 3.36–3.70	3.06±0.12 2.88–3.29
Leg IV tarsus length	0.48±0.02 0.46–0.50	0.40±0.03 0.38–0.42	0.57±0.04 0.49–0.64	0.41±0.02 0.38–0.44	0.29±0.01 0.27–0.31	0.20±0.01 0.18–0.21
Leg IV tarsus width	0.11±0.00 0.11–0.11	0.10±0.01 0.09–0.10	0.12±0.01 0.09–0.14	0.10±0.01 0.09–0.11	0.08±0.01 0.07–0.09	0.06±0.00 0.05–0.06
Leg IV tarsus length/width ratio	4.40±0.15 4.18–4.55	4.23±0.61 3.80–4.67	4.80±0.43 4.17–5.70	4.02±0.21 3.64–4.44	3.60±0.25 3.11–4.00	3.46±0.18 3.00–3.80

Figure 3. Female of *Lasiochernes cretonatus*. Scale line: 1 mm.

Male (1 specimen analyzed) (Fig. 2B, Table 1). Chaetotaxy of carapace: 82 setae, 42 of them on anterior disk, 27 on medial disk, posterior margin with 13 setae. Cheliceral galea with six short terminal rami, serrula exterior with 20 blades. Palps (Fig. 4A): fixed chelal finger with 44 and movable chelal finger with 49 marginal teeth; fixed chelal finger with nine and movable chelal finger with eight antiaxial accessory teeth; fixed and movable chelal fingers with four paraxial accessory teeth. Palpal hand and patella with long and dense setation on their medial sides (Fig. 2B). Legs: tarsus IV with long tactile seta situated one third from the joint with the tibia, that means 0.16 mm from the tarsal base. Chaetotaxy of tergites I–XI: 16 (left hemitergite 9 + right hemitergite 7): 17 (8 + 9): 18 (9 + 9): 24 (12 + 12): 24 (13 + 11): 21 (11 + 10): 21 (10 + 11): 21 (10 + 11): 22 (12 + 10): 21 (10 + 11), tergite XI with 10 setae (5 + 5) and with a pair of long tactile setae. Chaetotaxy of sternites IV–XI: 14 (left hemisternite 8 + right hemisternite 6): 25 (12 + 13): 26 (12 + 14): 25 (13 + 12): 26 (13 + 13): 23 (11 + 12): 22 (11 + 11), sternite XI with 11 (5 + 6) and with a pair of long tactile setae.

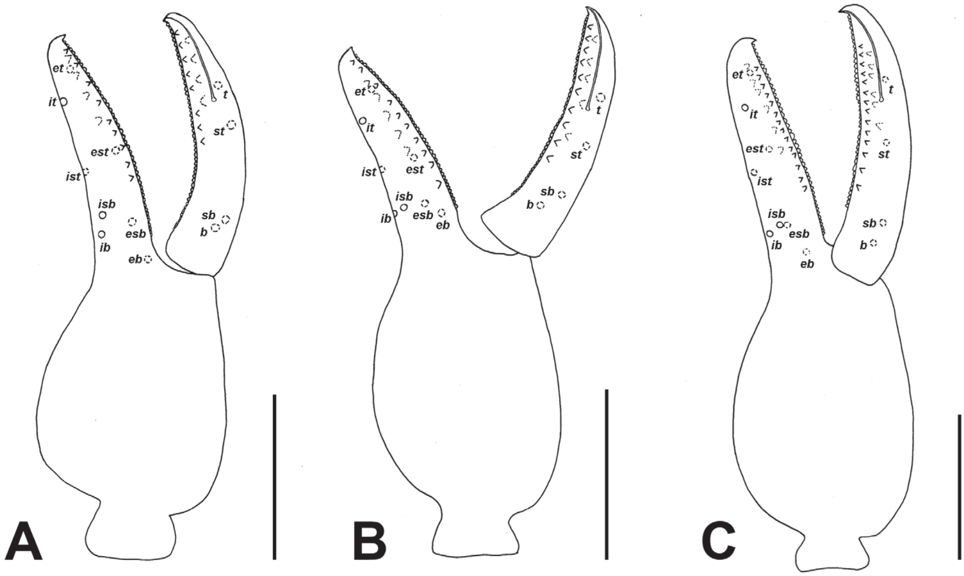

Figure 4. Palpal chela of *Lasiochernes* species, showing the trichobothrial pattern. **A** *L. cretonatus* male **B** *L. jonicus* female **C** *L. pilosus* male. Abbreviations in terminology of trichobothria: movable finger: *t*–terminal, *st*–subterminal, *sb*–subbasal, *b*–basal; fixed finger: *et*–exterior terminal, *est*–exterior subterminal, *esb*–exterior subbasal, *eb*–exterior basal, *it*–interior terminal, *ist*–interior subterminal, *isb*–interior subbasal, *ib*–interior basal. Scale lines: 0.5 mm.

Anterior genital operculum with 50 setae and two lyrifissures, posterior operculum with 20 setae and six lyrifissures (Fig. 6B).

Lasiochernes jonicus (Beier, 1929)

Figs 2A, C; Table 1

Description. Female (1 specimen analyzed) (Table 1). Chaetotaxy of carapace: 93 setae, 51 of them situated on anterior disk, 28 on medial disk, posterior margin with 14 setae. Cheliceral galea with six short terminal rami, serrula exterior with 20 blades. Palps (Fig. 4B): fixed chelal finger with 44 and movable chelal finger with 49 marginal teeth; fixed and movable chelal fingers with ten antiaxial accessory teeth and with five paraxial accessory teeth. Palpal femur with normal shape and without long and dense setation. Legs: tarsus IV with long tactile seta situated near middle of segment, that means 0.21 mm from the tarsal base. Chaetotaxy of tergites I–XI: 14 (left hemitergite 6 + right hemitergite 8): 14 (7 + 7): 14 (7 + 7): 19 (9 + 10): 21 (11 + 10): 19 (9 + 10): 19 (10 + 9): 20 (11 + 9): 17 (9 + 8): 17 (8 + 9), tergite XI with 8 setae (4 + 4) and with a pair of long tactile setae. Chaetotaxy of sternites IV–XI: 9 (left hemisternite 5 + right hemisternite 4): 21 (11 + 10): 24 (11 + 13): 26 (13 + 13): 26 (12 + 14): 23 (12 + 11):

17 (9 + 8), sternite XI with 8 (4 + 4) and with a pair of long tactile setae. Female spermatheca unpaired, T-shaped; anterior genital operculum with 34 setae and two lyrifissures, posterior operculum with 12 setae and three lyrifissures (Fig. 6C).

Male (1 specimen analyzed) (figs 2A, 2C; Table 1). Carapace with 82 setae, 37 of them on anterior disk, 32 on medial disk, posterior margin with 13 setae. Cheliceral galea with five short terminal rami, serrula exterior with 21 blades. Palps: fixed chelal finger with 42 and movable chelal finger with 47 marginal teeth; fixed chelal finger with 12 antiaxial and movable chelal finger with ten antiaxial accessory teeth; fixed chelal finger with six paraxial and movable finger with four paraxial accessory teeth. Palpal femur basally markedly broad, on the medial side with long and dense setation (Figs 2A, 2C). Legs: tarsus IV with long tactile seta situated near the middle of segment, that means 0.19 mm from the tarsal base Chaetotaxy of tergites I–XI: 15 (left hemitergite 7 + right hemitergite 8): 14 (7 + 7): 15 (7 + 8): 18 (9 + 9): 17 (10 + 7): 17 (8 + 9): 17 (9 + 8): 19 (10 + 9): 18 (9 + 9): 13 (7 + 6), tergite XI with 8 setae (4 + 4) and with a pair of long tactile setae. Chaetotaxy of sternites IV–XI: 25 (left hemisternite 13 + right hemisternite 12): 29 (15 + 14): 25 (12 + 13): 25 (12 + 13): 26 (13 + 13): 22 (10 + 12): 18 (9 + 9), sternite XI with 9 (4 + 5) and with a pair of long tactile setae. Anterior genital operculum with 48 setae and two lyrifissures, posterior operculum with 31 setae and ten lyrifissures (Fig. 6D).

Lasiochernes pilosus (Ellingsen, 1910)

Fig. 2D; Table 1

Description. Female (7 specimens analyzed) (Table 1). Chaetotaxy of carapace: 81–96 setae, 49–63 of them situated on anterior disk, 17–25 on medial disk, posterior margin with 10–13 setae. Cheliceral galea with 6–8 short terminal rami, serrula exterior with 23–25 blades. Palps: fixed chelal finger with 44–49 and movable chelal finger with 44–49 marginal teeth; fixed chelal finger with 11–16 antiaxial and movable chelal finger with 11–15 antiaxial accessory teeth; fixed and movable chelal finger with 6–7 paraxial accessory teeth. Palpal parts without long and dense setation. Legs: tarsus IV with long tactile seta situated approximately in the middle of segment, that means 0.25–0.32 mm from the tarsal base. Chaetotaxy of tergites I–XI: 12–17 (left hemitergite 6–9 + right hemitergite 6–8): 15 (7–8 +7–8): 14–19 (8–9 + 6–10): 17–24 (7–11+ 9–13): 18–23 (9–11 + 9–12): 18–22 (8–12 + 8–11): 18–23 (8–12 + 9–11): 18–22 (9–11 + 9–11): 17–20 (8–11 + 7–10): 13–19 (6–10 + 6–9), tergite XI with 8 setae (4 + 4) and with a pair of long tactile setae. Chaetotaxy of sternites IV–XI: 8–18 (left hemisternite 4–10: right hemisternite 4–9): 17–25 (9–13 + 8–13): 19–28 (9–13 + 10–15): 19–28 (9–15 + 9–13): 17–27 (9–13 + 8–14): 18–26 (8–13 + 9–13): 17–22 (8–11 + 8–11), sternite XI with 8–14 (4–6 + 4–5) and with a pair of long tactile setae. Female spermatheca unpaired, T-shaped; anterior genital operculum with 29–44 setae and 1–2 lyrifissures, posterior operculum with 10–14 setae and 1–4 lyrifissures (Fig. 6E).

Male (5 specimens analyzed) (Fig. 2D, Table 1). Chaetotaxy of carapace: 77–89 setae, 47–57 of them on anterior disk, 18–23 on medial disk, posterior margin with 10–14 setae. Cheliceral galea with 6–7 short terminal rami, serrula exterior with 23–24 blades. Palps (Fig. 4C): fixed chelal finger with 40–50 and movable chelal finger with 41–51 marginal teeth; fixed chelal finger with 12–16 antiaxial and movable chelal finger with 13–15 antiaxial accessory teeth; fixed chelal finger with 6–7 paraxial and movable chelal finger with six paraxial accessory teeth. Palpal femur and patella with long and dense setation on their medial sides (Fig. 2D). Legs: tarsus IV with long tactile seta situated approximately in the middle of segment, that means 0.25–0.31 mm from the tarsal base. Chaetotaxy of tergites I–XI: 13–17 (left hemitergite 7–9 + right hemitergite 6–8): 14–16 (7–8 + 7–8): 15–22 (7–11 + 8–11): 18–24 (10–12 + 7–13): 19–24 (10–12 + 9–12): 18–22 (9–12 + 9–12): 16–22 (7–10 + 9–12): 17–22 (9–11 + 8–11): 15–19 (8–9 + 7–10): 10–15 (5–7 + 5–8), tergite XI with 8 setae (4 + 4) and with a pair of long tactile setae. Chaetotaxy of sternites IV–XI: 16–24 (left hemisternite 8–11 + right hemisternite 7–13): 17–26 (9–16 + 8–12): 17–31 (6–15 + 11–16): 14–30 (2–15 + 12–15): 22–29 (10–17 + 9–13): 19–27 (9–14 + 9–13): 16–22 (8–12 + 8–11), sternite XI with 8–12 (4–6 + 4–6) and with a pair of long tactile setae. Anterior genital operculum with 44–62 setae and 1–2 lyrifissures, posterior operculum with 19–26 setae and 2–6 lyrifissures (Fig. 6F).

Nymphs (Fig. 5; Table 1): The morphology of tritonymphs, deutonymphs and protonymphs is similar in most respects to that of adults (e.g. morphology of setae on body, granulation of carapace, cheliceral rallum of three blades, presence of venom apparatus in movable chelal finger (Fig. 5), presence of a pair of relatively long tactile setae on tergite XI and long tactile seta situated approximately in the middle of leg IV tarsus). Body measurements are given in Table 1.

Tritonymphs (15 specimens analyzed) (Table 1). Chaetotaxy of carapace: 71–87 setae, 43–52 of them situated on anterior disk, 17–25 on medial disk, posterior margin with 9–11 setae. Chelicera: five setae on hand, one on movable finger; galea with six short terminal rami, serrula exterior with 18–20 blades. Palps (Fig. 5A): seven trichobothria on fixed chelal finger and three on movable chelal finger; fixed chelal finger with 34–42 and movable chelal finger with 36–41 marginal teeth; fixed chelal finger with 8–11 antiaxial and movable chelal finger with 8–12 antiaxial accessory teeth; fixed chelal finger with 4–6 paraxial and movable chelal finger with 4–5 paraxial accessory teeth. Chaetotaxy of tergites I–X: 10–13 (left tergite half 5–6 + right tergite half 5–7): 10–12 (5–7 + 5–6): 10–14 (5–7 + 5–8): 11–17 (5–8 + 6–9): 12–17 (6–9 + 6–8): 11–17 (5–8 + 6–9): 13–18 (6–9 + 6–10): 12–17 (5–9 + 6–8): 11–15 (5–8 + 5–7): 9–12 (4–6 + 4–6), tergite XI with 6 setae (3 + 3) and a pair of long tactile setae. Chaetotaxy of sternites II–X: 4–12 (left hemisternite 2–6 + right hemisternite 2–6): 5–11 (2–6 + 3–6): 8–13 (4–7 + 3–7): 12–18 (5–9 + 5–10): 14–19 (7–10 + 7–10): 14–17 (7–10 + 5–9): 13–18 (6–10 + 7–10): 14–18 (7–9 + 7–9), 12–17 (6–8 + 6–9), sternite XI with 8–10 (4–5 + 4–5) and a pair of long tactile setae; sternites II with two lyrifissures.

Deutonymphs (15 specimens analyzed) (Table 1). Chaetotaxy of carapace: 44–58 setae, 28–34 of them ivesituated on anterior disk, 9–20 on medial disk, posterior

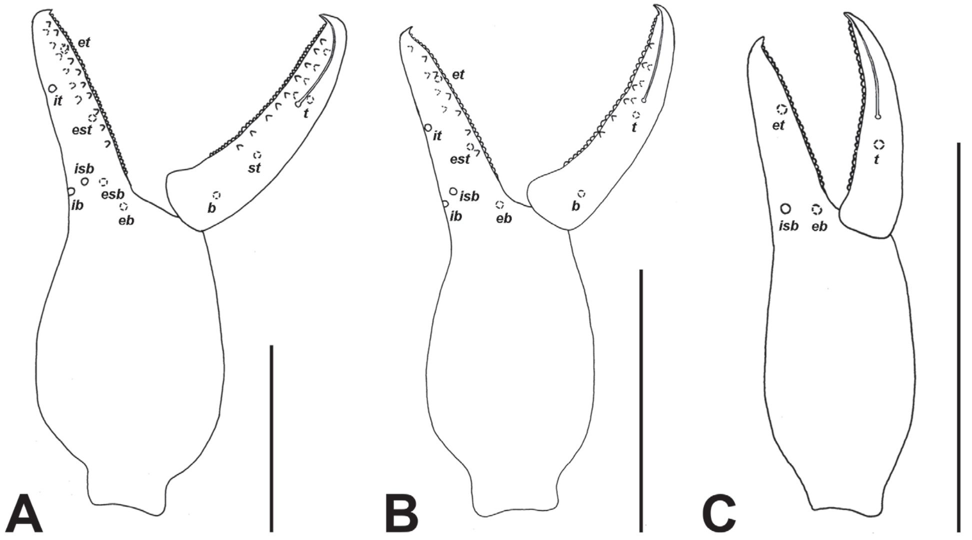

Figure 5. Palpal chela of *Lasiochernes pilosus* nymphs, showing the trichobothrial pattern. **A** Tritonymph **B** Deutonymph **C** Protonymph. Abbreviations as for Figure 4. Scale lines: 0.5 mm.

margin with 6–8 setae. Chelicera: five setae on hand, one on movable finger; galea with 3–4 short terminal rami, serrula exterior with 17–19 blades. Palps (Fig. 5B): six trichobothria on fixed chelal finger and two on movable chelal finger; fixed chelal finger with 27–32 and movable chelal finger with 29–33 marginal teeth; fixed chelal finger with 5–7 antiaxial and movable chelal finger with 5–7 antiaxial accessory teeth; fixed chelal finger with 4–5 paraxial and movable chelal finger with three paraxial accessory teeth. Chaetotaxy of tergites I–X: 8–10 (left tergite half 4–5 + right tergite half 4–5): 7–10 (3–5 + 3–5): 6–10 (3–5 + 1–5): 9–10 (4–5 + 4–5): 9–10 (4–5 + 5): 7–10 (3–5 + 3–5): 9–10 (4–5 + 4–5): 9–10 (4–5 + 4–5): 8–10 (4–5 + 4–5): 4–9 (3–5 + 1–5), tergite XI with 4 setae (2 + 2) and a pair of long tactile setae. Chaetotaxy of sternites II–X: 0–1 (left hemisternite 0–0 + right hemisternite 0–1): 4–6 (2–3 + 2–3): 5–8 (2–4 + 2–4): 6–11 (3–6 + 3–5): 7–12 (4–6 + 3–6): 9–11 (4–6 + 4–6): 8–10 (5 + 3–5): 9–11 (4–6 + 4–6), 8–10 (4–5 + 3–5), sternite XI with 6–7 (3–4 + 3–4) and a pair of long tactile setae; sternites II with two lyrifissures.

Protonymphs (15 specimens analyzed) (Table 1). Chaetotaxy of carapace: 29–38 setae, 17–22 of them on anterior disk, 4–11 on medial disk, posterior margin with 6–8 setae. Chelicera: four setae on hand, none on movable finger; galea with 3–4 short terminal rami, serrula exterior with 11–14 blades. Palps (Fig. 5C): three trichobothria on fixed chelal finger and 1 trichobothrium on movable chelal finger; fixed chelal finger with 24–29 and movable chelal finger with 26–31 marginal teeth; both chelal finger without any accessory teeth. Chaetotaxy of tergites I–X: each with 6 setae (left tergite half 3 + right tergite half 3), tergite XI with 2 setae (1 + 1) and a pair of long tactile setae. Chaetotaxy of sternites II–X: 0–9 (left hemisternite 0–1 + right hemist-

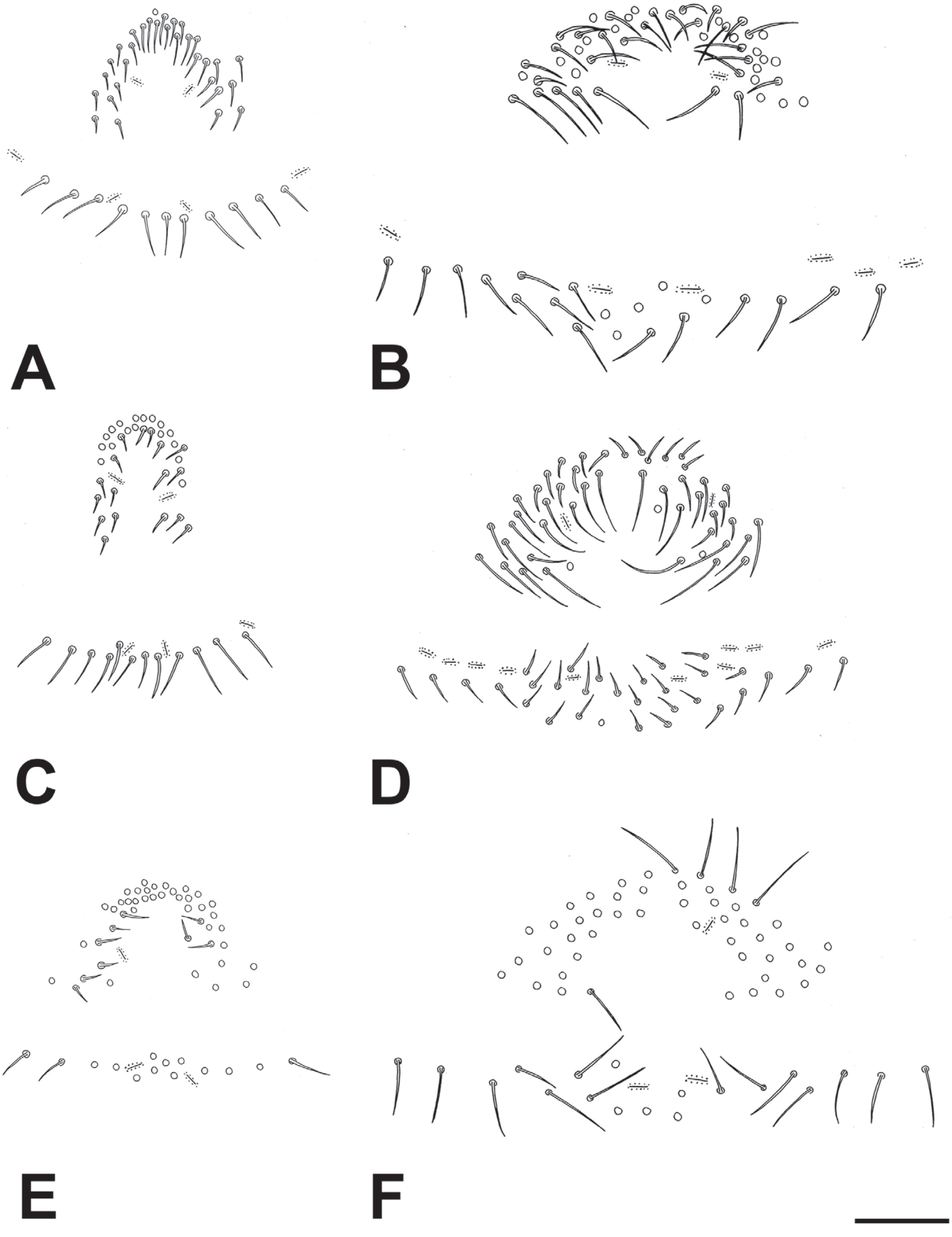

Figure 6. Variation in the setation of the genital area of *Lasiochernes* adults. **A** Female of *L. cretonatus* **B** Male of *L. cretonatus* **C** Female of *L. jonicus* **D** Male of *L. jonicus* **E** Female of *L. pilosus* **F** Male of *L. pilosus*. Scale lines: 0.1 mm.

ernite 0–9): 2 (1 + 1): 3–5 (1–3 + 1–3): 6–8 (3–5 + 3): 6–7 (3 + 3–4): 6–7 (3–4 + 3): 4–7 (3+ 1–4): 5–6 (2–3 + 3), 4–6 (2–3 + 2–3), sternite XI with 2 (1 + 1) and a pair of long tactile setae; sternites II with two lyrifissures.

Multivariate morphometrics

Most of the measured characters showed departures from a normal distribution. Therefore, the nonparametric correlation coefficient (Spearman) (apart from the Pearson parametric coefficient) and nonparametric classificatory discriminant analyses were used.

The ordination diagram of PCoA of the three *Lasiochernes* species, based on 85 morphological characters for 19 adult specimens, showed two large groupings of specimens separated along the first principal coordinate axis (Fig. 7). The first grouping consisted of *L. pilosus* specimens and the second comprised both *L. cretonatus* and *L. jonicus*. However, the specimens of the latter two species were not intermingled, being divided in accordance with their taxonomic assignment along the second and partly the third principal coordinate axis. The calculations of the correlation between the principal coordinate axes of PCoA and the original quantitative characters revealed the characters most responsible for the grouping of specimens along the first three axes. The characters most correlated with the first axes are: carapace length, length and width of femur of leg I, length of femoropatella of leg IV, length of palpal hand with and without pedicel, chelicera width, width of trochanter of leg I, posterior width of carapace and length of trochanter of leg I. The characters most correlated with the second axis are: numbers of setae on sternite X, tergite VIII, tergite VII, tergite VI and sternite IX; and those most correlated with the third axis are: body length, number of setae on anterior and posterior genital opercula, length/width ratio of tibia of leg IV and number of setae on sternite IV.

Eight canonical (CDA 1–CDA 8) and classificatory discriminant analyses (DA 1–DA 8) were performed to identify the characters and body parts that are most important for the differentiation of the three species, and to evaluate the degree of differentiation in each case. The three character pairs (length and posterior width of carapace, length of palpal hand with and without pedicel, length of patella and tibia of leg I) exceeded the correlation threshold of 0.95 in datasets with the body parts and, therefore, three characters (posterior width of carapace, length of palpal hand with pedicel and length of leg I patella) were excluded from further analyses. In CDAs (CDA 1–8), three species mostly formed their own clouds in the ordination space without overlaps (Fig. 8A–H), showing that all the body parts are useful for the differentiation of the three species. The best differentiation of the three species was reached in CDA 6, based on characters measured for leg IV (Fig. 8F), and the weakest differentiation was obtained in CDA 7, based on characters of the tergites (Fig. 8G). For the characters most correlated with the canonical axes and thus contributing to the differentiation of the three species, see Table 2. For details of the correlations of all characters with the axes, see Suppl. material 1. In almost all the classificatory DAs based on the body parts, the percentage of correctly classified specimens reached 100% for all three species. The only exception was the classificatory DA based on characters measured for tergites, for which 80% of specimens were correctly classified into *L. cretonatus*, 100% into *L. jonicus* and 58.3% into *L. pilosus*.

Finally, the classificatory DA 9 and CDA 9 were computed to assess the differentiation of the three species based on the selection of the most important characters

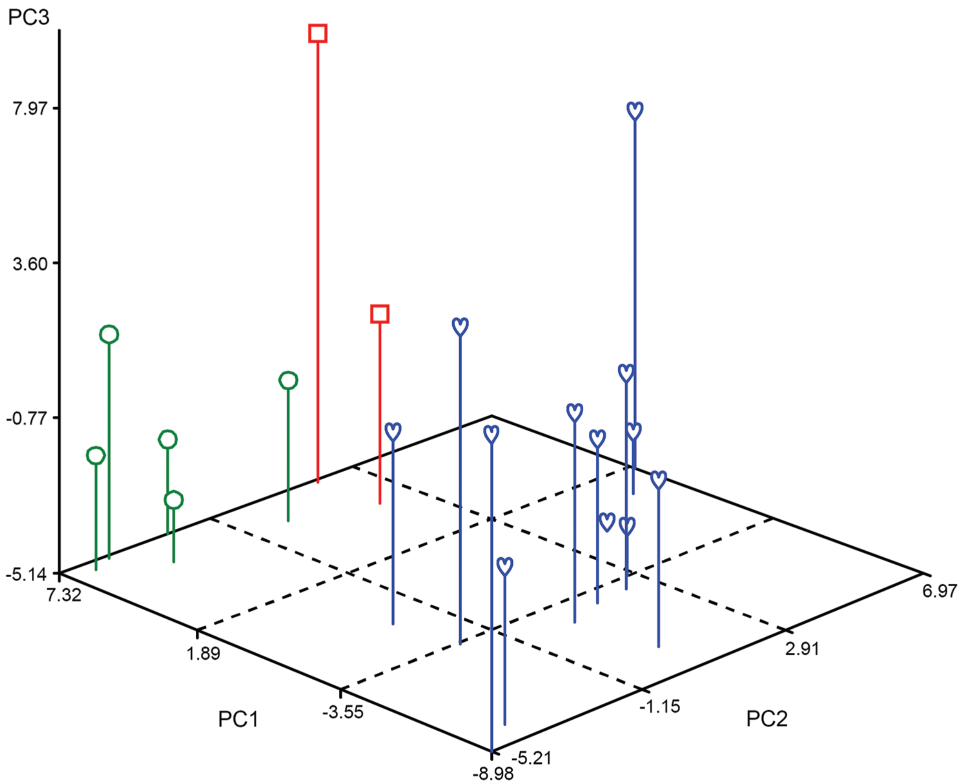

Figure 7. Principal coordinate analysis (PCoA) of 19 adult specimens of three species of *Lasiochernes* based on 85 morphological characters: *L. cretonatus* (green circles), *L. jonicus* (red squares) and *L. pilosus* (blue hearts). The first three coordinate axes explain 37.8%, 15.1% and 12.6% of the variation.

from all the parts of the body, as revealed in CDA 1–8. In the classificatory DA 9, the classification success rate reached 100% for all the specimens. The three species were clearly separated in the ordination space of CDA 9 (Fig. 9). The characters most highly correlated with the first and second canonical axis are those in bold type in Table 3.

The variations in morphological characters that are most useful for differentiation of the three *Lasiochernes* species are shown in Fig. 10.

Identification key to females of *L. cretonatus*, *L. jonicus*, and *L. pilosus*

Based on all the results obtained, nine morphological characters that differentiate females of the three species were selected (Table 4). The values of two of them, namely the length of cheliceral movable finger and the length of the palpal hand with pedicel, do not overlap and therefore allow the unambiguous identification of three *Lasiochernes* females.

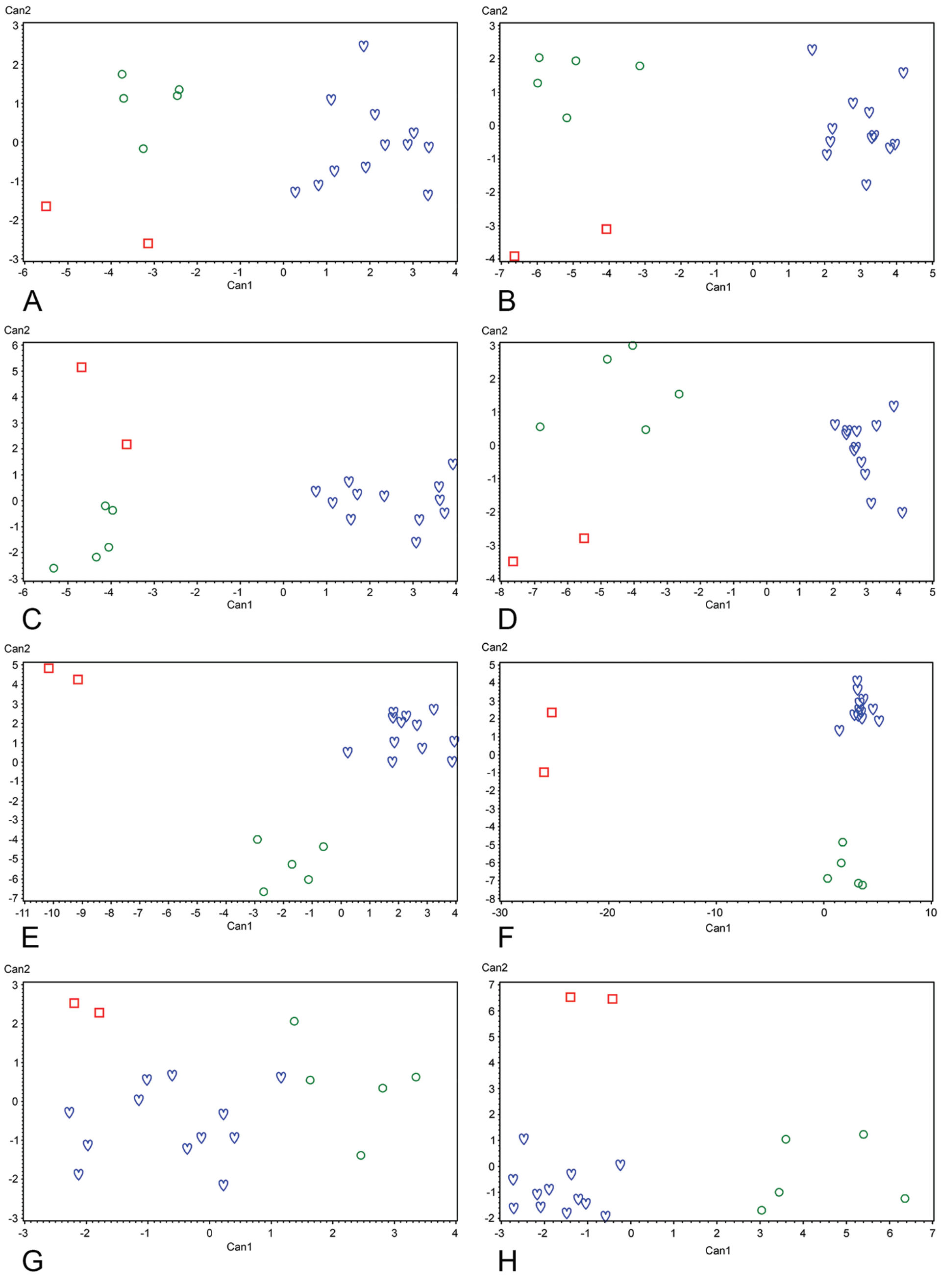

Figure 8. Eight canonical discriminant analyses (CDA 1–8) of three *Lasiochernes* species (*L. cretonatus*: green circles; *L. jonicus*: red squares; *L. pilosus*: blue hearts) based on 19 adult specimens and morphological characters measured/scored on eight different parts of the body (A–G): **A** CDA 1: Carapace **B** CDA 2: Chelicera **C** CDA 3: Palp (without chela) **D** CDA 4: Chela **E** CDA 5: Leg I **F** CDA 6: Leg IV **G** CDA 7: Tergites **H** CDA 8: Sternites. For total canonical structure and the lists of characters measured/scored on each body parts, see Supplementary file 1.

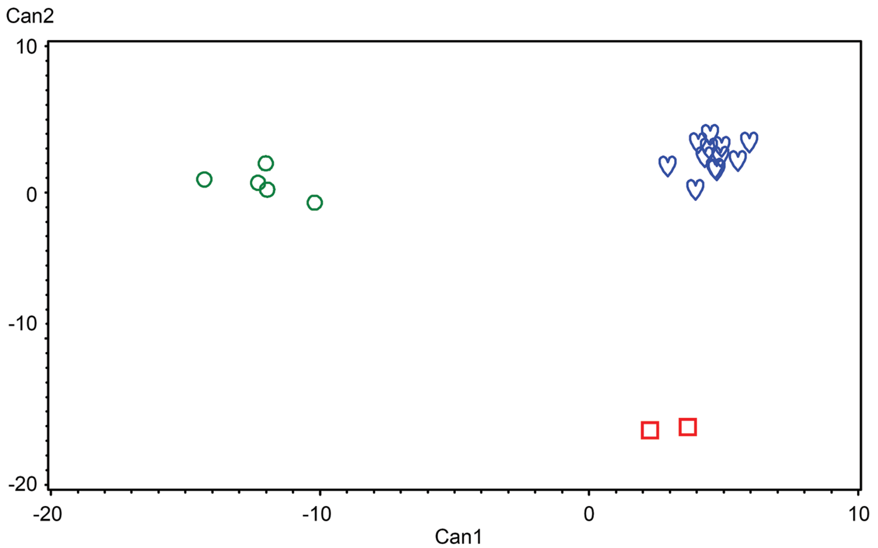

Figure 9. Canonical discriminant analysis (CDA 9) of three *Lasiochernes* species (*L. cretonatus*: green circles, *L. jonicus*: red squares and *L. pilosus*: blue hearts) based on 15 morphological characters for 19 adult specimens. For total canonical structure and the list of characters, see Table 3.

1 Movable finger of chelicera 0.20 mm long; tarsus of leg I 0.35 mm long; femoropatella of leg IV 5.11 times longer than deep .... ***L. jonicus***

– Movable finger of chelicera over 0.26 mm long; tarsus of leg I over 0.38 mm long; femoropatella of leg IV less than 4.95 times longer than deep **2**

2 Palpal hand with pedicel 0.88–0.91 mm long; palpal chela 1.58–1.78 mm long; femur of leg I 1.50–1.65 longer than deep; 71–74 setae on carapace, 31–38 of them situated in front of anterior transverse furrow; tarsus of leg IV with long tactile seta situated one third from base.................... ***L. cretonatus***

– Palpal hand with pedicel 1.00–1.18 mm long; palpal chela 1.88–2.06 mm long; femur of leg I 1.24–1.46 longer than deep; 81–96 setae on carapace, 49–63 of them situated in front of anterior transverse furrow; tarsus of leg IV with long tactile seta situated approximately in middle of segment ... ***L. pilosus***

Discussion

Distribution and habitat preference

Lasiochernes cretonatus was described from Souré Cave (Cave of 99 Holy Fathers) in Crete, based on one male collected under a small piece of stone near the cave wall (Henderickx 1998). Šťáhlavský et al. (2005) studied karyotypes of one female and one male tritonymph of *L. cretonatus* from the same cave. New specimens were found between organic material, pigeon feathers, dry leaves and pieces of branches in another

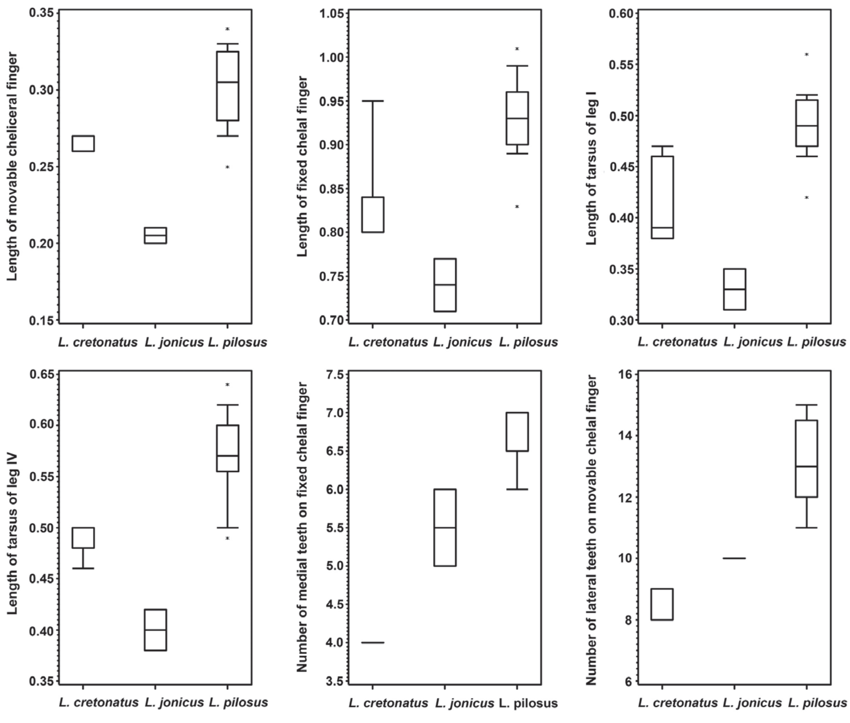

Figure 10. Variation in selected morphological characters of studied *Lasiochernes* species. Rectangles define the 25th and 75th percentiles, horizontal lines show the medians, whiskers are from the 10th to 90th percentiles and asterisks show extreme values (length in mm).

corner of the same upper cave room, less than six meters from where the holotype was found. Specimens were sifted from leaf litter and collected by vacuuming cracks with a modified portable electric vacuum cleaner.

Lasiochernes jonicus was described as *Chelifer* (*Trachychernes*) *jonicus* by Beier (1929) from Agios Mattheos, Corfu, Greece. The types were collected by sifting maquis litter. Later, Beier (1963) specified that, besides the maquis litter, a rotten mouse nest was sifted as well. Altogether 25 males, 19 females and 12 nymphal stages were collected (Beier 1929). Mahnert (1978) recorded three males, one female and 33 nymphs from soil samples in a nameless cave near Profitis Elias church, on Mount Ossa, Thessaly, Greece. The find of our specimens in the Tsouka cave in Pelion, Greece, represents the third known locality of *L. jonicus*. The specimens in the Tsouka cave were sifted from material (leaves, small branches and rock fragments between ingrown tree roots) in an upper dry room of the cave.

Ellingsen (1910) described one male of *Chelifer* (*Trachychernes*) *pilosus* from the vicinity of the town of Görz in Austria (now Goricia in Italy) and did not mention the habitat type or the collecting method. Heselhaus (1914) found females and nymphs in mole nests in Netherlands, and described them as *Chelifer falcomontanus*. Later, Berland (1925) recorded several specimens of *C. falcomontanus* from mole nests in Luxem-

Table 2. Results of eight canonical discriminant analyses (CDA 1–CDA 8, Fig. 8) based on morphological characters measured/scored for 19 adult specimens and eight body parts of *L. cretonatus*, *L. jonicus* and *L. pilosus*. The characters which most strongly correlated with the canonical axes (Can 1, Can 2) are listed for each CDA. The extended version of the table, showing all the characters and total canonical structure, is given in Supplementary file 1.

Body parts	Can 1	Can 2
Carapace (CDA 1, Fig. 8A)	Length	Total setae number
	Number of setae on anterior disk	
	Number of setae on posterior margin	
Chelicera (CDA 2, Fig. 8B)	Width	Length of movable finger
	Length/width ratio	
	Number of blades in serrula exterior	
Palp (CDA 3, Fig. 8C)	Length of trochanter	Width of femur
	Length of femur	Length/width ratio of femur
Chela (CDA 4, Fig. 8D)	Length of hand without pedicel	Length/width ratio of hand
	Length of fixed finger	Number of marginal teeth on fixed finger
	Length of chela	Number of antiaxial accessory teeth on movable finger
	Number of antiaxial accessory teeth on fixed finger	
	Number of antiaxial accessory teeth on movable finger	
Leg I (CDA 5, Fig. 8E)	Length of tarsus	Length/depth ratio of femur
Leg IV (CDA 6, Fig. 8F)	Length of trochanter	Length/depth ratio of trochanter
	Depth of trochanter	Length of femur
	Length of tarsus	Depth of tibia
	depth of tarsus	
Tergites (CDA 7, Fig. 8G)	Number of setae on tergite II	Number of setae on tergite III
	Number of setae on tergite V	Number of setae on tergite X
	Number of setae on tergite IX	
Sternites (CDA 8, Fig. 8H)	Number of setae on sternite IV	Lyrifissures number on genital operculum posterior
	Number of setae on sternite X	
	Lyrifissures number on genital operculum posterior	

bourg and France. Beier (1929) recorded several adults and nymphs in mole nests from Austria and synonymized *C. falcomontanus* with *C. pilosus*. Beier (1929) indicated that the species occurs in mole and ground-squirrel nests. Ressl (1965) and Ressl and Beier (1958) later found many specimens in mole nests with leaf content in Austria. Caporiacco (1949) recorded two *L. pilosus* males in the rotten trunk of an oak at Lipizza, Italy (now Lipica, Slovenia). Later Ćurčić (1974) listed *L. pilosus* in Slovenia (without providing collecting details) in his catalogue of the former Yugoslavian fauna. There is no mention of this species occurring in Slovenia in the current version of the world

Table 3. Results of the canonical discriminant analysis (CDA 9, Fig. 9) based on 15 morphological characters measured/scored for 19 specimens of *L. cretonatus*, *L. jonicus*, and *L. pilosus*. Values of the total canonical structure listed in the table express correlations of characters with canonical axes (Can 1, Can 2). Higher total canonical structure values are in bold type.

Morphological characters	Can 1	Can 2
Number of setae on posterior carapace margin	-0.635	-0.420
Total number of setae on carapace	**0.766**	-0.072
Number of setae on anterior disk	**0.829**	0.311
Width of chelicera	0.653	0.523
Length/width ratio of chelicera	-0.649	**-0.641**
Number of blades in serrula exterior	**0.779**	0.484
Length of palpal trochanter	0.661	0.415
Length of palpal femur	0.611	0.388
Length of palpal hand without pedicel	0.625	0.342
Length of palpal chela	0.573	0.500
Number of antiaxial accessory teeth on movable chelal finger	**0.805**	0.355
Depth of tibia of leg I	0.355	**0.584**
Length/depth ratio of femur of leg I	-0.449	0.012
Length of tarsus of leg I	0.411	**0.742**
Length of tarsus of leg IV	0.459	**0.734**

Table 4. Comparison of adult females of *L. cretonatus*, *L. jonicus*, and *L. pilosus* in values of most differentiating morphological characters (measurements in mm). Boldface values indicate the characters that unambiguously differentiate all the three species.

Characters/species	*L. cretonatus*	*L. jonicus*	*L. pilosus*
Total setae number on carapace	71–74	93	81–96
Number of setae on anterior disk of carapace	31–38	51	49–63
Number of antiaxial accessory teeth on fixed chelal finger	9–13	10	11–16
Length of movable cheliceral finger	**0.26–0.27**	**0.20**	**0.28–0.33**
Length of palpal hand with pedicel	**0.88–0.91**	**0.99**	**1.00–1.18**
Length of palpal chela	1.58–1.78	1.66	1.88–2.06
Length/depth ratio of femur of leg I	1.50–1.65	1.40	1.24–1.46
Length of tarsus of leg I	0.38–0.47	0.35	0.46–0.56
Length/depth ratio of femoropatella of leg IV	3.76–4.72	5.11	4.20–4.95

pseudoscorpion catalogue (Harvey 2013). The occurrence of *L. pilosus* in mole nests in Italy was recorded by Beier (1963) and Inzaghi (1981). In the Netherlands, *L. pilosus* was typically collected in mole nests (Van der Hammen 1969). Ventalló (1934) recorded the species for the first time from Spain, based on 14 specimens found in a cave. *L. pilosus* also occurs in mole nests in Germany (Hesse 1941, Weidner 1954, Weygoldt 1966, Rehage and Renner 1981). Weygoldt (1966, 1969) reported that the species can be found in water vole nests. *L. pilosus* was also collected in Belgium, in mole nests in forests (Cooreman 1946, Leleup 1948, Henderickx 1998, 1999, Šťáhlavský et al.

2005). The locality from which the material studied here was collected is a new record for the geographic distribution of *L. pilosus* in Belgium. The locality is located on a hilltop, all specimens were sifted from a mole nest between the roots of a tree on the hilltop, next to a road. Krumpálová and Krumpál (1993) extracted this species from a mole nest for the first time from Slovakia (at Borinka, the same locality as in the current paper). Christophoryová and Krumpál (2010) sifted two females from leaf litter in the Nature Reserve Šúr, Slovakia. New specimens from Borinka were extracted from a mole nest situated in the ecotone between forest and grassland.

Morphological variation

The original description of *L. cretonatus* was based on one male (Henderickx 1998). Comparison of our newly found male with the holotype showed similarity in a majority of the characters (palpal teeth numbers, morphometrics of palps and leg IV, length of body and chelicera and position of tactile seta on tarsus IV). Exceptions were the higher setae number on posterior carapace margin of the newly found male (13 versus 12) and higher number of paraxial accessory teeth on movable chelal finger of the newly found male (4 versus 3). The length of the palpal trochanter was incorrectly given by Henderickx (1998) as 0.84 mm (0.53 mm in the new male). In the present paper, several characters of this species are described for the first time: morphometrics of leg I and carapace, width of chelicera, length of cheliceral finger; number of setae on chelicera, form of galea, rallum, serrula exterior; complete trichobothrial pattern, complete chaetotaxy of carapace, tergites and sternites; numbers of setae and lyrifissures on genital opercula. The female is described here for the first time.

Beier's (1929, 1963) descriptions of *L. jonicus* provided information concerning the cheliceral rallum, serrula exterior, galea, setation and shapes of palpal parts and the position of the tactile setae on tarsus IV and tergite XI. The mean values (for an unspecified number of specimens) of palpal measurements, length of body and carapace of males and females were given by Beier (1929). Mahnert (1978) described one male, giving measurements of the palps and leg IV, and the numbers of marginal and accessory teeth on the chelal fingers. Most of the characters of our male and female correspond with previous descriptions (Beier 1929, 1963, Mahnert 1978); some differences in measurements are probably related to the number of specimens studied. Mahnert (1978) counted more marginal teeth (47 on the fixed finger, versus 42 here, and 50 on the movable finger, versus 47 here), more paraxial accessory teeth (7 on fixed finger, versus 6, and 5 on movable finger, versus 4) and more antiaxial teeth on movable finger (11 versus 10) of the male. In contrast, there are more antiaxial teeth on the fixed finger of our male (12 versus 11). Our results provide information on several new characters: measurements of chelicera, carapace width, measurements of leg I, setae number on carapace, chelicera, tergites, sternites, and genital operculum anterior and posterior.

Lasiochernes pilosus was described from one male by Ellingsen (1910), who counted more blades on the serrula exterior than were observed here (27 versus 23–24). Beier

(1963) described both sexes, mainly giving their palp measurements. The number of serrula exterior blades was modified to 25–27. The number of antiaxial accessory teeth on the chelal finger was lower than in our specimens (10 versus 11–16 on fixed finger and 8 versus 11–15 on movable finger). The present study provides a number of new details, such as measurements of leg I and IV; the number of paraxial accessory teeth on chelal fingers; the numbers of setae on the carapace, genital opercula, tergites and sternites. For the first time, all nymphal stages are described in detail.

In this paper, the potential of multivariate morphometric techniques for the diagnostic of pseudoscorpion species has been explored. Our study provides a first reference library of morphometric measurements that might be used for the identification of *Lasiochernes* specimens. The PCoA, which depicts the variation without prior definition of the groups in the dataset, showed rather clear differences between the three species. Two large groupings of specimens were visible in the PCoA, the first consisting of *L. pilosus* and the second of *L. cretonatus* and *L. jonicus*. The proximity of the latter two species in PCoA was probably caused by one specimen of *L. cretonatus* with significantly higher numbers of setae on the carapace (total and number on anterior disk). Discriminant analyses, which, unlike the PCoA, weight the characters to stress the between-group variation component, revealed considerable differences between the three species. These analyses were also used to identify the most differentiating body parts and the most important characters. The characters traditionally used most in identification keys to pseudoscorpions are those of the palps (Beier 1963, Christophoryová et al. 2011) and their importance was confirmed again by our data. A surprising discovery was that, from among the body parts, the best differentiation of the three species was obtained with leg IV. On the other hand, the tergites were not very useful for species differentiation, due to the high variability of setae number on each tergite. The majority of the most differentiating characters was measured or scored on the carapace, chelicera, chelal fingers and legs I and IV. Until now, the number of setae on the carapace was only rarely used in the descriptions of Chernetidae, mainly the setae number on posterior carapace margin (Beier 1963, Henderickx 1998). The whole count of setae could substantially facilitate the diagnosis of chernetid species in future. The setal counts on the tergites and sternites (except the genital ones) of *Lasiochernes* species showed a high degree of variability.

Multivariate morphometrics have been successfully applied in many other taxonomic studies of various invertebrates. For instance, they were very helpful in interpreting morphological differences between two cryptic species of *Sancassania* Oudemans, 1916, Acari (Klimov et al. 2004). Stekolnikov et al. (2010) revised a species group of chiggers (Acari) using multivariate morphometrics and developed a multivariate classification model to separate three closely related species. These analyses showed complete separation of the studied species. The characters contributing strongly to the discrimination were used in formal description of these species as well as in an identification key. Jagersbacher-Baumann (2014) analyzed four mite species of the *acarorum*-complex (Scutacaridae) using traditional and geometric morphometric methods. The results showed that multivariate morphometric methods are perfectly suitable for differentiating even between morphologically similar scutacarid species, with traditional morphometrics performing better than geometric morphometrics. Van Cann et al. (2015) explored the potential of wing morphometrics for the diagnosis of morphospecies of Tephritidae (Diptera). Multivariate analyses allowed the consistent identification of a significant proportion of specimens in that study. In pseudoscorpion taxonomy, multivariate analyses were used to separate two European Chthoniidae species. Although multivariate analyses suggest specific separation, there was only one unequivocal character for discrimination, the presence or absence of a single isolated tooth on the moveable finger of the chelicerae (Muster et al. 2004).

The genus *Lasiochernes* is noteworthy for its sexual dimorphism (Beier 1963). Males are unambiguously identified by the presence of a long setation arranged on different palpal parts, depending on the species. The setation of the palp is normal in females, without long setae. Our aim was to find characters that could be used for a more reliable identification of the females. It should be noted that our identification key is useful mainly for differentiation of females of *L. cretonatus* and *L. pilosus*. Values of some characters measured on the female of *L. jonicus* are influenced by low number of specimens examined and it is possible that better sampling might show stronger overlaps in future studies. The identification key is based on the characters that were rarely or never used in previously published taxonomic treatments of *Lasiochernes*. Therefore, the comparison of these characters with other European species of the genus is not yet possible.

Based on the results obtained, we assume that future studies will benefit from application of multivariate morphometric analyses, and could potentially help to find new characters and contribute to a more reliable identification of pseudoscorpion species.

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Supplementary material 1

Results of eight canonical discriminant analyses

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Data type: statistical data

Explanation note: Results of eight canonical discriminant analyses (CDA 1–CDA 8, fig. 8) based on morphological characters measured/scored on 19 specimens and eight body segments of *Lasiochernes cretonatus*, *L. jonicus*, and *L. pilosus*. Values of the total canonical structure listed in the table express correlations of characters with canonical axes (Can 1 and Can 2) in each CDA. Higher total canonical structure values are in bold type.

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RESEARCH ARTICLE

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Catalog of the phylloxerids of the world (Hemiptera, Phylloxeridae)

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Abstract

A taxonomic and nomenclatural catalog of the phylloxerids (Hemiptera, Phylloxeridae) is presented. Six family-group names are listed, three being synonyms. Thirty-five genus-group names, of which six are subjectively valid, are presented with their type species, etymology, and grammatical gender. Ninety-four species-group names are listed, of which 73 are considered subjectively valid. This is the last group of Aphidomorpha to be catalogued, bringing the list of valid extant species to 5,218.

Keywords

Aphidomorpha, nomenclature, *Phylloxera*, Sternorrhyncha, taxonomy

Introduction

Phylloxeridae is a small family of Hemiptera, closely related to Adelgidae and Aphididae. Little is known of the biology of most of the family's 69 species, although that of the economically important grape phylloxeran, *Daktulosphaira vitifoliae* (Fitch), has been studied in detail. Most species of phylloxerid feed on species of Juglandaceae or Fagaceae, with a large number forming galls on North American hickories (*Carya* spp.). Host alternation exists within the family (Stoetzel 1985) but it is either rare or understudied. Two fossil species are known, *Palaeophylloxera seilacheri* Heie and Peñalver 1999 and *Acanthochermes longirostris* Wegierek 2003, from the Miocene and Eocene, respectively.

Phylloxeridae is one of three extant families in the infraorder Aphidomorpha (Hemiptera, Sternorrhyncha) (Heie and Wegierek 2009). Whereas the Aphididae have been catalogued several times (Wilson and Vickery 1918, Eastop and Hille Ris Lambers 1976, Remaudière and Remaudière 1997) and the Adelgidae recently (Favret et al. 2015), the Phylloxeridae have not been comprehensively treated until now. Including the fossil taxa (Heie and Wegierek 2011), the entire infraorder has now been fully catalogued: 5,218 valid extant and 314 valid extinct species (Aphid.SpeciesFile.org).

In this catalog, we present six family-group, 35 genus-group, and 94 species-group names of extant phylloxerids. The family-group names include two valid subfamilies and two valid tribes and three subjective synonyms. The genus-group names include six valid names, 21 junior subjective synonyms, three junior objective synonyms, three junior homonyms, and two unavailable names. The species-group names include four subspecies (not including nominotypical subspecies), 14 subjective synonyms, one junior primary homonym, two nomina dubia, and four unavailable names.

The name Phylloxeridae in English is usually pronounced with the accent on the third syllable. However, the name of its type genus, *Phylloxera*, is often pronounced with an accent on the second. Because the *e* of *xērós* is an eta, the word made from it, once written in Roman letters and given Latin endings, must be considered to have a long *e*. The penultimate syllable of a Latin word must be accented when it contains such a long vowel and it is a fixed principle that the accentuation of Latin words is to be kept when they are borrowed into English. Therefore, strictly-speaking, only accentuation of the third syllable of *Phylloxera* is historically justified.

Russell (1975) described the complex history of the name of the grape phylloxeran, including the correct spelling of its generic name, *Daktulosphaira* Shimer 1866. Shimer also established *Dactylosphaera* (1867), probably meaning the latter to be an emended spelling of the former. The philological side of the alternate spellings can be stated briefly: k and c have both been used to transliterate classical Greek kappa, u and y to render upsilon, ai and ae the diphthong alpha+iota. C, y and ae were the preferred transliterations in classical Latin. K, u and ai are mostly used in linguistic circles that seek a more direct reflection of the phonetics of ancient Greek, bypassing the intermediary of Latin. Zoological nomenclature imposes Latin terminations, hence supposes Latinization of Greek (and other non-Latin) elements. *Dactylosphaera* is therefore the spelling more in the spirit of the system, although per ICZN Article 32.5.1 (International Commission on Zoological Nomenclature 1999), "incorrect transliteration or Latinization … are not to be considered inadvertent errors." In addition to these two official spellings, other authors have used every possible combination of c/k, u/y and ae/ai to refer to the grape phylloxeran, giving *Dactulosphaera* (e.g., Kleeburg and Hummel 2001), *Dactulosphaira* (e.g., Fahrentrapp et al. 2015), *Dactylosphaira* (e.g., Alleweldt et al. 1991), *Daktulosphaera* (e.g., Loxdale 2008), *Daktylosphaera* (e.g., Tecchio et al. 2007), and *Daktylosphaira* (e.g., Torregrossa et al. 1997).

In any case, Shimer (1866, 1867) established different type species for *Daktulosphaira* and *Dactylosphaera*, thus the two spellings must be considered independent, available genus-group names (Wilson 1910). *Dactylosphaera globosa* Shimer 1867, one of a large number of North American hickory-feeding species, is the type species of its genus. As a consequence, *Dactylosphaera* has priority over all other generic names attributable to this distinct group. These include *Xerophylla*, described by Walsh later the same year (1867), *Euphylloxera* Del Guercio 1908, *Notabilia* Mordvilko 1909, *Paramoritziella* Grassi 1912, *Parapergandea* Börner 1930, *Pergandea* Börner 1908b, and *Troitzkya* Börner 1930. If we consider a key diagnostic character of the hickory-feeding species, the lack of abdominal spiracles, we can add *Acanthaphis* Del Guercio 1908 and *Moritziella* Börner 1908b to the list. It will require a thorough taxonomic revision of the phylloxerid family to correctly assign the various species, many of which are hardly known, to any of these listed generic names. Given this fact, the unfortunate history and spelling problems associated with *Dactylosphaera* and *Daktulosphaira*, and the fact that the identity and validity of the type species of *Dactylosphaera* may be questionable (Russell 1975), we have chosen to present a conservative classification, retaining the majority of species within the genus *Phylloxera* Boyer de Fonscolombe 1834. At some future date when more information is available, it may in particular be necessary to formalize a distinction between the Palearctic species (abdominal spiracular plates present) and the Nearctic species, species that typically form galls on hickories (abdominal spiracular plates absent, where known). As with the Catalog of Adelgidae (Favret et al. 2015), it is our hope that the present Catalog of Phylloxeridae will serve to stimulate interest and research on this insect group.

Also as with other recent catalogs of groups of Aphidomorpha, the etymology and grammatical gender of genus-group names has been included (Favret et al. 2008, 2009, 2015, Cortés Gabaudan et al. 2011, Nieto Nafría et al. 2011). Where original descriptions are listed with two page numbers, the first refers to a nomenclaturally valid diagnosis (e.g., a dichotomous key) and the second refers to the formal description. Valid names are listed in bold and synonyms preceded by '='. The rank-specific endings of family-group synonyms are replaced by '–'. Species-group names are presented according to their current generic placement, their original generic placements in parentheses. An alphabetical index following the catalog provides the current placement of each name. Future updates will be published on Aphid Species File (Aphid.SpeciesFile.org).

Catalogue

PHYLLOXERIDAE Herrich-Schaeffer 1854
Subfamily **PHYLLOXERINAE** Herrich-Schaeffer 1854

Tribe **ACANTHOCHERMESINI** Börner 1913: 667
Original spelling. Acanthochermesini
Type genus. *Acanthochermes* Kollar 1848

ACANTHOCHERMES Kollar 1848: 191
Type species. *Acanthochermes quercus* Kollar 1848, by original monotypy
Etymology. Greek ákantha 'thorn' + *Chermes* [Hemiptera]
Gender. Masculine
quercus Kollar 1848: 191 (*Acanthochermes*)
=*balbianii* (Lichtenstein 1874a: 782) (*Phylloxera*)
similiquercus Jiang et al. 2009: 44,45 (*Acanthochermes*)

Tribe **PHYLLOXERINI** Herrich-Schaeffer 1854:VII
Original spelling. Phylloxeriden
Type genus. *Phylloxera* Boyer de Fonscolombe 1834
=DACTYLOSPHAER– Shimer 1867: 2
Original spelling. Dactylosphaeridae
Type genus. *Dactylosphaera* Shimer 1867
=MORITZIELL– Börner 1908b: 607
Original spelling. Moritziellini
Type genus. *Moritziella* Börner 1908b
=VACUN– Herrich-Schaeffer 1854:VII
Original spelling. Vacuniden
Type genus. *Vacuna* von Heyden 1837

APHANOSTIGMA Börner 1909b: 61
Type species. *Phylloxera piri* Cholodkovsky 1904, by original monotypy
Etymology. Greek aphanḗs 'invisible' + -o + Greek stigma 'spot' [pterostigma]
Gender. Neuter
=*CINACIUM* Kishida 1924: 473
Type species. *Cinacium iaksuiense* Kichida 1924, by original monotypy
Etymology. Japanese Kinako 'soybean flour' + -ium
Gender. Neuter
iaksuiense (Kishida 1924: 473) (*Cinacium*)
piri (Cholodkovsky 1904: 119) (*Phylloxera*)

DAKTULOSPHAIRA Shimer 1866: 365
Type species. *Pemphigus vitifoliae* Fitch 1855, by original monotypy

Etymology. Greek dáktylos 'finger' + Greek sphaîra 'ball'
Gender. Feminine

=*PERITYMBIA* Westwood 1869: 109
Type species. *Peritymbia vitisana* Westwood 1869, by original monotypy
Etymology. Greek perí 'around' + Greek týmbos 'tomb' ["tomb-like gall"]
Gender. Feminine
Note. Some references cite Westwood 1867: 6, but this is a note referencing an oral presentation that was never published (Westwood 1877:xlvii).

=*RHIZAPHIS* Planchon in Bazille et al. 1868: 336
Type species. *Rhizaphis vastatrix* Planchon 1868, by original monotypy
Etymology. Greek ríza 'root' + *Aphis* [Hemiptera: Aphididae]
Gender. Feminine

=*RHIZOCERA* Despeissis 1896: 14
Type species. None
Etymology. Greek ríza 'root' + Greek xērós 'dry' ["root drier" per Despeissis 1896, but note, Latin cēra 'wax']
Gender. Feminine
Note. Unavailable, not proposed as a valid name. Often misattributed to Kirk 1897: 8.

=*VITEUS* Shimer 1867: 6
Type species. *Pemphigus vitifoliae* Fitch 1855, by original monotypy
Etymology. Latin 'of or pertaining to the vine'
Gender. Masculine
Note. Junior objective synonym of *Daktulosphaira* Shimer 1866

=*XERAMPELUS* Del Guercio 1900: 77,80
Type species. *Rhizaphis vastatrix* Planchon 1868, by original monotypy
Etymology. Greek xērós 'dry' + Greek ámpelos 'vine'
Gender. Masculine
Note. Junior objective synonym of *Rhizaphis* Planchon 1868

vitifoliae (Fitch 1855: 862) (*Pemphigus*)
=*pemphigoides* (Donnadieu 1887: 1246) (*Phylloxera*)
=*pervastatrix* (Börner 1910: 4) (subspecies of *Peritymbia vitifoliae* (Fitch))
=*vastatrix* (Planchon in Bazille et al. 1868: 336) (*Rhizaphis*)
=*vitisana* (Westwood 1869: 109) (*Peritymbia*)
=*vitis viniferae* (Theobald 1914: 337) (*Phylloxera*) nomen nudum
=*vulpinae* (Börner 1952: 213) (subspecies of *Viteus vitifoliae* (Fitch))

FOAIELLA Börner 1909b: 61
Type species. *Phylloxera danesii* Grassi and Foà 1907, inherited from replaced name
Etymology. (Anna) Foà [Italian entomologist] + -i + ella [diminutive suffix]
Gender. Feminine
Note. Replacement name for *Boerneria* Grassi and Foà 1908. Described as subgenus of *Peritymbia* Westwood 1869

=*BOERNERIA* Grassi and Foà 1908: 685
Type species. *Phylloxera danesii* Grassi and Foà 1907, by original monotypy
Etymology. (Carl) Börner [German entomologist] + -ia
Gender. Feminine
Note. Junior homonym of *Boerneria* Willem 1902: 4 (Collembola) and *Boerneria* Axelson 1902: 101 (Collembola). Replaced by *Foaiella* Börner 1909b

danesii (Grassi and Foà 1907: 431) (*Phylloxera*)

OLEGIA Shaposhnikov 1979: 734
Type species. *Aphanostigma ulmifoliae* Aoki 1973, by original designation
Etymology. Oleg (Vasilyevich Kovalev) [Russian entomologist] + -ia
Gender. Feminine

ulmifoliae (Aoki 1973: 144) (*Aphanostigma*)

PHYLLOXERA Boyer de Fonscolombe 1834: 222
Type species. *Phylloxera quercus* Boyer de Fonscolombe 1834, by original monotypy
Etymology. Greek phýllon 'leaf' + Greek xērós 'dry'
Gender. Feminine

=*ACANTHAPHIS* Del Guercio 1908: 156,157
Type species. *Phylloxera corticalis* Kaltenbach 1867, by original designation
Etymology. Greek ákantha 'thorn' + *Aphis* [Hemiptera: Aphididae]
Gender. Feminine
Note. Junior objective synonym of *Moritziella* Börner 1908b

=*DACTYLOSPHAERA* Shimer 1867: 290
Type species. *Dactylosphaera globosa* Shimer 1867, by original monotypy
Etymology. Greek dáktylos 'finger' + Greek sphaîra 'ball'
Gender. Feminine

=*EUPHYLLOXERA* Del Guercio 1908: 155,156
Type species. *Phylloxera foveola* Pergande 1904, by original designation
Etymology. Greek eû 'truly' + *Phylloxera*
Gender. Feminine

=*HYSTRICHIELLA* Börner 1908b: 609
Type species. *Phylloxera spinulosa* Targioni Tozzetti 1875, by original designation
Etymology. Greek hýstrix 'porcupine' + -i + -ella [diminutive suffix]
Gender. Feminine
Note. Described as subgenus of *Phylloxera* Boyer de Fonscolombe 1834

=*MICRACANTHAPHIS* Grassi in Grassi et al. 1912: 48
Type species. *Vacuna coccinea* von Heyden 1837, by original designation
Etymology. Greek mikrós 'small' + *Acanthaphis*
Gender. Feminine

=*MORITZIELLA* Börner 1908b: 608

Type species. *Phylloxera corticalis* Kaltenbach 1867, by original designation
Etymology. (Julius) Moritz [German entomologist] + -i + ella [diminutive suffix]
Gender. Feminine

=*NOTABILIA* Mordvilko 1909: 362
Type species. *Phylloxera notabilis* Pergande 1904, by original designation
Etymology. Latin notabilis 'remarkable, sizeable', inflected in the neuter plural
Gender. Neuter

=*PARAMORITZIELLA* Grassi in Grassi et al. 1912: 13
Type species. *Phylloxera caryaefoliae* Fitch 1856, by original designation
Etymology. Greek pará 'beside' + *Moritziella*
Gender. Feminine

=*PARAPERGANDEA* Börner 1930: 160
Type species. *Phylloxera caryaevenae* Fitch 1856, by original designation
Etymology. Greek pará 'beside' + *Pergandea*
Gender. Feminine

=*PARAPHYLLOXERA* Grassi in Grassi et al. 1912: 11,60
Type species. *Vacuna glabra* von Heyden 1837, by original designation
Etymology. Greek pará 'beside' + *Phylloxera*
Gender. Feminine

=*PARTHENOPHYLLOXERA* Grassi in Grassi et al. 1912: 11,62
Type species. *Parthenophylloxera ilicis* Grassi 1912, by original designation
Etymology. Greek parthénos 'girl, virgin' + *Phylloxera*
Gender. Feminine

=*PERGANDEA* Börner 1908b: 610
Type species. *Dactylosphaera conica* Shimer 1869, by original designation
Etymology. (Theodore) Pergande [American entomologist] + -a
Gender. Feminine
Note. Junior homonym of *Pergandea* Ashmead 1905: 382 (Hymenoptera). Described as subgenus of *Dactylosphaera* Shimer 1867

=*PHYLLOXERELLA* Grassi in Grassi et al. 1912: 11,54
Type species. *Phylloxerella confusa* Grassi 1912, by original designation
Etymology. *Phylloxera* + -ella [diminutive suffix]
Gender. Feminine

=*PHYLLOXEROIDES* Grassi in Grassi et al. 1912: 11,48
Type species. *Phylloxera italica* Grassi 1912, by original designation
Etymology. *Phylloxera* + Greek –ō(i)dēs 'resembling'
Gender. Masculine

=*PSYLLOPTERA* Ferrari 1872: 85
Type species. *Psylloptera quercina* Ferrari 1872, by original monotypy
Etymology. *Psylla* [Hemiptera: Psyllidae] + Greek pterá 'wings'
Gender. Feminine

=*RHANIS* von Heyden 1837: 289
Type species. None

Etymology. Greek rhanís ‘drop (of a liquid)’
Gender. Feminine
Note. Unavailable, described in synonymy with *Vacuna* von Heyden 1837. Junior homonym of *Rhanis* Dejean 1836: 440 (Coleoptera)
=*TROITZKYA* Börner 1930: 160
Type species. *Dactylosphaera caryaesemen* Walsh 1867, by original designation
Etymology. (Nikolay Nikolaevich) Troitzky [Russian entomologist] + -a
Gender. Feminine
=*VACUNA* von Heyden 1837: 289
Type species. *Vacuna coccinea* von Heyden 1837, by original monotypy
Etymology. Latin Vacuna [minor goddess of ancient Italy]
Gender. Feminine
=*XEROPHYLLA* Walsh 1867: 283
Type species. *Pemphigus caryaecaulis* Fitch 1855, by subsequent designation (Börner 1930: 159)
Etymology. Greek xērós ‘dry’ + Greek phýllon ‘leaf’
Gender. Feminine
caryaeavellana Riley 1880: 230 (*Phylloxera*)
caryaecaulis (Fitch 1855: 859) (*Pemphigus*)
=*caryaemagna* (Shimer 1869: 391) (*Dactylosphaera*)
caryaefallax Riley 1874a: 1387 (*Phylloxera*)
caryaefoliae Fitch 1856: 446 (*Phylloxera*)
caryaeglobuli Walsh 1863: 309 (*Phylloxera*)
=*hemisphericum* (Shimer 1869: 387) (*Dactylosphaera*)
caryaegummosa Riley 1874a: 1387 (*Phylloxera*)
c*aryaepilula* (Walsh 1867: 283) (*Xerophylla*) nomen nudum
caryaeren Riley 1874a: 1387 (*Phylloxera*) original spelling *caryaereniformis* but *caryaeren* in prevailing usage (ICZN Article 33.3.1)
caryaescissa Riley 1880: 230 (*Phylloxera*)
caryaesemen (Shimer 1869: 392) (*Dactylosphaera*) specific epithet first used by Walsh (1867: 283), but not placed in combination with a genus and hence unavailable until Shimer established it as a binomen
caryaesepta (Shimer 1869)
subspecies ***caryaesepta*** (Shimer 1869: 389) (*Dactylosphaera*)
subspecies ***perforans*** Pergande 1904: 188,193 (variety of *Phylloxera caryaesepta* (Shimer 1869))
caryaevenae (Fitch 1856: 444) (*Pemphigus*)
castaneae (Haldeman 1850: 106) (*Chermes*)
castaneivora (Miyazaki 1968: 400) (*Moritziella*)
coccinea (von Heyden 1837: 289) (*Vacuna*)
=*escorialensis* Lichtenstein 1876: 130 (*Phylloxera*) nomen nudum
=*globifera* (von Heyden 1837: 289) (*Rhanis*) unavailable, described in synonymy with *Vacuna coccinea* von Heyden 1837

=*rutila* Dreyfus 1889: 95 (*Phylloxera*)
confusa Grassi in Grassi et al. 1912: 54 (*Phylloxera*)
conica (Shimer 1869: 390) (*Dactylosphaera*)
corticalis Kaltenbach 1867: 44 (*Phylloxera*)
=*iberica* Staroselsky 1892: 177 (*Phylloxera*)
=*lichtensteinii* Balbiani 1874: 645 (*Phylloxera*)
davidsoni Duncan 1922: 271 (*Phylloxera*)
deplanata Pergande 1904: 188,205 (*Phylloxera*)
depressa (Shimer 1869: 390) (*Dactylosphaera*)
devastatrix Pergande 1904: 243,248 (*Phylloxera*)
foae Börner 1909a: 26 (*Phylloxera*)
foveata (Shimer 1869: 393) (*Dactylosphaera*)
foveola Pergande 1904: 188,200 (*Phylloxera*)
fraxini Stebbins 1910: 46 (*Phylloxera*) nomen dubium, only the gall was described and it is probably not a phylloxerid
georgiana Pergande 1904: 243,249 (*Phylloxera*)
glabra (von Heyden 1837: 291) (*Vacuna*)
=*punctata* Lichtenstein 1874b:CCI (*Phylloxera*) original name *bipunctatum* but *punctata* in prevailing usage (ICZN Article 33.3.1)
globosa (Shimer 1867)
subspecies ***coniferum*** (Shimer 1869: 397) (*Dactylosphaera*)
subspecies ***globosa*** (Shimer 1867: 2) (*Dactylosphaera*)
ilicis (Grassi in Grassi et al. 1912: 62) (*Parthenophylloxera*)
intermedia Pergande 1904: 188,189 (*Phylloxera*)
italica (Grassi in Grassi et al. 1912: 48) (*Phylloxeroides*)
kunugi Shinji 1943: 2 (*Phylloxera*)
minima (Shimer 1869: 391) (*Dactylosphaera*)
notabilis Pergande 1904: 217,235 (*Phylloxera*)
perniciosa Pergande 1904: 244,251 (*Phylloxera*)
picta Pergande 1904: 188,197 (*Phylloxera*)
pilosula Pergande 1904: 188,203 (*Phylloxera*)
querceti Pergande 1904: 263 (*Phylloxera*)
quercina (Ferrari 1872: 85) (*Psylloptera*)
=*spinulosa* Targioni Tozzetti 1875: 308 (*Phylloxera*)
quercus Boyer de Fonscolombe 1834: 223 (*Phylloxera*)
=*florentina* Targioni Tozzetti 1875: 287 (*Phylloxera*)
=*scutifera* Signoret 1867: 303 (*Phylloxera*) nomen dubium; Signoret (1867) wrote he was unable to find significant differences between this species and *Phylloxera quercus* Boyer de Fonscolombe except that *scutifera* was "slightly larger and darker"; he also drew a scale-like structure (Plate 7, Figure 6) that is not of phylloxerid origin, suggesting his description included a mixture of species
=*signoreti* Targioni Tozzetti 1875: 302 (*Phylloxera*)
reticulata Duncan 1922: 271 (*Phylloxera*)

rileyi Riley 1874b: 64 (*Phylloxera*)
rimosalis Pergande 1904: 216,217 (*Phylloxera*)
russellae Stoetzel 1981: 128 (*Phylloxera*)
similans Duncan 1922: 272 (*Phylloxera*)
spinifera Pergande 1904: 261 (*Phylloxera*)
spinosa (Shimer 1869: 397) (*Dactylosphaera*)
spinuloides Pergande 1904: 243 (*Phylloxera*)
stanfordiana Ferris 1919: 103 (*Phylloxera*)
stellata Duncan 1922: 269 (*Phylloxera*)
subelliptica (Shimer 1869: 389) (*Dactylosphaera*)
symmetrica Pergande 1904
subspecies ***purpurea*** Pergande 1904: 232 (variety of *Phylloxera symmetrica* Pergande 1904)
subspecies ***symmetrica*** Pergande 1904: 218,230 (*Phylloxera*)
subspecies ***vasculosa*** Pergande 1904: 233 (variety of *Phylloxera symmetrica* Pergande 1904)
texana Stoetzel 1981: 141 (*Phylloxera*)
tuberculifera Duncan 1922: 272 (*Phylloxera*)

Subfamily **PHYLLOXERININAE** Börner 1908b: 607
Original spelling. Phylloxerinini
Type genus. *Phylloxerina* Börner 1908a

PHYLLOXERINA Börner 1908a: 94
Type species. *Phylloxera salicis* Lichtenstein 1884, by original monotypy
Etymology. *Phylloxera* + Latin -ina ‘in relation to’
Gender. Feminine
=*GUERCIOJA* Mordvilko 1909: 361
Type species. *Chermes populi* Del Guercio 1900, by original designation
Etymology. (Giacomo Del) Guercio [Italian entomologist] + -ja
Gender. Feminine
=*LAUFFERELLA* Lindinger 1933: 32
Type species. *Chermes populi* Del Guercio 1900, inherited from replaced name
Etymology. (Jorge) Lauffer [German entomologist] + -ella [diminutive suffix]
Gender. Feminine
Note. Replacement name for *Pseudochermes* Bonfigli 1909. Junior objective synonym of *Guercioja* Mordvilko 1909
=*PSEUDOCHERMES* Bonfigli 1909: 398
Type species. *Chermes populi* Del Guercio 1900, by original monotypy
Etymology. Greek pseudo- ‘untrue’ + *Chermes* [Hemiptera]
Gender. Masculine
Note. Junior homonym of *Pseudochermes* Nitsche in Judeich and Nitsche 1895: 1248 (Hemiptera: Cryptococcidae). Replaced by *Lauferella* Lindinger 1933

capreae Börner 1942: 265 (*Phylloxerina*)
daphnoidis Iglisch 1965: 424 (*Phylloxerina*)
moniliferae (Börner 1931: 696) (*Guercioja*) new name for *Chermes populi* Gillette 1914; possible synonym of *Phylloxerina popularia* (Pergande)
=*populi* (Gillette 1914: 269) (*Chermes*) junior primary homonym of *Phylloxerina populi* (Del Guercio 1900)
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XEROPHYLLA Walsh 1867 – synonym of *Phylloxera*

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RESEARCH ARTICLE

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Review of the East Palaearctic and North Oriental *Psyttalia* Walker, with the description of three new species (Hymenoptera, Braconidae, Opiinae)

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Abstract

The East Palaearctic and North Oriental species of the genus *Psyttalia* Walker (Hymenoptera, Braconidae, Opiinae) are reviewed. Three new species are described and illustrated: *P. latinervis* Wu & van Achterberg, **sp. n**. and *P. majocellata* Wu & van Achterberg, **sp. n**. from China, and *P. spectabilis* van Achterberg, **sp. n.** from Japan. *Coeloreuteus formosanus* Watanabe, 1934, *Opius* (*Lissosema*) *proclivis* Papp, 1981, *O.* (*Psyttalia*) *subcyclogaster* Tobias, 1998, *O.* (*P.*) *darasunicus* Tobias, 1998, *O.* (*P.*) *cyclogastroides* Tobias, 1998, *Psyttalia extensa* Weng & Chen, 2001, and *Rhogadopsis longicaudifera* Li & van Achterberg, 2013, are new synonyms of *Psyttalia cyclogaster* (Thomson, 1895); *Opius* (*Psyttalia*) *ophthalmicus* Tobias, 1977, and *O.* (*P.*) *brevitemporalis* Tobias, 1998, of *Psyttalia carinata* (Thomson, 1895) and both *O.* (*P.*) *vacuus* Tobias, 1998, and *O.* (*Lissosema*) *longurius* Chen & Weng, 1995, of *Rhogadopsis mediocarinata* (Fischer, 1963). *Phaedrotoma daghestanicum* (Telenga, 1950), *Rhogadopsis mediocarinata* (Fischer, 1963) and *R. mystica* (Fischer, 1963) are new combinations. New records are *Psyttalia carinata* (Thomson, 1895) from The Netherlands and Norway, and *P. cyclogaster* (Thomson, 1895) from Japan. A lectotype is designated for *Psyttalia carinata* (Thomson, 1895) and *P. cyclogaster* (Thomson, 1895). A key to the East Palaearctic and North Oriental species of the genus *Psyttalia* Walker is included.

Keywords

Braconidae, Opiinae, *Psyttalia*, new species, Tephritidae, East Palaearctic, North Oriental, Japan, China, Far East Russia, Korea, Netherlands, Norway

Introduction

The large subfamily Opiinae (Braconidae), with 2,020+ valid species (Yu et al. 2012, van Achterberg et al. 2012, Li et al. 2013), is a common group of generally small (2–5 mm) parasitoid wasps. It has a worldwide distribution and the world fauna has been reviewed by Fischer (1972, 1977, 1986, 1987). Wharton (1988, 1997), van Achterberg (1997, 2004a, 2004b), van Achterberg and Salvo (1997), van Achterberg and Chen (2004) and Li et al. (2013) published updates or some additions for the existing keys to the genera of the Opiinae, but the number of genera and the limits of several genera are still matter of discussion. Currently about 39 genera are used, with about 60 additional names circulating in the existing literature; mostly as subgenera in the genus *Opius* Wesmael s.l. Recently, 28 subgenera were synonymized by Li et al. (2013).

Psyttalia is a fairly large genus, currently with 79 valid species (Wharton 2009). The number of valid species in the Palaearctic and Oriental regions is unknown because of undercollecting and different generic limits used by different authors. Several of the species listed by Wharton (2009) after examination of the types proved to be junior synonyms or belong to other genera (e.g. *P. vacua*; see below). Nevertheless, the total number will be much more than 80, because several undescribed species are recognised in existing collections (e.g. Wharton 2009 and personal experience of authors) and cryptic species are likely present (Wharton 2009). Fischer (1972, 1987) and Wharton (2009) divided the species into two main groups (A: vein m-cu of fore wing antefurcal or interstitial; B: vein m-cu postfurcal) but this is problematical and too simplistic. For instance, *P. cyclogaster* has either vein m-cu distinctly postfurcal (group B; Figs 13–14) or subinterstitial (group A).

Opiinae are solitary koinobiont endoparasitoids of larvae of cyclorraphous Diptera, but oviposition may take place in the egg of the host (ovo-larval parasitoids). The parasitoid larva has its final development when the host larva has made its puparium and the adult wasp emerges from this puparium. Opiinae may play an important role in the biocontrol of dipterous pests as fruit-infesting Tephritidae and mining Agromyzidae and the genus *Psyttalia* is no exception. Several species (e.g. *P. fletcheri, P. incisi, P. makii*) have been introduced to control fruit flies (Wharton 2009, Yu et al. 2012) with variable success.

Material and methods

The material examined is deposited in the collections of the Zhejiang University (ZJUH) at Hangzhou, Northwest University (NWUX) at Xi'an, Institute of Zoology (IZAS) at Beijing, Naturalis Biodiversity Center (RMNH) at Leiden, Hungarian National Museum for Natural History (MTMA) at Budapest and Zoological Institute (ZISP) at St. Petersburg. The specimens collected by the third author during fieldwork on the Qinling Mts in Shaanxi province (Northwest China) and the type series of *P. spectabilis* were directly preserved in alcohol and the specimens were later prepared with the AXA method (van Achterberg 2009), the other specimens were collected by hand net and later card-pointed.

For identification of the subfamily Opiinae, see van Achterberg (1990, 1993), for identification of the genus, see Wharton (1997, 2009), Chen and Weng (2005) and the diagnosis in this paper. Wharton's (1987, 1997, 2009) interpretation of the genus is followed here; only a combination of the listed characters allows a valid identification because of the observed variation in most characters and the less variable characters are not exclusive for the genus (Wharton 2009). For references to the biology, see Yu et al. (2012) and for the terminology used in this paper, see van Achterberg (1988, 1993). Measurements are taken as indicated by van Achterberg (1988). Morphological terminology follows van Achterberg (1988, 1993), including the abbreviations for the wing venation. Measurements are taken as indicated by van Achterberg (1988): for the length and the width of a body part the maximum length and width is taken, unless otherwise indicated. The length of the mesosoma is measured from the anterior border of the mesoscutum till the apex of the propodeum and of the first tergite from the posterior border of the adductor till the medio-posterior margin of the tergite. A new provincial record of China is indicated by an asterisk.

Descriptions and measurements were made under a stereomicroscope (Zeiss Stemi SV 6). Photographs were made with an Olympus SZX12 motorized stereomicroscope with AnalySIS Extended Focal Imaging Software or with Keyence VHX-2000 and -5000 digital microscopes. Adobe Photoshop software was used to make small adjustments and to assemble the plates.

Results

Psyttalia Walker, 1860
Figs 1–110

Psyttalia Walker, 1860: 311. Type species (by monotypy): *Psyttalia testacea* Walker, 1860 (= *Opius walkeri* Muesebeck, 1931) [examined].

Mesostoma Cameron, 1905: 42. Type species (by monotypy): *Mesostoma testaceipes* Cameron, 1905.

Marginopius Fahringer, 1935: 9. Type species (by monotypy): *Opius* (*Marginopius*) *romani* Fahringer, 1935.

Austroopius Szépligeti, 1900: 64. Type species (by monotypy): *Austroopius novaguineensis* Szépligeti, 1900 [examined].

Acidoxanthopius Fischer, 1972: 71 (as subgenus of *Opius* Wesmael, 1835). Type species (by original designation): *Opius acidoxanthicidus* Fullaway, 1949.

Diagnosis (mainly after Wharton 2009)**.** Hypopygium of ♀ enlarged, 0.3–0.5 times as long as length of metasoma, distinctly acute apically (Figs 13, 44, 65) and vein m-cu of fore wing 0.5–0.7 times vein 1-M (Figs 2, 14, 28, 55); pterostigma distinctly triangular

(Figs 2, 55, 78, 90); scutellum slightly convex; second metasomal tergite strongly transverse, posterior width 4–7 times its median length (Fig. 5, but sometimes not separated from third tergite and nearby border only indicated by line of setae) and its anterior half usually without granulation, but sometimes distinct in *P. cyclogaster* (Fig. 17) and similar species; hypoclypeal depression wide and clypeus medium-sized (Fig. 19) or narrow (Figs 49, 71, 83, 95); precoxal sulcus impressed and usually crenulate medially; antenna of ♀ 1.1–1.7 times as long as fore wing; temple narrow (Figs 8, 32, 50, 96) or medium-sized (Figs 20, 84); vein m-cu of fore wing more or less antefurcal or interstitial (but more or less postfurcal in *P. cyclogaster* (Fig. 13) and similar species), gradually merging into vein 2-CU1 (Figs 28, 78) or angled with 2-CU1 (Figs 2, 13, 55, 90), straight or slightly (Fig. 2) to strongly curved; vein 1-CU1 of fore wing more or less widened (Figs 2, 28, 35, 66; but hardly so in *P. cyclogaster* (Fig. 13) and similar species); vein 2-SR+M of fore wing absent (Fig. 13) or present and more or less widened (Figs 2, 28, 55) or slender (Figs 55, 90); vein CU1b of fore wing present; second submarginal cell of fore rather elongate (Figs 2, 14); antero-medially pronotum at most with a transverse groove (Fig. 9) or with an shallow point-like pronope; mandible symmetrical, without extra protuberance (Fig. 86); medio-longitudinal carina of propodeum often present, but hardly so in *P. cyclogaster* (Fig. 17) and similar species); ovipositor sheath protruding far beyond apex of metasoma, its setose part usually 3–5 times as long as first metasomal tergite.

Biology. Parasitoids of larvae of Tephritidae; mainly in fruits, but sometimes in buds, flowers or galls (Wharton 2009).

Distribution. Cosmopolitan, except Nearctic and Neotropical regions. Wharton (2009) excluded *P. ovaliops* (Fischer, 1980) and *P. rufoflava* Fischer, 2001 (the only species known from the New World) because they belong to different New World species groups.

Notes. Tobias and Jakimavičius (1986) synonymized *Phlebosema* Fischer, 1972 (as "*Phelbosema*") with *Psyttalia*. This is not accepted here because the type species (*Opius discreparius* Fischer, 1963, from Japan) has a narrow elliptical pterostigma and the second metasomal tergite is granulate. Later Tobias included the type species in the subgenus *Tolbia* Cameron, 1907 (Tobias 1998). Both subgenera (*Phlebosema* and *Tolbia*) were synonymized with *Phaedrotoma* Foerster, 1863, by Li et al. (2013).

All known *Psyttalia* species from China have the setose part of ovipositor sheath about as long as the metasoma or slightly longer (= 3–5 times as long as first metasomal tergite). If the sheath is about twice as long as the metasoma, see the similar *Phaedrotoma daghestanicum* (Telenga, 1950) comb. n. that may occur in NW China. It is not included in *Psyttalia*, because the medio-posterior depression of the mesoscutum is present, vein CU1b of the fore wing is absent, the pterostigma is narrow, vein 1-CU1 of the fore wing is narrow, the precoxal sulcus is absent and the second metasomal tergite is as long as the third tergite (Fischer 1983). It is included in *Phaedrotoma* because it keys out there in the key by Li et al. (2013) and in the key below.

The genus *Psyttalia* Walker may be confused with *Psyttoma* van Achterberg & Li and some species of *Phaedrotoma* Foerster (Li et al. 2013), because of the acute hypopygium and far-protruding ovipositor. They can be separated as follows (for convenience *Rhogadopsis* is added because sometimes *Rhogadopsis* species are mistaken for *Psyttalia*).

1 Scutellum distinctly protruding above level of mesoscutum; hypopygium of ♀ distinctly acute apically and about 0.3 times as long as metasoma **and** hind wing narrow; hind femur very robust, 2–3 times as long as wide; labrum slanted backwards, leaving a depression below clypeus; medio-anterior veins of hind wing of ♂ strongly widened....... ***Psyttoma* van Achterberg & Li, 2012**

– Scutellum at level of mesoscutum; hypopygium of ♀ variable, **if** distinctly acute apically and about 0.3 times as long as metasoma **then** hind wing moderately wide and hind femur slender, 4–5 times as long as wide; labrum normal, without depression below clypeus; medio-anterior veins of hind wing of ♂ narrow **2**

2 Hypopygium of ♀ often distinctly acute apically and 0.3–0.6 times as long as metasoma, **if** without narrow acute apex **then** vein 2-SR+M of fore wing distinctly widened medially; second metasomal tergite strongly transverse and shorter than third tergite; first discal cell of fore wing transverse (Fig. 28), but less so in *P. cyclogaster* (Fig. 14); vein m-cu of fore wing often gradually merging into vein 2-CU1 and more or less curved (Fig. 28); Old World............. .... ***Psyttalia* Walker, 1860**

– Hypopygium of ♀ obtuse apically or nearly so and 0.1–0.3 times as long as metasoma; **if** rather acute apically and enlarged, **then** vein 2-SR+M of fore wing narrow medially, second tergite less transverse and about as long as third tergite; first discal cell of fore wing usually less transverse (Fig. 101); vein m-cu of fore wing usually angled with vein 2-CU1 and straight (Fig. 101); cosmopolitan **3**

3 Propodeum with medio-longitudinal carina anteriorly; vein m-cu of fore wing often gradually merging into 2-CU1 and linear with vein 2-M or nearly so; vein 1r-m of hind wing less oblique and 0.6–1.0 times as long as vein 1-M (combined with a comparatively wide hind wing); anterior groove of metapleuron crenulate dorsally; vein CU1b of fore wing medium-sized........ .... ***Rhogadopsis* Brèthes, 1913**

– Medio-longitudinal carina of propodeum absent anteriorly; vein m-cu of fore wing angled with vein 2-M, **if** rarely linear **then** angled with vein 2-CU1; vein 1r-m of hind wing usually distinctly oblique and 0.3–0.6 times as long as vein 1-M; at least dorsal half of anterior groove of metapleuron smooth; vein CU1b of fore wing usually short or absent, but sometimes medium-sized..... .... ***Phaedrotoma* Foerster, 1863**

Key to East Palaearctic and North Oriental species of the genus *Psyttalia* Walker

1 Scutellum medio-posteriorly densely setose and micro-sculptured, and slightly protruding or pinched subposteriorly (Figs 16, 17); vein m-cu of fore wing distinctly postfurcal (Fig. 14) to subinterstitial; area behind stemmaticum with a small pit and in front of anterior ocellus with a smooth protuberance (Figs 20, 21; often absent or obsolescent in small specimens); propodeum largely finely rugose (Fig. 17); [hind femur 3.5–4.2 times as long as wide (Fig.

25); antenna with 26–39 segments; setose part of ovipositor sheath 0.43–0.57 times as long as fore wing and 1.3-1.8 times hind tibia; T2 more or less micro-sculptured; clypeus flattened, medium-sized trapezoid (Fig. 19)] .... ***P. cyclogaster*** **(Thomson, 1895)**

– Scutellum medio-posteriorly with some setae and smooth, and flat subposteriorly (Figs 4, 37, 58, 68); vein m-cu of fore wing more or less antefurcal (Figs 2, 28, 55, 78, 90); area behind stemmaticum without a pit or pit minute and in front of anterior ocellus flat or with a narrow convex ridge (Figs 8, 32, 84, 96); propodeum at least partly smooth (Figs 5, 30, 64, 68, 93) **2**

2 Propodeum with pair of complete, medium-sized and coarsely crenulate grooves sublaterally (Fig. 93); frons largely punctate-rugose in front of anterior ocellus (Fig. 96); vein SR of hind wing absent (Fig. 90); sixth tergite longer than fifth tergite or nearly as long and ivory (Figs 89, 99); vein m-cu of fore wing subparallel to vein 1-M, straight and vein 2-SR+M slender (Fig. 90); antenna with 52–53 segments ..... ***P. spectabilis*** **van Achterberg, sp. n.**

– Propodeum at most with pair of finely crenulate narrow grooves (Fig. 80) or with wide and incomplete crenulate grooves anteriorly (Figs 47, 64, 68); frons smooth in front of anterior ocellus, at most near antennal sockets sculptured (Figs 50, 72, 84); vein SR of hind wing indicated as faint depression (Fig. 78); sixth tergite shorter than fifth tergite or nearly as long and usually black or brownish yellow (Figs 12, 51, 73); vein m-cu of fore wing usually distinctly converging to vein 1-M posteriorly, more or less curved and vein 2-SR+M more or less widened (Figs 2, 28, 35, 55, 66, 78); antenna with 36–55 segments **3**

3 Vein r of fore wing 0.7–1.0 times vein 2-SR (Fig. 28); vein 2-SR+M of fore wing distinctly widened (Fig. 28); antenna largely brownish yellow **4**

– Vein r of fore wing 0.3–0.5 times vein 2-SR (Figs 2, 35, 55, 66); vein 2-SR+M of fore wing hardly or not widened (Figs 2, 55, 78); antenna (except scapus and pedicellus) dark brown or brown.. **6**

4 Vein 2-SR+M of fore wing 3.5–4.0 times as long as wide (Fig. 28); vein m-cu of fore wing weakly curved or straight (Fig. 28) ....***P. incisi*** **(Silvestri, 1916)**

– Vein 2-SR+M of fore wing about twice as long as wide; vein m-cu of fore wing strongly curved.. **5**

5 Vein r of fore wing about 0.8 times vein 2-SR; vein 1-CU1 of fore wing about as long as vein cu-a ....***P. makii*** **(Sonan, 1932)**

– Vein r of fore wing about as long as vein 2-SR; vein 1-CU1 of fore wing at most 0.7 times as long as vein cu-a .... ***P. fletcheri*** **(Silvestri, 1916)**

6 Head directly narrowed behind eyes in dorsal view, eye 3–6 times longer than temple (Figs 8, 50); wing membrane subhyaline (Fig. 1); hypopygium of ♀ pale yellowish or pale brown medio-ventrally (Figs 12, 51); length of fore wing 2.8–3.4 mm; antenna of ♀ with 36–44 segments.............................. **7**

– Head gradually narrowed behind eyes in dorsal view, eye 1.8–2.5 times longer than temple (Figs 72, 84); wing membrane weakly to distinctly infuscate (Figs

66, 78); hypopygium of ♀ dark brown or brown medio-ventrally (Figs 73, 85); length of fore wing 4.5–5.5 mm; antenna of ♀ with 44–47 segments **9**

7 Vein 1-CU1 of fore wing strongly widened and nearly as long as vein 2-CU1 (Figs 34–35); ocelli large (Fig. 40); frons smooth laterally; mesoscutum of ♂ with well-defined V-shaped pale yellow area (Fig. 37).. ***P. latinervis* Wu & van Achterberg, sp. n.**

– Vein 1-CU1 of fore wing at most moderately widened and much shorter than vein 2-CU1 (Figs 2, 55); ocelli smaller (Fig. 8); **if** rather large (Fig. 61) then frons punctate laterally (Fig. 61); mesoscutum of ♂ without distinct V-shaped area medio-posteriorly (Fig. 58), at most mesoscutum with rectangular yellowish brown area medially.. **8**

8 OOL 2.0–2.4 times diameter of posterior ocellus and POL slightly longer than diameter of ocellus (Fig. 8); frons and vertex laterally largely smooth, except some punctulation (Fig. 8); medio-posterior triangular areola of propodeum short (Fig. 5); pterostigma dark brown medially (Fig. 2); vein 2-SR+M of fore wing about 0.4 times as long as vein m-cu (Fig. 2); base of hind tibia and hind tarsus brownish yellow (Fig. 12) .... ***P. carinata* (Thomson, 1895)**

– OOL 1.2–1.7 times diameter of posterior ocellus and POL 0.8–1.0 times diameter of ocellus (Figs 50, 61); frons and vertex punctate laterally (Fig. 50); medio-posterior triangular areola of propodeum variable, often longer (Figs 48, 63, 64); pterostigma pale brown medially (Figs 44, 54, 55); vein 2-SR+M of fore wing 0.6–0.8 times as long as vein m-cu (Figs 45, 54, 55); base of hind tibia often and hind tarsus largely dark brown (Fig. 57).. ***P. majocellata* Wu & van Achterberg, sp. n.**

9 Mesosoma orange brown, contrasting with mainly black metasoma (Fig. 65); hind femur robust and 2.9–3.3 times as long as wide (Fig. 73); fore wing distinctly infuscate (Fig. 66); vein 2-SR+M of fore wing rather widened (Fig. 66); legs yellowish brown (Fig. 65); vein 3-SR of fore wing 1.4–1.8 times as long as vein 2-SR (Fig. 66) .... ***P. romani* (Fahringer, 1935)**

– Mesosoma mainly black or dark brown as metasoma (Fig. 77); hind femur slenderer and 3.5–3.9 times as long as wide (Fig. 85); fore wing slightly infuscate (Fig. 78); vein 2-SR+M of fore wing slightly widened (Fig. 78); legs brownish yellow (Fig. 77); vein 3-SR of fore wing 1.4–1.5 times as long as vein 2-SR (Fig. 78) ....***P. sakhalinica* (Tobias, 1998)**

***Psyttalia carinata* (Thomson, 1895) s.l.**
Figs 1–12

Opius carinatus Thomson, 1895: 2177.
Opius (*Psyttalia*) *carinatus*: Fischer 1972: 335–337; Tobias 1998: 613.
Psyttalia carinata: Fischer and Koponen 1999: 144; Belokobylskij et al. 2003: 396; van Achterberg 2004c: FE on-line database.

Opius rhagoleticola Sachtleben, 1934: 76; Fischer 1972: 344–346; Belokobylskij et al. 2003: 396 (as synonym of *P. carinata*).
Psyttalia rhagoleticola: Fischer and Koponen 1999: 144; Tobias 2000: 12.
Opius (*Psyttalia*) *ophthalmicus* Tobias, 1977: 425, 430, 1998: 613; Fischer 1984: 114–117. **Syn. n.** (examined).
Psyttalia ophthalmica: Wharton 1997: 23; Tobias 2000: 12.
Opius (*Psyttalia*) *brevitemporalis* Tobias, 1998: 613. **Syn. n.** (examined).
Psyttalia brevitemporalis: Tobias 2000: 12.

Type material. Lectotype of *O. carinatus* here designated, ♀ (ZIL), "Broa" [= North Gottland, **Sweden**], 12–12.vii.[18]50"; 1 paralectotype, ♂ (ZIL) with same label data as lectotype; 1 paralectotype, ♂ (ZIL), "Gott", "*carinatus* m. ", "*O. carinatus* Th.". Paratypes of *O. rhagoleticola*: 3 ♀ (RMNH, ZJUH), "Cotypus", "[**Germany**], Naumburg, 1932, aus *Rhagoletis cerasi*, Thiem", "*Opius rhagoleticolus* Sachtl." Holotype of *Opius ophthalmicus* ♀ (ZISP), "[**Russia**:], Primorskij kraj, okr. Ussurskiska, 13.ix.[1]968, Kandybina", "*Rhagoletis alternatum* Flln., Kandybina det.", "Litsinka v plodach zhipovnika *Rosa*", "Holotypus *Opius ophthalmicus* Tobias"; 1 paratype, ♀ (ZISP), same data as holotype. Holotype of *O. brevitemporalis*, ♀ (ZISP), "[Russia:], Primorskij kraj, Spassk, 21.viii.1987, G. Belokobylskaja", "*Opius brevitemporalis* sp. n., det. Tobias '95", "Holotypus *Opius brevitemporalis* Tobias"; 1 paratype, ♀ (ZISP), "Primorskij kraj, zap. Kedrovaja Pad, 25.ix.[1]968, Kandybina", "[ex] *My[i]oleja sinensis* Zia, Kandybina det.", "[ex] *Ch[a]etostoma continuans* Zia & Chen", "Litsinka v plodach shimolosti *Lonicera maackii* Rupr."; "Paratypus *Opius brevitemporalis* Tobias".

Additional material. 1 ♂ (ZISP), "[Russia], Ilmenskij zapoved, Tseljainskoj obl., 15.vii.[1]959, Tobias" (det. Tobias as *O. carinatus*); 3 ♀ (ZISP), id., but 18.vii.1958. Additional specimens (ZISP) of *P. carinata* with complete yellowish mesoscutum examined from Gravan, Bijsp, Altajskij kraj, Karagand. Obl., Toshska Obl. (Russia) and Kizhinev (Moldova).

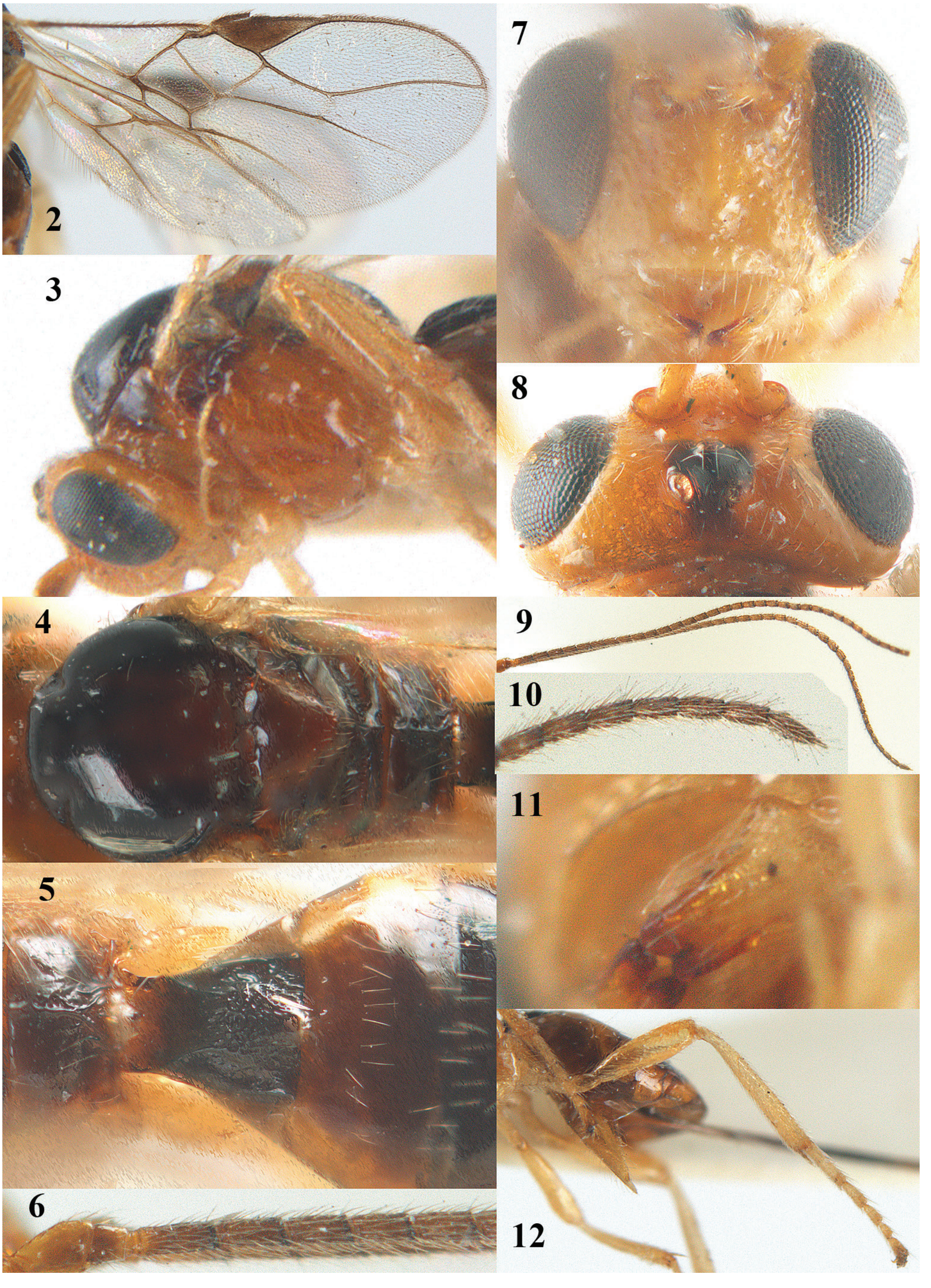
Comparative diagnosis. *Psyttalia carinata* is a widespread Palaearctic species with the head distinctly narrower behind the eyes in dorsal view (eye 2.5–5 times longer than temple) and medium-sized ocelli (Fig. 8). This species is very similar to SW. Palaearctic and Afrotropical *P. concolor* (Szépligeti, 1910) as indicated by Fischer (1972); *P. carinata* differs by having mesosoma dorsally and the first metasomal tergite mainly or entirely black or dark brown (*vs* brownish or reddish yellow in *P. concolor*), vein cu-a of fore wing about as long as vein 1-CU1 (*vs* vein cu-a shorter than 1-CU1) and temple slightly less distinctly narrowed behind eyes (*vs* more directly narrowed) and by largely different spectrum of hosts belonging to *Carpomya*, *Chetostoma, Myoleja* and *Rhagoletis* species (*vs Anastrepha*, *Bactrocera*, *Capparimyia*, *Carpomya*, *Ceratitis*, *Dacus*, *Euphranta*, *Rhagoletis* and *Synclera* spp.).

Description. Holotype of *Opius brevitemporalis*, ♀, length of body 2.8 mm, of fore wing 3.3 mm.

Head. Antenna with 40 segments, bristly and erect setose and 1.5 times as long as fore wing; third segment 1.2 times as long as fourth segment, length of third, fourth

Figure 1. *Psyttalia carinata* (Thomson), ♀, holotype of *Opius brevitemporalis* Tobias, habitus lateral.

and penultimate segments 2.6, 2.2 and 2.3 times their width, respectively (Figs 6, 10); length of maxillary palp 0.9 times height of head; length of eye in dorsal view 4.2 times temple (Fig. 8); temple in dorsal view shiny, smooth and with sparse setae; OOL: diameter of ocellus: POL = 10:5:6; area behind stemmaticum reclivous and with minute pit (Fig. 8); face coarsely punctate with interspaces wider than diameter of punctures, shiny, with a smooth medio-longitudinal convexity widened ventrally (Fig. 7); frons slightly depressed behind antennal sockets and with some oblique striae; in front of anterior ocellus with slightly convex ridge, shiny, smooth and glabrous but laterally setose and punctulate (Fig. 8); labrum slightly depressed; clypeus transverse, sparsely punctate, convex, and its ventral margin truncate and narrow (Fig. 7); width of clypeus 4.3 times its maximum height and 0.7 times width of face; hypoclypeal depression wide and deep (Figs 7, 11); malar suture wide and shallow, punctate between malar



Figures 2–12. *Psyttalia carinata* (Thomson), ♀, holotype of *Opius brevitemporalis* Tobias. **2** wings **3** head and mesosoma lateral **4** mesosoma dorsal **5** propodeum and first–third metasomal tergites dorsal **6** base of antenna **7** head anterior **8** head dorsal **9** antenna **10** apex of antenna **11** mandible lateral **12** hind leg and hypopygium lateral.

suture and clypeus; mandible not twisted, apically moderately narrowed and with both teeth wide; mandible normal basally and with narrow ventral carina (Fig. 11); occipital carina remains far removed from hypostomal carina and dorsally largely absent; hypostomal carina narrow ventrally.

Mesosoma. Length of mesosoma 1.2 times its height; dorsal pronope minute, round; pronotal side largely smooth, but posterior groove dorsally crenulate (Fig. 3); propleuron slightly convex; epicnemial area smooth dorsally; precoxal sulcus medially medium-sized and only medially distinctly crenulate, absent anteriorly and posteriorly (Fig. 3); remainder of mesopleuron smooth and shiny; pleural sulcus smooth ventrally; mesosternal sulcus moderately deep, narrow and finely crenulate; postpectal carina absent; mesoscutum very shiny and glabrous (Fig. 4); notauli only anteriorly as pair of finely crenulate impressions and absent on disc; scutellar sulcus deep and with 6 short crenulae, parallel-sided medially; scutellum moderately convex and smooth, but apically sparsely punctate and setose (Fig. 4); metanotum with a protruding medio-longitudinal carina anteriorly and very finely crenulate posteriorly; surface of propodeum smooth and shiny except for rugose area near distinct and reversed Y-shaped median carina (Fig. 5), lateral grooves shallow and sparsely crenulate or smooth and anterior groove parallel-sided medially (Fig. 5).

Wings. Fore wing: 1-SR distinctly longer than wide and linear with 1-M (Fig. 2); pterostigma wide triangular (Fig. 2); 1-R1 ending at wing apex and 1.6 times as long as pterostigma (Fig. 2); r linear with 3-SR and medium-sized; r-m not tubular; r:3-SR:SR1 = 5:33:73; 2-SR:3-SR:r-m = 22:33:11; 1-M straight and SR1 curved; m-cu distinctly antefurcal and slightly curved, 2-M+CU1 moderately widened (as apex of M+CU1: Fig. 2) and 0.4 times as long as m-cu; cu-a distinctly postfurcal and 1-CU1 widened; 1-CU1:2-CU1= 5:23; first subdiscal cell closed; CU1b medium-sized; only apex of M+CU1 sclerotized. Hind wing: 1-M of hind wing straight, resulting in subparallel-sided cell apically; M+CU:1-M:1r-m = 5:5:4; cu-a straight; m-cu absent; SR slightly indicated apically.

Legs. Length of femur, tibia and basitarsus of hind leg 3.4, 8.0 and 4.4 times as long as width, respectively (Fig. 12); hind femur with rather long setae, tarsus and tibia densely setose.

Metasoma. Length of first tergite 1.2 times to its apical width, convex medio-posteriorly, its surface strongly and irregularly rugose-punctate (Fig. 5), dorsal carinae strong in its basal half and area below depressed; second suture slightly indicated; basal depressions of second tergite large and tergite 0.9 times as long as third tergite; second and following tergites smooth, shiny and sparsely setose; combined length of second and third metasomal tergites 0.25 times total length of metasoma; length of setose part of ovipositor sheath 0.52 times fore wing, 3.8 times first tergite, 2.4 times hind femur, 1.6 times hind tibia and 1.2 times metasoma; hypopygium about 0.5 times as long as metasoma, distinctly acute apically and about reaching apex of metasoma (Fig. 12).

Colour. Brownish yellow, but stemmaticum and area behind it, mesoscutum, metanotum, propodeum, first tergite and ovipositor sheath mainly black or blackish brown; antenna (except scapus and apically pedicellus), scutellum, pronotum and mesopleuron dorsally, second third tergites medially, fourth and fifth tergites (except lateral patch), sixth tergite medially, pterostigma and veins dark brown; remainder of sixth tergite yellowish; palpi, mandible (but teeth dark brown), tegulae and legs pale yellow; fore wing membrane subhyaline.

Male. Except for the sexual differences males are (as in other spp.) very similar to females; in general the size is less and more often than in females the metasomal tergites are darkened.

Variation. Length of fore wing 2.9–3.3 mm; antenna of ♀ with 35(1), 38(1), 39(1) and 40(1) segments, of ♂ 39(1); first tergite 1.1–1.2 times as long as its apical width; hind femur 3.4–4.2 times as long as wide; setose part of ovipositor sheath 0.50–0.54 times as long as fore wing, 0.8–1.1 times mesosoma and 1.5–1.7 times hind tibia; middle of mesoscutum black, chestnut brown or brown; area behind stemmaticum and scutellum dark brown to brownish yellow.

Variation of type series. The holotype of *Psyttalia ophthalmica* differs from typical *P. carinata* by having body partly dark brown and remainder yellowish brown, and scutellum with some setae and punctures posteriorly. These punctures are sometimes also present in typical *P. carinata* and both have been reared from *Rhagoletis alternata* (Fallén) (rose hip fly; Tephritidae). *P. brevitemporalis* has a similar scutellum (Fig. 4), but has the body largely dark brown dorsally and the holotype has the eye in dorsal view 4.2 (paratype 5.2) times as long as temple (4.2 times in holotype of *P. ophthalmica*, up to 3.8 times in *P. carinata*). According to Tobias (1998) *P. carinata* has the upper half of the mesopleuron granulate and *P. rhagoleticola* has it completely smooth, but clean specimens have always the mesopleuron smooth and shiny dorsally. The length of the temple in dorsal view seems to be variable. The W. Palaearctic specimens have the eye in dorsal view 2.5 times as long as temple (see fig. 267 in Fischer 1972) up to 3.8 times. In the East Palaearctic *P. brevitemporalis* and *P. ophthalmica* it varies between 4.2–5.2 times and because we could not find additional differences (except some variation in colour), we assume the variation is clinal. Therefore, we treat *P. carinata sensu lato* in this paper and synonymize both species under *P. carinata*.

Distribution. Armenia; Austria; Bulgaria; Czech Republic; Finland; France; Germany; Hungary; Italy; Kazakhstan; Kyrgyzstan; Lithuania; Moldova; Netherlands (new record); Norway (id.); Poland; Russia (including Far East); Sweden; Switzerland; Uzbekistan and former Yugoslavia; introduced into Canada.

Biology. Endoparasitoid of *Rhagoletis*, *Myoleja*, *Chetostoma* and *Carpomya* species (Tephritidae) in fruits.

Notes. In ZJUH there is a similar female from S. China (Yunnan, Simao, 1982, Shiqing Yang, No. 826893) which most likely represents another new species. It has similar small ocelli and smooth frons, but the entirely mesoscutum is yellow, the base of the hind tibia is dark brown, the head is less transverse and vein m-cu of the fore wing is slightly longer than 2-SR+M (as in *P. majocellata* sp. n.). Differs from *P. majocellata* sp. n. by the largely dark brown second–fifth tergites of ♀ (*vs* yellow in ♀ of *P. majocellata*), the smaller ocelli, the dark brown middle of the pterostigma of ♀ and the less sculptured frons.

Psyttalia cyclogaster **(Thomson, 1895), comb. n.**
Figs 13–27

Opius (*Opius*) *cyclogaster* Thomson, 1895: 2178 (examined).
Opius (*Psyttalia*) *cyclogaster*: Fischer 1972: 340–341.
Coeloreuteus formosanus Watanabe, 1934: 188; Chou 1981: 74; Chen and He 1997: 108. **Syn. n.**
Opius (*Lissosema*) *proclivis* Papp, 1981: 155–157. **Syn. n.** (examined).
Opius (*Psyttalia*) *subcyclogaster* Tobias, 1998: 612. **Syn. n.** (examined).
Psyttalia subcyclogaster: Tobias 2000: 12.
Opius (*Psyttalia*) *darasunicus* Tobias, 1998: 612. S**yn. n.** (examined).
Psyttalia darasunica: Tobias 2000: 12.
Opius (*Psyttalia*) *cyclogastroides* Tobias, 1998: 613. **Syn. n.** (examined).
Psyttalia cyclogastroides: Tobias 2000: 12.
Psyttalia extensa Weng & Chen, 2001: 84–86; Chen and Weng 2005: 150–151. **Syn. n.**
Rhogadopsis longicaudifera Li & van Achterberg, 2013: 151–154. **Syn. n.**

Type material. Lectotype of *Opius cyclogaster* here designated, ♀ (ZIL), "[**France**:] Delazy, [1872]", "*cyclogaster* m., "O. *cyclogaster* Th.". Holotype of *O. proclivis*, ♀ (TMAB), "**Korea**, prov. South Pyongan, Za-mo san, 60 km NE from Pyongyan, 2.ix.1971", "No. 231, leg. S. Horvatovich et J. Papp", "Holotypus ♀ % *Opius* (*Lissosema*) *proclivis* sp. n., Papp J., 1981", "Hym. Typ. No. 2841, Museum Budapest", "*Rhogadopsis* ♀ *proclivis* Papp, det. Papp J., 2012". Holotype of *O. subcyclogaster*, ♀ (ZISP), "[**Russia**:], Zabajkalsk, Tsitin., step, 1.vii.[1]975, Kasparjan", "*Opius subcyclogaster* sp. n., Tobias det. 1998", "Holotypus *Opius subcyclogaster* Tobias". Holotype of *O. darasunicus*, ♀ (ZISP), "[Russia:], 9 km S Kurorta, Darasun, Tsit. Obl., 27.vi.[1]975, Kasparjan", "*Opius darasunicus* sp. n., Tobias det. 1998", "Holotypus *Opius darasunicus* Tobias". Holotype of *O. cyclogastroides*, ♀ (ZISP), "[Russia:], Primorskij kraj, 20 km YuV Ussurijska, na svet, 18-21.vii.1996, S. Belokobylskij", "*Opius cyclogastroides* sp. n., Tobias det. 1998", "Holotypus *Opius cyclogastroides* Tobias"; 1 paratype, ♀ (ZISP), "[Russia:], Primorskij kraj, 10 km YuYuZ Partizanska, les, opushki, 12–13.vii.1996, S. Belokobylskij", "Paratypus *Opius cyclogastroides* Tobias". Holotype of *R. longicaudifera*, ♀ (ZJUH), "S. **China**: **Hunan**, Yongzhou, Jiangyong, Yuankou, 28.v.1988, Jian-Ping Liu, No. 181".

Additional material. 1 ♀ (ZISP), "[**Japan**: Kyushu], Miyazaki, Yatake, 700 m, Shiiba-mura, 21.vii.1992, V. Makarkin"; 1 ♀ (ZISP), "[**Russia**:], 9 km S Kurorta, Darasun, Tsit. Obl., 27.vi.[1]975, Kasparjan" (under *O. subcyclogaster*); 1 ♀ (ZISP), "[Russia:], Primorskij kraj, 20 km YuV Ussurijska, les, 5.viii. 1991, Belokobylskij"; 1 ♀ (ZISP), id., but nzap. "Kedrovaja Pad", dubnjak, 22.vii.1979; 1 ♂ (ZISP), id., but Baradash-Levada, 2.ix.1978; 1 ♀ (ZISP), id., but Anisimovka, poljan, 12.vii.1984; 1 ♀ (ZISP), "[Russia:] Ilmenskij Zapoved, Tseljabinskoj obl., 17.vii.1950, Tobias"; 1 ♀ (ZISP), "**Kazachst[an]**, Janvartsevo, prav., b. Urala, 31.viii.[1]949, Rubolph"; 1 ♀ (NWUX), "NW. **China**: **Shaanxi**, Xunyangba, Ningshan, c.

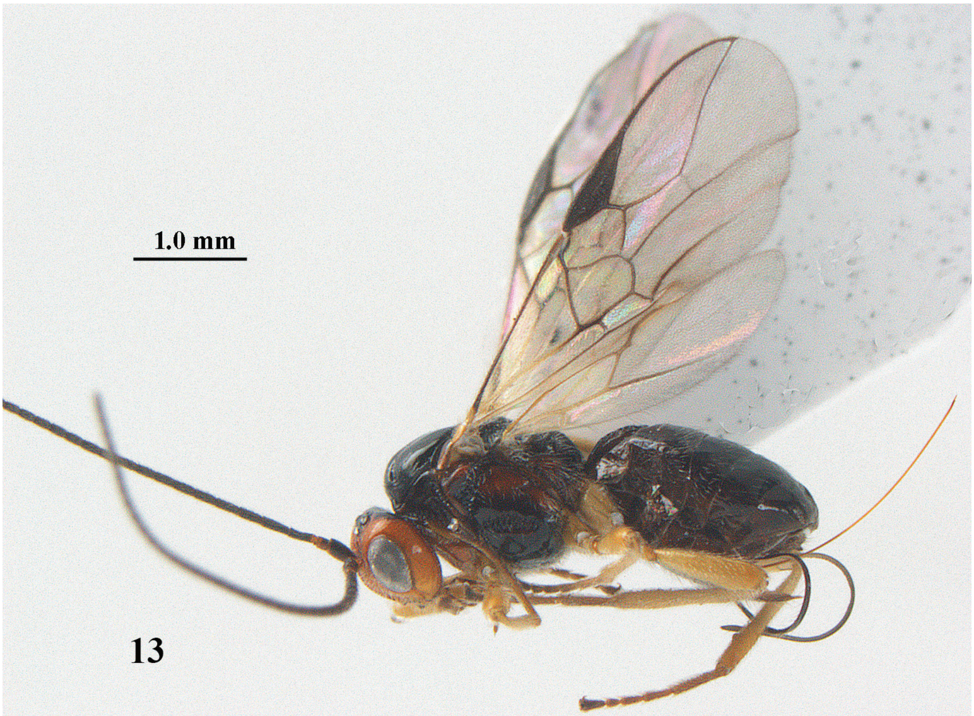


Figure 13. *Psyttalia cyclogaster* (Thomson), ♀, China, Ningshan, habitus lateral.

1300 m, 2.vi.2014, 33°33'N 108°32'E, Jiangli Tan, NWUX"; 1 ♀ (ZJUH), "[NE. China:] **Liaoning**, Shenyang, Dongling, 6.v.1994, Juxian Lou, No. 947532"; 2 ♀ (ZJUH), "[NE. China:] **Jilin**, Changbai Mts, 4.vii.1994, Juxuan Lou, Nos 951911 and 952014"; 2 ♀ (ZJUH), "[N. China:] **Henan**, Neixiang, Baotianman, 13 & 15.vii.1998 Yun Ma, Nos 986161 and 986801"; 1 ♀ (ZJUH), "[N. China:] Henan, Jigong Mts, 11.vii.1997, Xuexin Chen, No. 973737"; 2 ♀ (ZJUH), "[N. China:] **Hebei**, Xiaowutai Mts, Yangjiaping, 20.viii.2005, Min Shi, Hongying Zhang, Nos 200604624 and 200604804"; 1 ♀(ZJUH), "[SE. China]: **Fujian**, Chongan, Wuyi Mts, 5–10.vii.1989, Junhua He, No. 894760"; 1 ♀ (ZJUH), id., but 6.viii.1986, Jiashe Wang, No. 865476"; 2 ♀ (ZJUH), "[SE. China:] Fujian, Dehua, Daiyun Mts, 13 and 14.iv.2002, Yiping Wang, No. 20024716 and Jingxian Liu, No. 20024977"; 1 ♀ (ZJUH), "[SE. China:] Fujian, Dehua, Chishuizhen, 13.iv.2002, Zaifu Xu, No. 20025208"; 1 ♂ (ZJUH), "[SE. China:] Fujian, Liancheng, Tiaoxi, 18.viii.1988, Jian Huang, No. 20005629"; 2 ♂ (ZJUH), id., but Luochi, 23.viii.1988, Jian Huang, Nos 20005501 and 20005521"; 2 ♂ (ZJUH), "[SE. China:] Fujian, Nanping, Xiqinzhen, 21.ix.2002, Fangfang Li, Nos 20025524 and 20025551"; 1 ♀ 2 ♂ (ZJUH), "[SE. China:] Fujian, Shaxian, 15.ix.1980, Junhua He, No. 803805"; 1 ♀ 1 ♂ (ZJUH), id., but Yangfang, 1.vii.1981, Naiquan Lin, Nos 20044078 and 20044080"; 2 ♀ (ZJUH), "[SE. China:] Fujian, vi.1989, Zhishan Wu, Nos. 20009819 and 20009830"; 1 ♂ (ZJUH), "[SE. China:] Fujian, Yongan, Tianbaoyan, 15–18.vii.2001, Zaifu Xu, No. 20020238”; 5 ♀ (ZJUH), “[SE. China:] Fujian, Youxi, 15.v.1988, Qi Zheng, Nos 20005097, 20005106, 20005107, 20005122 and 20005148”; 2 ♀ (ZJUH), id., but Meixian, 15.x.1988, Changfu Lin, Nos 20005106 and 20005231”; 1 ♀ (ZJUH), “[S. China:] **Guangdong**, Fengkai, Heishiding, 15.viii.2003, Jujian Chen, No. 20048957”; 1 ♂ (ZJUH), “[S. China:] Guangdong, Guangzhou, 1.xi.1989, Junhua He, No. 896617”; 1 ♀ (ZJUH), “[S. China:] Guangdong, Huizhou, Xiangtou Mts, 11.v.2004, Zaifu Xu, No. 20053407”; 2 ♀ (ZJUH), “[S. China:] Guangdong, Yunan, Tongle Mts, 12–13.viii.2003, Zaifu Xu, Nos 20054397 and 20054613”; 3 ♀ 5 ♂ (ZJUH), “[S. China:] Guangdong, Yangchun, Baishui Waterfalls, 1.v.2002, Zaifu Xu, Nos 20028327, 20028352, 20028353, 20028371, 20028372, 20028383, 20028385 and 20028395”; 4 ♀ (ZJUH), id., but Baiyong, 5–6.v. 2002, Zaifu Xu, Nos 20028016, 20028022, 20028044 and 20028060; 2 ♀ (ZJUH), id., but Huatan, 3-4.v.2002, Zaifu Xu, Nos 20027570 and 20027811; 5 ♀ 1 ♂ (ZJUH), “[S. China:] Guangdong, Yangchun, Efengling Mts, 2.v.2002, Zaifu Xu, Nos 20028199, 20028221, 20028237, 20028238, 20028254 and 20028265”; 4 ♀ 1 ♂ (ZJUH), “[S. China:] Guangdong, Heyuan, Gui Mts, 18.v.2002, Zaifu Xu, Nos 20028572, 20028637, 20028657, 20028686 and 20028706”; 3 ♀ (ZJUH), “[S. China:] Guangdong, Shixing, Chebaling Mts, 21.viii.2003, Zaifu Xu, Nos 20051956, 20052375 and 20052443”; 3 ♀ (IZAS, RMNH) “[S. China:] **Hainan**, Tongshi, 340 m”, “3.iv.1960, Suofu Li”, “IOZ(E) 617436-38”; 5 ♀ 1 ♂ (ZJUH), “[S. China:] Hainan, Yinggeling Mts, 18.x. 2007 and 24–25.v.2007, Jingxian Liu, Nos 200702620, 200702639, 200702754, 200702774, 200209739 and 200209997”; 1 ♀ (ZJUH), id., but Hongmao, 23–25.v.2007, Jie Zeng, No. 200804464; 1 ♀ (ZJUH), id., but 28.v.2007, Liqiong Weng, No. 200804194; 3 ♀ (ZJUH), “[S. China:] Hainan, Diaoluo Mts, 1–2.vi.2007 and 16–17.vii.2007, Jingxian Liu, Nos 200703899, 200703929 and 200802336”; 1 ♀ (ZJUH), “[S. China:] Hainan, Jianfengling Mts, 9–14.v.2007, Kuiyan Zhang, No. 200703651”; 4 ♀ (ZJUH), “[S. China:] Hainan, Wuzhi Mts, Shuimanxiang, 15–20.v.2007, Liqiong Weng, Nos 200803746, 200803755, 200803954 and 200803994”; 10 ♀ 7 ♂ (ZJUH), id., but 16–20.v.2007, 29.x.2007, Jingxian Liu, Nos 200703180, 200703261, 200703298, 200703385, 200710037, 200710040, 200710056, 200710091, 200710095, 200710114, 200710121, 200710129, 200710204, 200710205, 200710212, 200710282, 200710289 and 200710328”; 6 ♀ (ZJUH), id., but Shuimanxiong, 17–20.v.2007, Bin Xiao, Nos 200804666, 200804786, 200804793, 200804796, 200804814 and 200804857”; 1 ♀ (ZJUH), “[SW. China:] **Guangxi**, Fangcheng, Banba, 8.vi.2000, Hong Wu, No. 200100263”; 1 ♂ (ZJUH), “[SW. China:] Guangxi, Beiliu, 26.ix.1980, Youfu Zhong, No. 824470”; 1 ♂ (ZJUH), “[SW. China:] Guangxi, Daming Mts, Neichao,12.viii.2011, Chengjin Yan, No. 201100571”; 1 ♂ (ZJUH), “[SW. China:] Guangxi, Napo, Guinong Mts, 21.vi.2000, Hong Wu, No. 200100150”; 1 ♂ (ZJUH), “[SW. China:] Guangxi, Tianlin, Anjiaping, 29.v.1982, Junhua He, No. 821867”; 3 ♀ (ZJUH), “[SW. China:] Guangxi Botanical Garden, 30.x.2002, Naiquan Lin, Nos 20034981, 20034996 and 20035021”; 1 ♀ (ZJUH), “[SW. China:] **Sichuan**, Jiuzhaigou, 16.vii.1987, Gang Chen, No. 200012336”; 1 ♀ (ZJUH), “[SW. China:] **Yunnan**, Jinghong, 9.iv.1981, Junhua He, Nos 711675 and 811752"; 2 ♂ (ZJUH), "[SW. China:] Yunnan, Lancang, 20.iv.1981, Junhua He, Nos 814341 and 814358"; 1 ♂ (ZJUH), "[SW. China:] Yunnan, Mangshi, 9.v.1981, Junhua He, No. 813202"; 1 ♀ (ZJUH), "[SW. China:] Yunnan, Menghai, 17.iv.1981, Junhua He, No.811752"; 1 ♀ (ZJUH), "[SW. China:] Yunnan, Ruili, 4.v.1981, Junhua He, No. 815069"; 2 ♂ (ZJUH), id., but Mengxiu, 2–6.v.1981, Junhua He, Nos 813152 and 814057"; 2 ♀ (ZJUH), "[SW. China:] Yunnan, Tengchong, Jietouxiang, 11–12.vii.2006, Jie Zeng, Nos 20081636 and 20081839"; 1 ♀ (ZJUH), "[SW. China:] Yunnan, Youle Mts, 11.iv.1981, Junhua He, No. 811923"; 2 ♀ (ZJUH), "[SW. China:] Yunnan, Yuanjiang, 4.iv.1981, Junhua He, Nos 811414 and 811428"; 1 ♀ (ZJUH), "[E. China:] **Zhejiang**, Anji, Longwang Mts, 31.viii.1993, Xuexin Chen, No. 939738"; 1 ♀ (ZJUH), id., but 28.vii.1996, Hong Wu, No. 970389"; 1 ♀ (ZJUH), "[E. China:] Zhejiang, Gutian Mts, 1.viii.1990, Yun Ma, No. 906143"; 1 ♀ (ZJUH), "[E. China:] Zhejiang, Lin'an, Qingliangfeng Mts, 9.viii.2005, Hongying Zhang, No. 200607118"; 1 ♀ (ZJUH), "[E. China:] Zhejiang, Longquan, Fengyang Mts, 22–24.vii.1982, Qisheng Song, No. 826576"; 1 ♀ (ZJUH), "[E. China:] Zhejiang, Tianmu Mts, 21.vii.1987, Xuexin Chen, No.873064"; 1 ♀ (ZJUH), id., but 18.vi.1983, Yun Ma, No.831156; 2 ♀ (ZJUH), id., but Zuhua Shi, Nos 830471 and 830473; 1 ♀ 1 ♂ (ZJUH), id., but Junhua He, Nos 830703 and 830708; 1 ♀ (ZJUH), id., but 11.vi.1993, Yun Ma, No. 934354; 1 ♀ (ZJUH), id., but 20.vii.1987, Xuexin Chen, No. 872088; 2 ♀ (ZJUH), id., but 4.vi.1994, Xuexin Chen, Nos 941900 and 941912; 5 ♀ (ZJUH), id., but 1.vii.2000, Xuexin Chen, Nos 20032047, 20032048, 20032050, 20032059 and 20032079; 1 ♀ (ZJUH), id., but Chanyuan Temple, 16.v.1988, Xuexin Chen, No. 882029; 1 ♀ (ZJUH), id., but Xiaoming Lou, No. 883224; 5 ♀(ZJUH), id., but 31.v.1998, Xuexin Chen, Nos 980067, 980149, 980158, 980504 and 980520; 1 ♀ (ZJUH), id. but Jinjing Fan, No. 884351; 2 ♀ 1 ♂ (ZJUH), id., but Laodian-Xianrending, 17–18.v.1988, Xuexin Chen, Nos 884383, 882587 and 891615; 1 ♀ (ZJUH), id., but Laodian, 13.vi.1998, Xuexin Chen, No. 980685; 2 ♀ (ZJUH), id., but Mingshui Zhao, Nos 20000806 and 20002334; 1 ♀ (ZJUH), id., but Sanmuping, 30.vii.1998, Mingshui Zhao, No. 999219; 1 ♀ (ZJUH), id., but Xianrending, 2–4.vi.1990, Yonggen Lou, No. 900124; 1 ♀ (ZJUH), id., but 3.vii.2000, Weidi Li, No. 200104179.

Comparative diagnosis. As aptly indicated by its name the female lectotype of *P. cyclogaster* has the metasoma nearly circular because of the strongly transverse second and third tergites. Best to recognise by the scutellar subapical prominence, more or less developed smooth bump in front of anterior ocellus and pit behind stemmaticum, the laterally distinctly setose scutellum and the more or less distinctly micro-sculptured medio-posterior area of scutellum. According to the key by Fischer (1972) closely related to *P. nilotica* (Schmiedeknecht, 1900) from Egypt and Israel. However, the given differences (propodeum with bifurcate carina in *P. cyclogaster* and without in *P. nilotica*, and head mesosoma and base of metasoma mainly black in *P. cyclogaster* and reddish yellow in *P. nilotica*) are variable in the specimens examined and the possibility that *P. nilotica* is a pale southern form of *P. cyclogaster* should be considered.

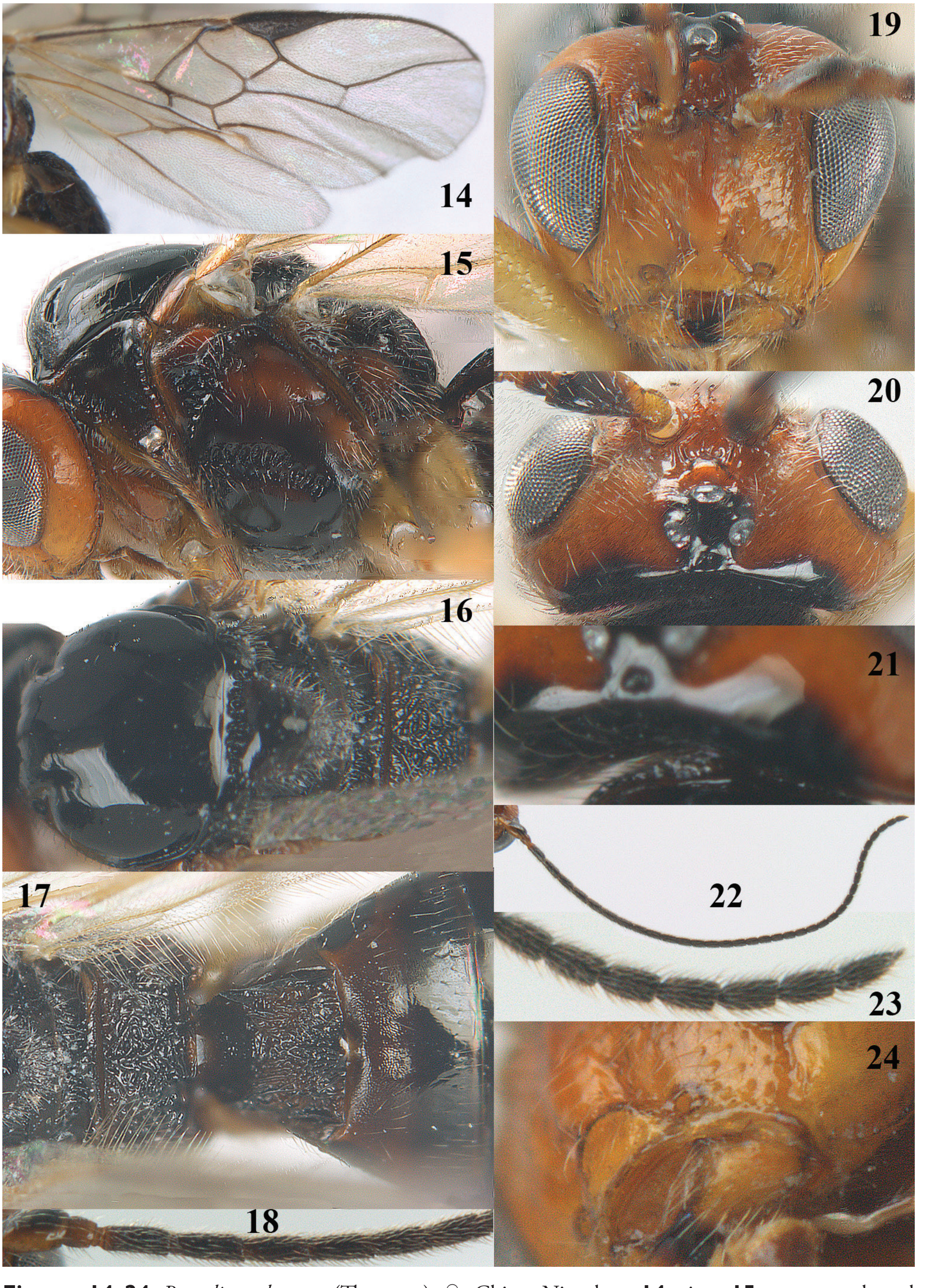
According to Fischer (1972, 1987) *P. nilotica* should have the precoxal sulcus narrow and the sulcus remains removed from the anterior border of the mesopleuron; this may allow a separation. In the key by Fischer (1987) *P. cyclogaster* runs to two S. African species: *P. vittator* (Brues, 1926) if bifurcate carina of propodeum is well developed and *P. prothoracalis* (Fischer, 1972) if carina is weakly developed or absent. Both species have the eye 1.5–1.6 times as long as temple in dorsal view (*vs* 2.5–5 times in *P. cyclogaster*) and, additionally, *P. prothoracalis* differs from both other species by the narrow, finely crenulate and long sinuate precoxal sulcus (*vs* medially wide, shorter and coarsely crenulate sulcus).

Description. Redescribed ♀ from Shaanxi (Ningshan), length of body 3.9 mm, of fore wing 4.2 mm.

Head. Antenna with 36 segments and 1.1 times as long as fore wing; third segment as long as fourth segment, length of third, fourth and penultimate segments 3.3, 3.2 and 1.3 times their width, respectively (Figs 18, 23); length of maxillary palp 1.1 times height of head; length of eye in dorsal view 1.6 times temple (Fig. 20); temple in dorsal view shiny, smooth and with sparse setae; OOL: diameter of ocellus: POL = 18:7:10; area behind stemmaticum with a round depression and in front of anterior ocellus with a bump (Fig. 8); face largely smooth, with satin sheen and sparsely punctulate with a medio-longitudinal convexity dorsally and widened ventrally (Fig. 19); frons depressed behind antennal sockets, slightly shiny, glabrous and crenulate (Fig. 20); labrum depressed; clypeus nearly trapezoid, flat, and its ventral margin nearly straight and thin (Fig. 19); width of clypeus 1.9 times its maximum height and 0.4 times width of face; hypoclypeal depression wide and deep (Figs 19, 24); malar suture present, punctate between malar suture and clypeus (Fig. 24); mandible somewhat twisted and narrowed apically and normal basally, with narrow ventral carina (Fig. 24); occipital carina widely removed from hypostomal carina and dorsally absent; hypostomal carina narrow.

Mesosoma. Length of mesosoma 1.2 times its height; dorsal pronope absent (Fig. 20); pronotal side largely smooth, but anterior and posterior grooves present and coarsely crenulate (Fig. 15); epicnemial area crenulate dorsally; precoxal sulcus medially wide and coarsely crenulate, complete (Fig. 15); remainder of mesopleuron sparsely and finely punctate; pleural sulcus finely crenulate ventrally; mesosternal sulcus shallow and crenulate; postpectal carina absent; mesoscutum very shiny and glabrous (Fig. 16); notauli only anteriorly as pair of nearly smooth impressions and absent on disc; scutellar sulcus deep and with short crenulae, widened medially; scutellum distinctly convex and smooth, but medio-posteriorly longitudinally rugulose (Fig. 17); metanotum with a short longitudinal carina medially; surface of propodeum coarsely rugose and without an obvious medio-longitudinal carina (but bifurcate carina slightly indicated; Fig. 17) and anterior groove somewhat widened medially (Fig. 16).

Wings. Fore wing: 1-SR distinctly longer than wide and linear with 1-M (Fig. 14); pterostigma elongate triangular (Fig. 14); 1-R1 ending before wing apex and 1.5 times as long as pterostigma (Fig. 14); r long; r-m not tubular; r:3-SR:SR1 = 5:18:38; 2-SR:3-SR:r-m = 2:3:1; 1-M slightly curved near pterostigma and SR1 more or less straight; m-cu distinctly postfurcal and slightly curved; cu-a distinctly postfurcal and



Figures 14–24. *Psyttalia cyclogaster* (Thomson), ♀, China, Ningshan. **14** wings **15** mesosoma lateral **16** mesosoma dorsal **17** propodeum and first–third metasomal tergites dorsal **18** base of antenna **19** head anterior **20** head dorsal **21** detail of posterior part of head and pronotum dorsal **22** antenna **23** apex of antenna **24** mandible antero-lateral.

Figures 25–27. *Psyttalia cyclogaster* (Thomson), ♀, China, Ningshan. **25** hind leg lateral **26** hypopygium lateral **27** head lateral.

1-CU1 widened; 1-CU1:2-CU1= 5:11; first subdiscal cell closed; CU1b short; only apex of M+CU1 sclerotized. Hind wing: 1-M straight; M+CU:1-M:1r-m = 14:13:10; cu-a straight; m-cu absent.

Legs. Length of femur, tibia and basitarsus of hind leg 4.2, 8.8 and 4.5 times as long as width, respectively (Fig. 25); hind femur and tibia with long setae.

Metasoma. Length of first tergite equal to its apical width, rather flat, its surface strongly and densely punctate-rugose (Fig. 17); second suture slightly indicated; second and following tergites smooth (except some superficial granulation), shiny and sparsely setose; combined length of second and third metasomal tergites 0.3 times total length of metasoma; length of setose part of ovipositor sheath 0.47 times fore wing, 3.5 times first tergite and 1.5 times hind tibia; hypopygium about 0.5 times as long as metasoma and distinctly acute apically (Fig. 26).

Colour. Black; head (including mandible) and propleuron yellowish brown, but teeth of mandible, stemmaticum and back of head dorsally black; scapus ventrally and tegula brown; pronotum ventrally, mesopleuron posteriorly and antero-dorsally, and metapleuron brown; palpi infuscate; humeral plate and legs yellowish, but tarsi brown; pterostigma and veins dark brown; laterally hypopygium brown and medially dark brown; fore wing membrane slightly infuscate.

Variation. Length of fore wing 2.4–4.2 mm; antenna of ♀ with 26(1), 28(1), 29(3), 34(1), 36(1), 37(1) and 38(1) segments; frons sculptured to often entirely smooth; hind femur 3.5–4.2 times as long as wide; first tergite 1.0–1.2 times as long as wide apically; setose part of ovipositor sheath 0.43–0.57 times as long as fore wing and 1.3–1.8 times hind tibia; second tergite entirely shiny granulate to (often entirely) smooth; head mainly black (except orbita) to nearly entirely orange or yellowish brown (except posteriorly), mesoscutum and mesopleuron largely black to entirely orange or yellowish brown; metasoma black to dark brown, sometimes first and second tergites brownish yellow or first tergite brown and second yellow or dark brown.

Variation of types series. The synonymy of *Coeloreuteus formosanus* Watanabe is based on photos of its holotype kindly supplied by Andrew Liston (SDEI); it is a pale specimen (with the head and the mesosoma mainly yellowish brown and the hind femur about 3.5 times as long as wide) having all the characteristics of *P. cyclogaster* as listed in the key. The only differences concern the paler head and mesosoma, smooth scutellum posteriorly and the more retracted (but equally long) hypopygium; these are considered insufficient for retaining it as valid species (both colour and sculpture are too variable in this species). *Rhogadopsis longicaudifera* Li & van Achterberg belongs also to this extreme form and is, therefore, also synonymized. *P. proclivis* (Papp) has first tergite of holotype only 1.1 times longer than its apical width (not 1.4 or 1.5 times as indicated by Papp (1981), Fischer (1989) and Tobias (1998)) and fits the diagnosis despite having the first tergite rather smooth. It shares this with *P. subcyclogaster* (Tobias) and both are rather small (length of body 2.0–2.7 mm and antenna with 28–29 segments). The holotype of *P. darasunica* (Tobias) differs mainly by the mainly black head and mesosoma, its rather small size, and having 29 antennal segments. In *P. cyclogastroides* (Tobias) the head and the mesosoma are partly brownish, the type specimens are larger and have 39 antennal segments. Finally, *P. extensa* Weng & Chen shares the micro-sculptured and setose medio-posterior area of scutellum (fig. 242 in Weng and Chen 2005), the frontal protuberance and the flattened medium-sized clypeus (Fig. 241, l.c.). The reported basally widened mandible is actually normal as shown on photographs of the holotype taken by Min-Lin Zheng (Fuzhou); it has only a ventro-basal carina.

Distribution. France, Kazakhstan, Russia Far East (as *cyclogastroides*, *darasunicus* and *subcyclogaster*) Korea (as *proclivis*), China (Fujian (as *extensa*), *Guangdong, *Guangxi, *Hainan, *Henan, *Hebei, Hunan (as *longicaudifera*), Jilin (as *extensa*), *Liaoning, *Shaanxi, *Sichuan, Taiwan, *Yunnan, *Zhejiang), Japan (new record).

Biology. Unknown.

Psyttalia fletcheri (Silvestri, 1916)

Opius fletcheri Silvestri, 1916: 163–164; Wharton and Gilstrap 1983: 738.
Psyttalia (*Psyttalia*) *fletcheri*: Quicke et al. 1997: 25.
Psyttalia fletcheri: Wharton 1997: 23, 2009: 353; Fischer and Madl 2008: 1479–1480. Not Yao et al. (2008).

Comparative diagnosis. *Psyttalia fletcheri* shares with the very similar *P. makii* and *P. incisi* the long vein r of fore wing (Fig. 28), the short temple (Fig. 32), vein 2-SR+M of fore wing distinctly widened (Fig. 28) and the antenna largely brownish yellow. Differs from

P. incisi by the short vein 2-SR+M of fore wing (about twice as long as wide *vs* 3.5–4.0 times in *P. incisi*) and the strongly curved vein m-cu of fore wing (*vs* weakly curved or straight in *P. incisi*). Very similar to *P. makii*, but *P. fletcheri* has vein r of fore wing about as long as vein 2-SR (*vs* about 0.8 times vein 2-SR in *P. makii*) and vein 1-CU1 of fore wing at most 0.7 times as long as vein cu-a (*vs* about of equal length in *P. makii*).

Distribution. Australia (Queensland), India, Indonesia, Malaysia, Réunion, Sri Lanka and Thailand. Introduced in Brazil, China (Taiwan), Fiji, Guam, Japan (Ryukyu Isl.), Philippines, Puerto Rico and U.S.A. (Hawaii, Florida).

Biology. Parasitoid of Tephritidae: probably only of *Dacus* spp.; other reported hosts may be based on incorrect identification of the parasitoid (confusion with *P. incisi*) and/or host-relationship (Wharton and Gilstrap 1983). The male of *P. fletcheri* reported from mainland China (Guangdong) by Yao et al. (2008) reared from *Bactrocera dorsalis* (Hendel) is obviously misidentified. It is a species near *P. majocellata* sp. n., but differs by the short and widened vein 1-SR of the fore wing, the wider first subdiscal cell of fore wing, the dark brown pterostigma and the less sculptured frons.

***Psyttalia incisi* (Silvestri, 1916)**

Figs 28–32

Opius incisi Silvestri, 1916: 164–165; Beardsley 1961: 357; Wharton and Gilstrap 1983: 738; Ji et al. 2004: 144–145.
Psyttalia incisi: Wharton 1997: 23, 2009: 353.

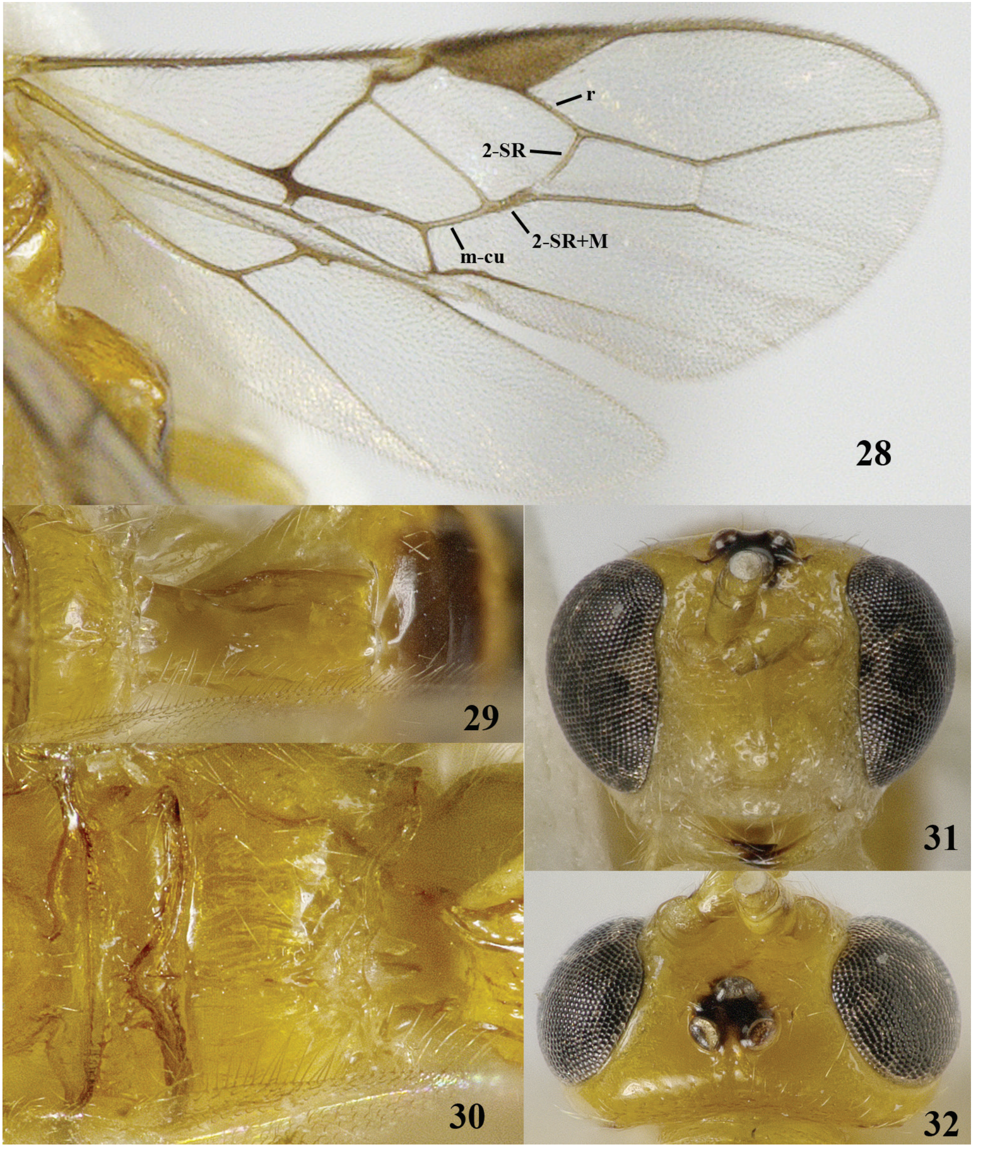
Material. 4 ♀ 4 ♂ (RMNH, ZJUH), "S. **China**: **Fujian**, Fuzhou, reared in lab for release, 6.vi.2012, C. v. Achterberg, RMNH'12, *Psyttalia incisi* (Silvestri)". The released reared specimens originate from locally collected stock (Ji et al. 2004).

Comparative diagnosis. *Psyttalia incisi* shares with the very similar *P. makii* and *P. fletcheri* the long vein r of fore wing (Fig. 28) and the short temple (Fig. 32). *Psyttalia incisi* can be separated by having vein 2-SR+M of fore wing 3.5–4.0 times as long as wide (Fig. 28; *vs* about twice as long as wide in *P. makii* and *P. fletcheri*) and vein m-cu of fore wing weakly curved or straight (*vs* strongly curved in *P. makii* and *P. fletcheri*).

Distribution. China (Fujian), India, Malaysia, Thailand, Philippines (Luzon). Introduced in U.S.A. (Hawaii, Florida), Mexico, Fiji, Guam and Australia (New South Wales, Queensland, Western Australia) (Yu et al. 2012).

Biology. Parasitoid of Tephritidae: *Carpomyia vesuvuana* Costa, *Bactrocera carambolae* Drew & Hancock, *B. correcta* (Bezzi), *B. cucurbitae* (Coquillet), *B. dorsalis* (Hendel), *B. incisa* (Walker), *B. latifrons* (Hendel), *B. papayae* Drew & Hancock, *B. tuberculata* (Bezzi), *Ceratitis capitata* (Wiedemann) and *Dacus ciliatus* Loew.

Notes. The series reared in the lab has either the basal half of pterostigma entirely dark brown and similar to its apical half (Fig. 28; males) or its basal half is yellow and contrasting with its dark brown apical half (females). The latter is considered to be typical (Wharton and Gilstrap 1983) but can be used only for females.



Figs 28–32. *Psyttalia incisi* (Silvestri), ♂, China, Fujian. **28** wings **29** first metasomal tergite dorsal **30** propodeum dorsal **31** head anterior **32** head dorsal.

Psyttalia latinervis Wu & van Achterberg, sp. n.

http://zoobank.org/27F0CC72-A3A3-40D8-B672-D3F6AAA3BA60

Figs 33–43

Type material. Holotype, ♂ (ZJUH), "[S. **China**:] **Hainan**, Bawangling Mts, 24–25.v.2007, Jingxian Liu, No. 200702714".

Figure 33. *Psyttalia latinervis* sp. n., ♂, holotype, habitus lateral.

Comparative diagnosis. Easily recognizable species, because of the unique long, widened and slightly curved vein 1-CU1 of the fore wing (Fig. 35) in combination with the largely unsclerotized vein 1-SR+M, the widened but short vein 2-SR+M, and parallel veins m-cu and 1-M of the fore wing (Fig. 35).

Description. Holotype, ♂, length of body 3.5 mm, of fore wing 2.8 mm.

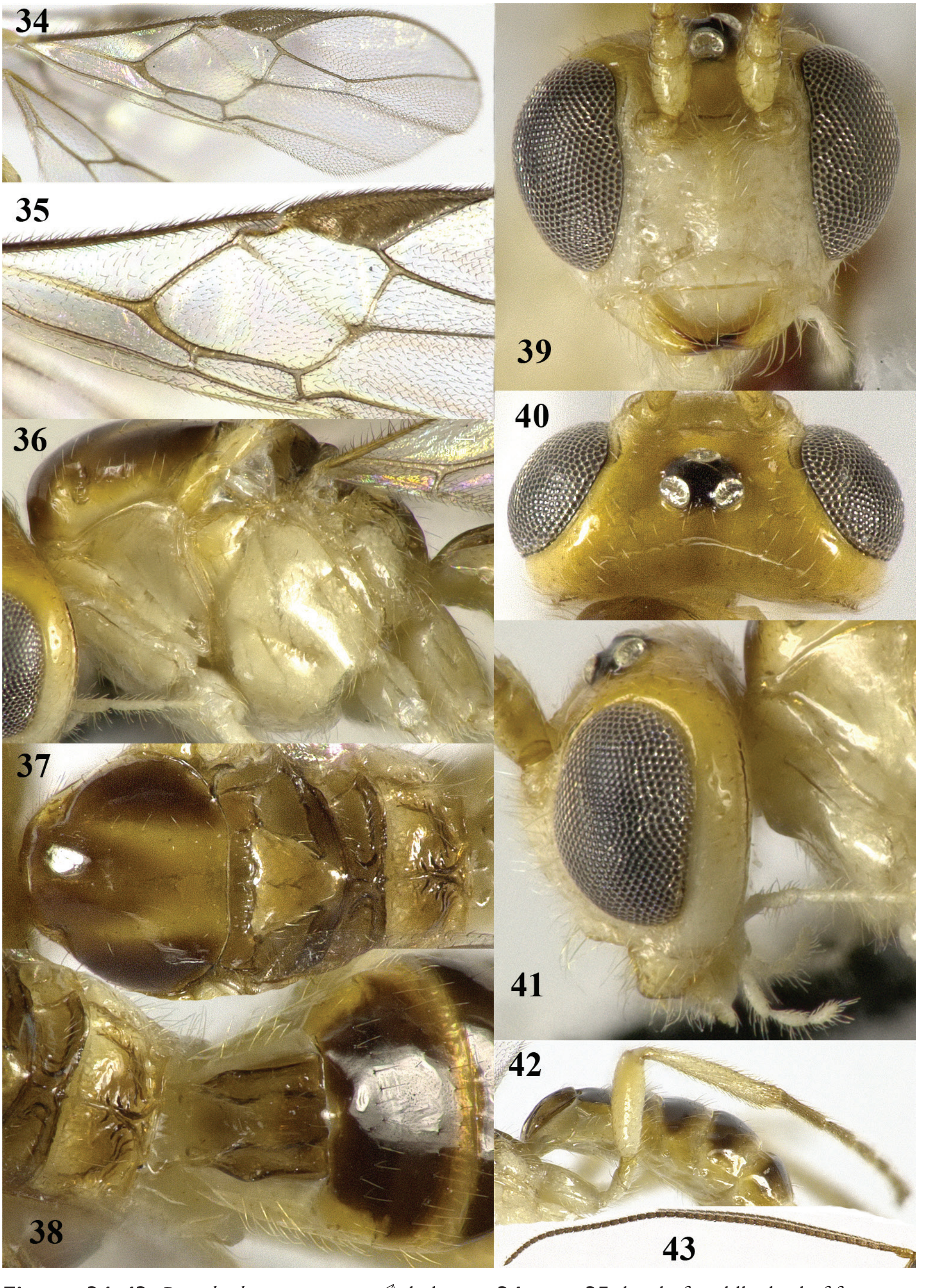
Head. Antenna with 43 segments, bristly and rather adpressed setose and 1.7 times as long as fore wing; third segment 1.4 times as long as fourth segment, length of third, fourth and penultimate segments 3.0, 2.2 and 1.8 times their width, respectively (Fig. 43); length of maxillary palp 0.9 times height of head; length of eye in dorsal view 3.2 times temple (Fig. 40); temple shiny, smooth except for some punctures posteriorly and with sparse setae; OOL: diameter of ocellus: POL = 45:22:30; area behind stemmaticum reclivous (Fig. 40); face coarsely punctate with interspaces about equal to diameter of punctures and with satin sheen (Fig. 39); frons slightly depressed behind antennal sockets and in front of anterior ocellus, shiny, smooth and glabrous but laterally setose and punctulate (Fig. 40); labrum nearly flat; clypeus transverse, convex, and its ventral margin truncate and thin (Fig. 39); width of clypeus 3.5 times its maximum height and 0.8 times width of face; hypoclypeal depression wide and deep (Figs 39, 41); malar suture largely absent; malar space 0.4 times longer than basal width of mandible and area micro-sculptured (Fig. 41); mandible not twisted, apically moderately narrowed and with both teeth wide, normal basally and with narrow ventral carina (Fig. 41); occipital carina remains far removed from hypostomal carina and dorsally largely absent; hypostomal carina medium-sized ventrally.

Mesosoma. Length of mesosoma 1.2 times its height; pronope absent, only with groove; pronotal side largely smooth, but anterior and posterior grooves present and posteriorly with some crenulae (Fig. 36); propleuron flattened; epicnemial area smooth dorsally; precoxal sulcus only medially present and moderately crenulate (Fig. 36); remainder of mesopleuron smooth and shiny; pleural sulcus smooth ventrally; mesosternal sulcus shallow, narrow and finely crenulate; postpectal carina absent; mesoscutum very shiny and nearly entirely glabrous (Fig. 37); notauli only anteriorly as pair of partly finely crenulate impressions and absent on disc; scutellar sulcus deep and with 7 short crenulae, parallel-sided medially; scutellum slightly convex and smooth, only laterally sparsely setose (Fig. 37); metanotum with short longitudinal carina anteromedially and short carina posteriorly (Figs 37–38); surface of propodeum smooth, except for crenulae near reversed Y-shaped median carina and with short lateral crenulate groove above spiracle (Figs 37–38).

Wings. Fore wing: 1-SR as long as wide and linear with 1-M; pterostigma triangular and r not linear with postero-basal border (Fig. 34); 1-R1 ending at wing apex and 1.7 times as long as pterostigma; r linear with 3-SR and medium-sized; r-m and most of 1-SR+M unsclerotized; r:3-SR:SR1 = 5:29:56; 2-SR:3-SR:r-m = 15:29:7; 1-M straight and SR1 slightly curved; m-cu narrowly antefurcal and slightly curved, subparallel with 1-M (Fig. 35); 2-SR+M short and widened; cu-a short, vertical and far postfurcal; 1-CU1 curved and widened; 1-CU1:2-CU1= 15:24; first subdiscal cell widened apically and closed, CU1b medium-sized; only apex of M+CU1 sclerotized. Hind wing: 2-M slightly sinuate; M+CU:1-M:1r-m = 20:21:10; cu-a straight; m-cu and SR absent.

Legs. Length of femur, tibia and basitarsus of hind leg 4.2, 7.8 and 4.2 times as long as width, respectively (Fig. 42); hind femur with long setae.

Metasoma. Length of first tergite 1.4 times its apical width, convex medio-posteriorly, its surface largely smooth except some sculpture subposteriorly (Fig. 38), dorsal carinae strong in basal half of tergite and with depressed area below; second suture not



Figures 34–43. *Psyttalia latinervis* sp. n., ♂, holotype. **34** wings **35** detail of middle third of fore wing **36** mesosoma lateral **37** mesosoma dorsal **38** propodeum and first–third metasomal tergites dorsal **39** head anterior **40** head dorsal **41** head lateral **42** hind leg **43** antenna.

indicated; basal depressions of second tergite deep and elliptical; second tergite 0.7 times as long as third tergite; second and following tergites smooth, shiny and sparsely setose; combined length of second and third metasomal tergites 0.35 times total length of metasoma.

Colour. Ivory or white; head dorsally (but stemmaticum black), scapus, pedicellus, V-shaped patch on mesoscutum, mesoscutum laterally, tegulae, scutellum largely and apical margin of third–seventh tergites yellow; remainder of antenna brown with apices of segments dark brown; scutellum posteriorly, metanotum and propodeum brownish; remainder of mesoscutum and of second–seventh tergites dorsally, pterostigma and veins dark brown; wing membrane subhyaline.

Distribution. China (Hainan).

Biology. Unknown.

Etymology. From "latus" (Latin for "wide") and "nervus" (Latin for "nerve, vein") because of the widened vein 1-CU1 of the fore wing.

Psyttalia majocellata **Wu & van Achterberg, sp. n.**

http://zoobank.org/625ACC7F-A65D-4B4A-99D7-F611807B8EC6

Figs 44–64

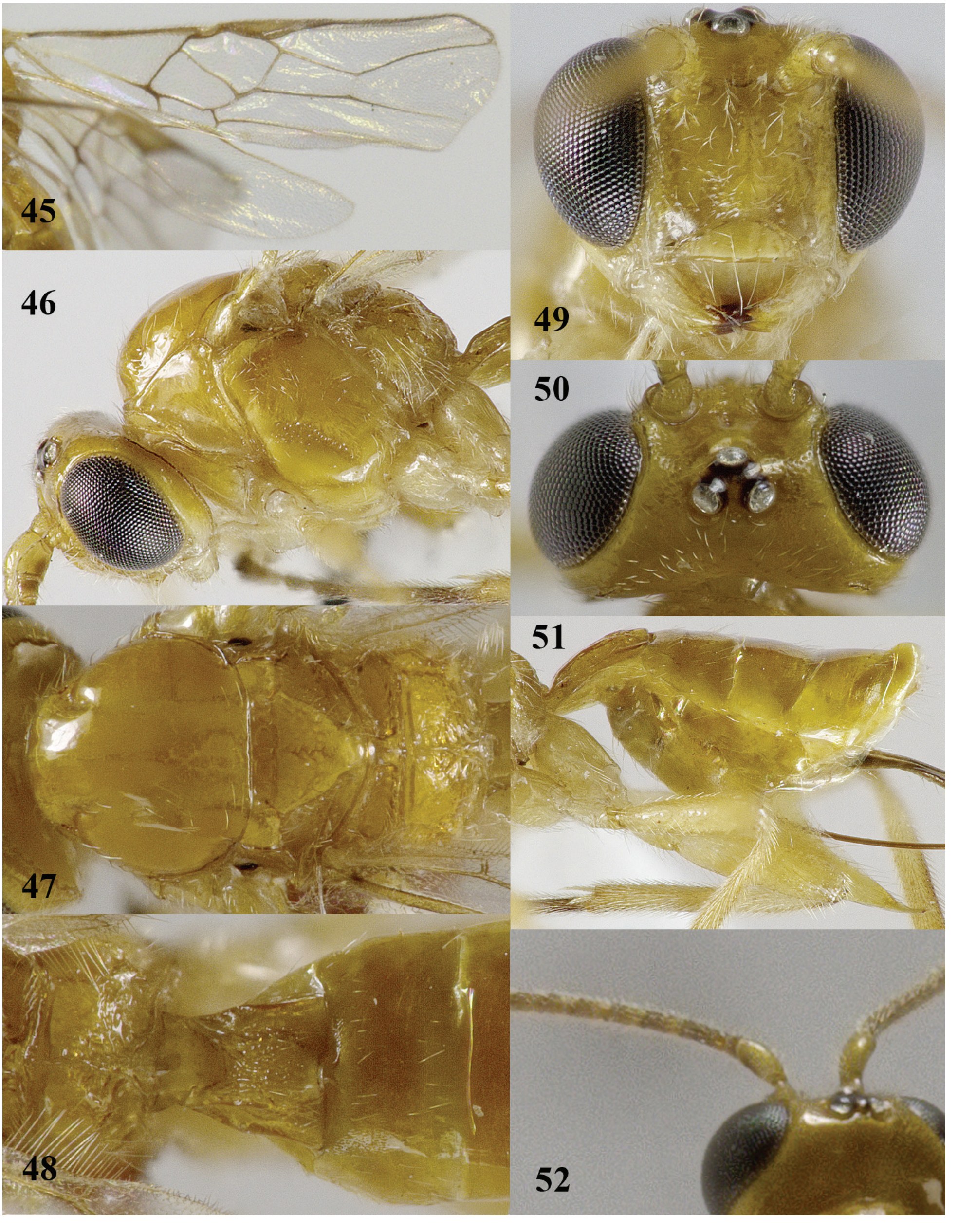
Type material. Holotype, ♀ (ZJUH), "[S. **China**:] **Hainan**, Bawangling Mts, 28.v.-3.vi. 2007, Liqiong Weng, No. 200804217". Paratypes (2 ♀ 2 ♂): 1 ♀ 2 ♂ (ZJUH, RMNH), id., but 9–10.vi.2007, Jingxian Liu, Nos 200703438, 200703465 and 201503525; 1 ♀ (ZJUH), "[SW. China:] **Guizhou**, Mayanghe river, 1–3.x.2007, Jingxian Liu, No. 200709564".

Comparative diagnosis. The new species runs in the key to the subgenus *Psyttalia* by Fischer (1987) to the Oriental *P. walkeri* (Muesebeck, 1931). The new species differs by having a short median carina on the propodeum, bifurcated medially and posterior half of propodeum with crenulae (Fig. 48; *vs* median carina long, bifurcated apically and posteriorly smooth in *P. walkeri*), POL equal to diameter of posterior ocellus (*vs* smaller), face and mesosoma similarly yellow (Fig. 46; *vs* face pale yellow, different from reddish yellow mesosoma), second tergite smooth (*vs* superficially granulate) and first tergite slightly longer than wide apically (Fig. 48; *vs* about 1.3 times). The new species can be easily confused with pale *P. carinata* (Thomson). The new species differs by having larger ocelli (OOL 1.2–1.7 times diameter of posterior ocellus and POL 0.8–1.0 times diameter of ocellus (Fig. 50) *vs* OOL 2.0–2.4 times diameter of posterior ocellus and POL slightly longer than diameter of ocellus in *P. carinata* (Fig. 8)), frons and vertex laterally punctate (*vs* largely smooth), vein 2-SR+M of fore wing 0.6–0.8 times as long as vein m-cu (*vs* about 0.4 times), second tergite half as long as third tergite (vs 0.8-0.9 times), first discal cell more transverse (*vs* transverse), base of hind tibia dark brown (*vs* brownish yellow) and distributed N. Oriental (*vs* Palaearctic). See note under *P. carinata* about a similar species from S. China.

Description. Holotype, ♀, length of body 3.3 mm, of fore wing 3.2 mm.

Figure 44. *Psyttalia majocellata* sp. n., ♀, holotype, habitus lateral.

Head. Antenna with 40+ segments (apical segments missing), bristly and rather erect setose and at least 1.3 times as long as fore wing; third segment 1.2 times as long as fourth segment, length of third and fourth penultimate segments 3.2 and 2.6 times their width, respectively (Fig. 44); maxillary palp 1.1 times as long as height of head; length of eye in dorsal view 3.9 times temple (Fig. 50); temple shiny, smooth except for some punctulation posteriorly and with sparse setae; OOL: diameter of ocellus: POL = 22:13:13; area behind stemmaticum reclivous (Fig. 50); face coarsely punctate with interspaces about equal to diameter of punctures and with satin sheen (Fig. 49); frons slightly depressed behind antennal sockets and with triangular depression between antennal sockets, shiny, smooth and glabrous but laterally (as vertex)



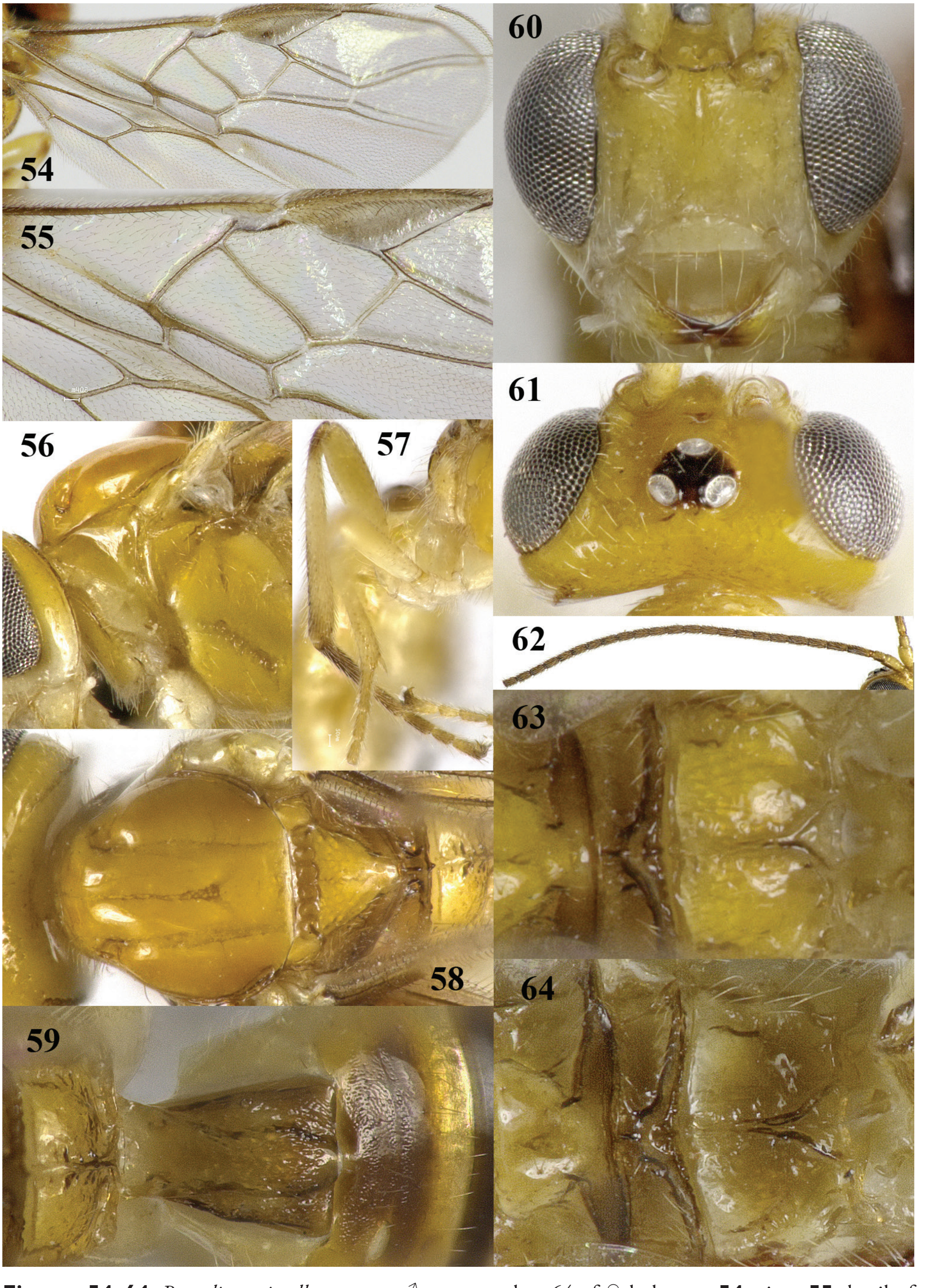
Figures 45–52. *Psyttalia majocellata* sp. n., ♀, holotype. **45** wings **46** head and mesosoma lateral **47** mesosoma dorsal **48** propodeum and first–third metasomal tergites dorsal **49** head anterior **50** head dorsal **51** hind femur and hypopygium lateral **52** base of antenna.

setose and punctate (Fig. 50); labrum nearly flat; clypeus transverse, convex, punctate and its ventral margin truncate and thin (Fig. 49); width of clypeus 2.7 times its maximum height and 0.7 times width of face; hypoclypeal depression wide and deep

Figure 53. *Psyttalia majocellata* sp. n., ♂ paratype, habitus lateral.

(Fig. 49); malar suture largely absent; malar space 0.4 times longer than basal width of mandible and punctate; mandible not twisted, apically moderately narrowed and with both teeth wide, normal basally and with narrow ventral carina; occipital carina remains far removed from hypostomal carina and dorsally absent; hypostomal carina medium-sized ventrally.

Mesosoma. Length of mesosoma 1.4 times its height; pronope absent and only with groove; pronotal side largely smooth, but anterior and posterior grooves present, anteriorly and posteriorly with some crenulae (Fig. 46); propleuron flattened; epicnemial area smooth dorsally; precoxal sulcus moderately punctate-crenulate, absent posteriorly and nearly complete anteriorly (Fig. 46); remainder of mesopleuron smooth (except for band of fine punctures medially) and shiny; pleural sulcus smooth ventrally; mesosternal sulcus medium-sized and moderately crenulate; postpectal carina absent; mesoscutum very shiny and nearly entirely glabrous (Fig. 47); notauli only anteriorly as pair of partly finely crenulate impressions and absent on disc; scutellar sulcus deep and with 4 short crenulae, parallel-sided medially; scutellum slightly convex and smooth, only laterally sparsely setose (Fig. 47); metanotum with short longitudinal carina antero-medially and finely crenulate posteriorly (Fig. 47); surface of propodeum smooth, except for crenulae near reversed Y-shaped median carina (median carina part rather short), distinctly depressed posteriorly near triangular areola and with lateral crenulate groove above spiracle (Fig. 48).



Figures 54–64. *Psyttalia majocellata* sp. n., ♂ paratype, but 64 of ♀ holotype. **54** wings **55** detail of middle third of fore wing **56** mesosoma lateral **57** hind leg **58** mesosoma dorsal **59** propodeum and first–third metasomal tergites dorsal **60** head anterior **61** head dorsal **62** antenna **63–64** metanotum and propodeum dorsal.

Wings. Fore wing: 1-SR about 4 times longer than wide and linear with 1-M; pterostigma triangular and r linear with postero-basal border (Figs 45, 55); 1-R1 ending at wing apex and 1.7 times as long as pterostigma; r linear with 3-SR and medium-sized; r-m unsclerotized; 1-SR+M narrow and sclerotized; r:3-SR:SR1 = 2:9:16; 2-SR:3-SR:r-m = 23:45:13; 1-M straight and SR1 slightly curved; m-cu far antefurcal and straight, converging to 1-M (Fig. 45); 2-SR+M rather long and narrow (Fig. 55); cu-a medium-sized, oblique and far postfurcal; 1-CU1 straight and widened; 1-CU1:2-CU1= 15:24; first subdiscal cell widened apically and closed, CU1b medium-sized; only apex of M+CU1 sclerotized. Hind wing: 2-M slightly sinuate; M+CU:1-M:1r-m = 5:5:3; cu-a straight; m-cu and SR absent.

Legs. Length of femur, tibia and basitarsus of hind leg 3.5, 8.6 and 5.6 times as long as width, respectively (Fig. 42); hind femur with rather long setae.

Metasoma. Length of first tergite 1.1 times its apical width, convex medio-posteriorly, its surface largely finely rugose (Fig. 48), dorsal carinae strong in basal 0.7 of tergite and with depressed area below; second suture slightly indicated; basal depressions of second tergite deep and elliptical; second tergite 0.5 times as long as third tergite; second partly superficially coriaceous and following tergites smooth, shiny and sparsely setose; combined length of second and third metasomal tergites 0.25 times total length of metasoma; length of setose part of ovipositor sheath 0.47 times fore wing, as long as metasoma, 3.2 times first tergite, twice hind femur and 1.5 times hind tibia; hypopygium about 0.5 times as long as metasoma, distinctly acute apically and reaching apex of metasoma (Fig. 51).

Colour. Brownish yellow; stemmaticum black; antenna (except scapus and pedicellus but with dark patch on outer side, third segment darker than fourth one and apical segments becoming paler), ovipositor sheath, base of hind tibia and hind tarsus largely dark brown; tegulae pale yellow; palpi and base of legs ivory; pterostigma pale brown with margins darkened (Fig. 45) and veins brown; wing membrane subhyaline.

Variation. Length of fore wing 2.9–3.3 mm; antenna of ♀ with 37–44 segments and 1.4–1.5 times as long as fore wing; OOL 1.2–1.7 times diameter of posterior ocellus and POL 0.8–1.0 times diameter of ocellus; first tergite 1.1–1.3 times as long as its apical width (Figs 48, 59); hind femur 3.4–3.8 times as long as wide; setose part of ovipositor sheath 0.45–0.47 times as long as fore wing and 1.4–1.5 times hind tibia; second tergite more or less coriaceous; pterostigma of ♂ somewhat darker than of ♀ (Fig. 55); posterior areola of propodeum short (♀) or elongate triangular (♂) with long and rather short median carina, respectively (Figs 63–64); second–sixth tergites of ♂ partly dark brown and first tergite infuscate (Figs 53, 59); ♀ from Guizhou has base of hind tibia yellowish, basal half of antenna mainly brownish yellow (including third segment), propodeum more sculptured, antenna with 37 segments and second tergite almost entirely smooth. Males have mesoscutum only slightly darker brown laterally than medially, without distinct pattern (Fig. 58).

Distribution. China (Hainan, Guizhou).

Biology. Unknown.

Etymology. From “major” (Latin for “larger”) and “ocellus” (Latin for “small eye”) because of the larger ocelli.

Psyttalia makii (Sonan, 1932)

Opius makii Sonan, 1932: 68–69; Wharton and Gilstrap 1983: 739.
Psyttalia makii: Wharton, 1997: 23.

Comparative diagnosis. Very similar to *P. fletcheri* because of the short vein 2-SR+M of fore wing (about twice as long as wide) and the strongly curved vein m-cu of fore wing. *Psyttalia makii* has vein r of fore wing about 0.8 times as long as vein 2-SR (about as long as vein 2-SR in *P. fletcheri*) and vein 1-CU1 of fore wing about as long as vein cu-a (at most 0.7 times as long as vein cu-a).

Distribution. China (Taiwan, type locality); Indonesia (Java); Malaysia (Peninsular), Philippines (Mindanao); Thailand; U.S.A. (Hawaii, introduced but not retrieved).

Biology. Parasitoid of Tephritidae: mainly reported from *Bactrocera* species (Yu et al. 2012).

Psyttalia romani (Fahringer, 1935)

Figs 65–76

Opius (*Marginopius*) *romani* Fahringer, 1935: 9.
Opius romani: Fischer 1961: 13–15 (redescription), 1972: 346–347.
Opius (*Psyttalia*) *romani*: Tobias 1998: 613.
Psyttalia romani: Tobias 2000: 12; Chen and Weng 2005: 152.

Material. 2 ♀ (ZISP), "[**Russia**:], Amurskaja oblast, s. Novorossijka, r. Selemdzha, 1–10.viii.1966, D. Kasparjan"; 1 ♀ (ZISP), "[Russia:], Primorskij kraj, okr. Nachodki, dubnjak kustarnik, 20.viii.1985, Belokobylskij"; 1 ♀ (ZISP), id., but Baradazh-Levada, 2.ix.1978, "*Opius romani* Fahr., det. Tobias 1994"; 1 ♀ (ZJUH), "[NW. **China**:] Shaanxi, Dasanguan, 4.ix.1999, Ping Cai, No. 200011724".

Comparative diagnosis. In the East Palaearctic region the only similar *Psyttalia* species known is *P. sakhalinica* (Tobias) because of the similar gradually narrowed head in dorsal view (Figs 72, 84). *Psyttalia romani* differs by having mesosoma orange brown, contrasting with mainly black metasoma (*vs* meso- and metasoma mainly black or dark brown in *P. sakhalinica*), hind femur 2.9–3.3 times as long as wide (*vs* 3.5–3.9 times), fore wing distinctly infuscate (*vs* slightly infuscate) and legs yellowish brown (*vs* brownish yellow).

Description. Redescribed after ♀ from Novorossijka, length of body 4.4 mm, of fore wing 4.4 mm.

Head. Antenna with 47 segments, bristly and erect setose and 1.4 times as long as fore wing; third segment 1.6 times as long as fourth segment, length of third, fourth and penultimate segments 3.4, 2.2 and 1.9 times their width, respectively (Figs 70, 75–76); length of maxillary palp equal to height of head; length of eye in dorsal view 2.2 times temple (Fig. 72); temple in dorsal view shiny, smooth and with sparse setae;

65

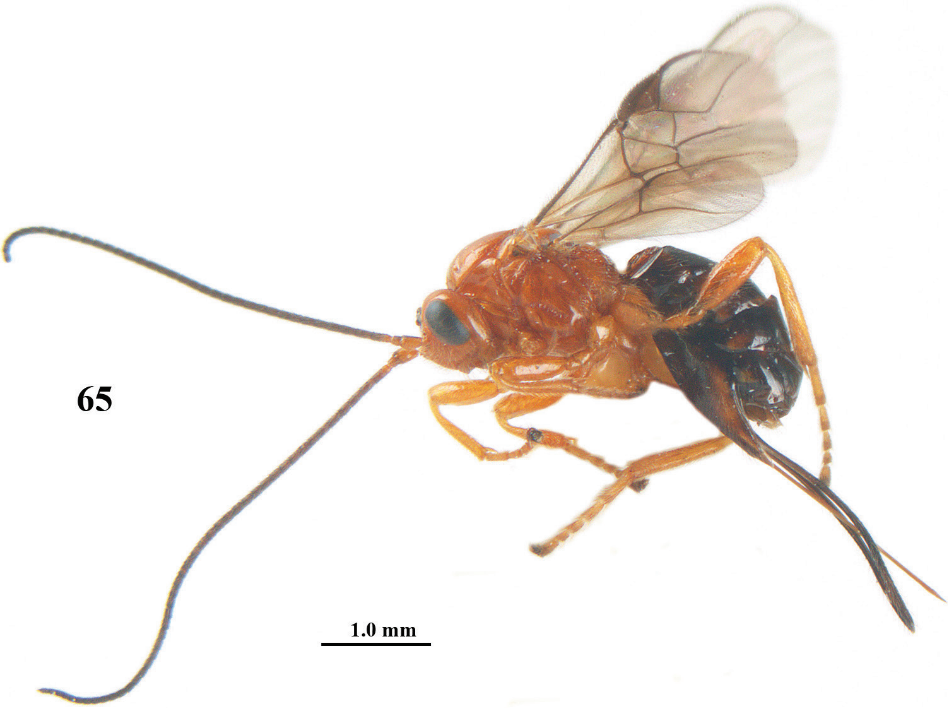
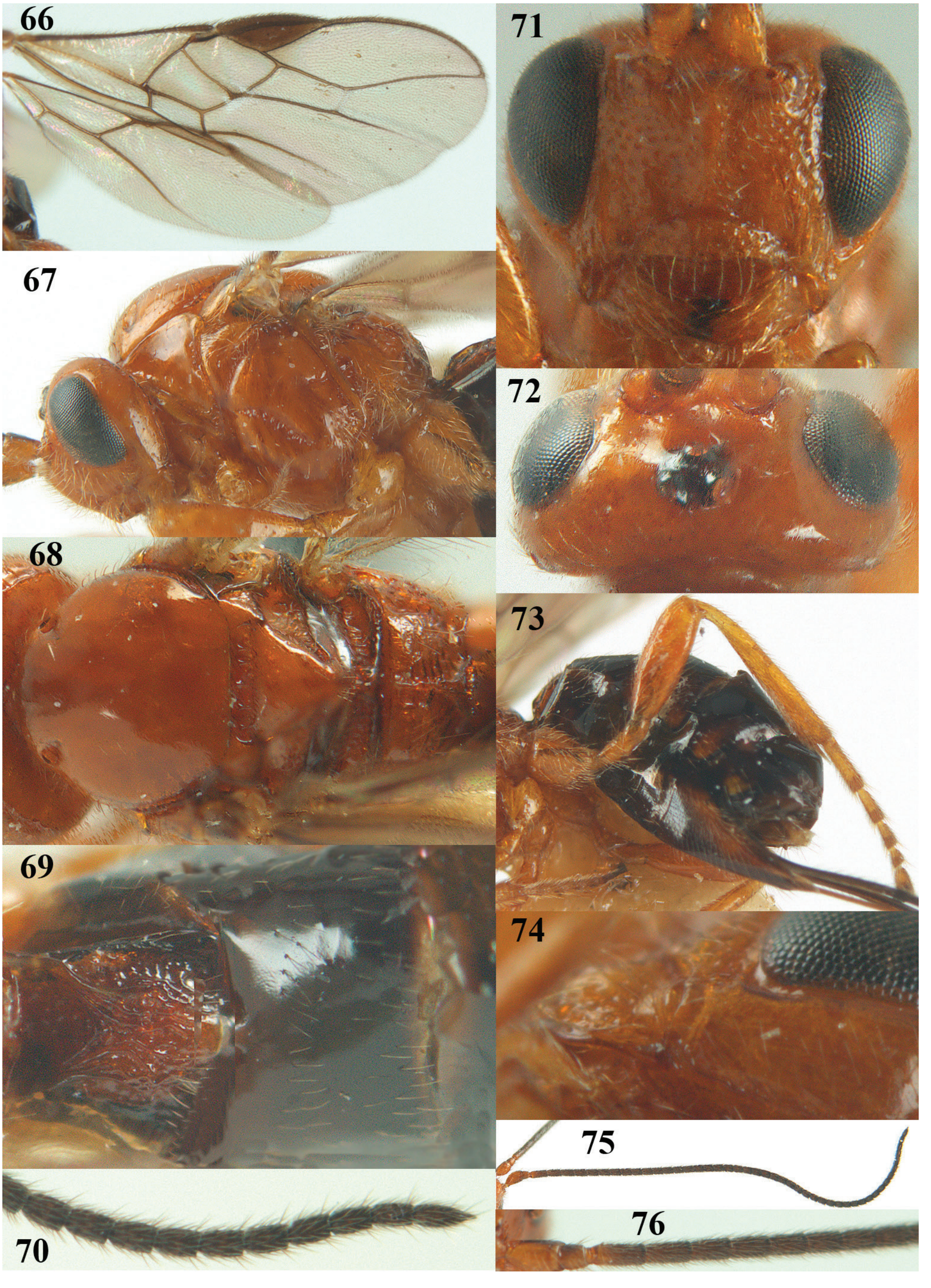


Figure 65. *Psyttalia romani* (Fahringer), ♀, Russia, Novorossijka, habitus lateral.

OOL: diameter of ocellus: POL = 14:5:8; area behind stemmaticum flat (Fig. 72); face coarsely punctate with most interspaces wider than diameter of punctures, shiny and smooth medio-longitudinal convexity dorsally and widened ventrally (Fig. 71); frons slightly depressed behind antennal sockets and in front of anterior ocellus slightly impressed, shiny, smooth and glabrous but laterally with few setae (Fig. 72); labrum slightly depressed; clypeus transverse, convex, with some coarse punctures and its ventral margin protruding, with fringe of long setae and rather thin (Fig. 71); width of clypeus 3.4 times its maximum height and 0.7 times width of face; hypoclypeal depression wide and deep (Figs 67, 71); malar suture indistinct except for deep depression near eye, sparsely punctate-rugose between malar suture and clypeus (Fig. 74); mandible not twisted, apically moderately narrowed and with both teeth wide; mandible normal basally and with narrow ventral carina (Fig. 74); occipital carina remains far removed from hypostomal carina and dorsally largely absent; hypostomal carina rather wide ventrally.

Mesosoma. Length of mesosoma 1.2 times its height; dorsal pronope absent; pronotal side largely smooth, but posteriorly grooves with some crenulae (Fig. 67); propleuron flattened; epicnemial area smooth dorsally; precoxal sulcus anteriorly and medially rather narrowly crenulate, absent posteriorly (Fig. 67); remainder of mesopleuron smooth and shiny except for some crenulae dorsally; pleural sulcus smooth



Figures 66–76. *Psyttalia romani* (Fahringer), ♀, Russia, Novorossijka. **66** wings **67** head and mesosoma lateral **68** mesosoma dorsal **69** first–third metasomal tergites dorsal **70** apex of antenna **71** head anterior **72** head dorsal **73** hind leg and hypopygium lateral **74** mandible lateral **75** antenna **76** base of antenna.

ventrally except for a few short crenulae; mesosternal sulcus deep, narrow and finely crenulate; postpectal carina absent; mesoscutum very shiny and glabrous (Fig. 68); notauli only anteriorly as smooth impressions and absent on disc; scutellar sulcus deep and with 5 short crenulae, parallel-sided medially; scutellum slightly convex and smooth, but laterally sparsely punctulate and setose (Fig. 68); metanotum with short longitudinal carina antero-medially and finely crenulate posteriorly; surface of propodeum smooth dorsally but posteriorly and area near distinct and reversed Y-shaped median carina rugose (Fig. 68), lateral grooves shallow and irregularly rugose.

Wings. Fore wing: 1-SR distinctly longer than wide and linear with 1-M (Fig. 66); pterostigma triangular and r linear with postero-basal border (Fig. 66); 1-R1 ending at wing apex and 1.6 times as long as pterostigma; r linear with 3-SR and medium-sized; r-m not tubular; r:3-SR:SR1 = 10:40:73; 2-SR:3-SR:r-m = 22:40:13; 1-M and SR1 slightly curved; m-cu distinctly antefurcal, converging to 1-M posteriorly and slightly curved, 2-SR+M rather widened (as apex of M+CU1: Fig. 66); cu-a distinctly postfurcal and 1-CU1 widened; 1-CU1:2-CU1= 3:22; first subdiscal cell closed; CU1b medium-sized; only apical fifth of M+CU1 sclerotized. Hind wing: 1-M straight; M+CU:1-M:1r-m = 22:23:15; cu-a straight; m-cu absent; SR slightly indicated apically.

Legs. Length of femur, tibia and basitarsus of hind leg 2.9, 6.8 and 4.2 times as long as width, respectively (Fig. 73); hind femur with long setae, tarsus and tibia densely setose (Fig. 73).

Metasoma. Length of first tergite equal to its apical width, convex medio-posteriorly, its surface largely coarsely rugose (Fig. 69), dorsal carinae strong in its basal half and with depressed area below; second suture slightly indicated; pair of basal depressions of second tergite large and tergite 0.9 times as long as third tergite; second and following tergites smooth, shiny and sparsely setose; combined length of second and third metasomal tergites 0.25 times total length of metasoma; length of setose part of ovipositor sheath 0.56 times fore wing, 4.9 times first tergite, 2.4 times hind femur and 1.7 times hind tibia; hypopygium 0.6 times as long as metasoma, distinctly acute apically and surpassing apex of metasoma (Fig. 73).

Colour. Orange brown, but stemmaticum and metasoma (except mainly reddish brown first tergite, lateral patches of sternites and tergites and hypopygium dorsally brown), tegulum pale yellowish and humeral plate infuscate; palpi, scapus and pedicellus ventrally and legs yellowish brown, but telotarsi infuscate; pterostigma and veins dark brown; fore wing membrane distinctly infuscate, especially near veins.

Variation. Length of fore wing 4.4–4.7 mm; antenna of ♀ with 47 segments; dorsal pronope absent or present as small round pit; vein 3-SR of fore wing 1.4–1.8 times as long as vein 2-SR; hind femur 2.9–3.2 times as long as wide; setose part of ovipositor sheath 0.46–0.56 times as long as fore wing and 1.5–1.7 times hind tibia.

Distribution. China (Gansu, *Shaanxi), Russia Far East, Korea.

Biology. Unknown.

Psyttalia sakhalinica (Tobias, 1998)

Figs 77–88

Opius (*Psyttalia*) *sakhalinicus* Tobias, 1998: 612.
Psyttalia sakhalinica: Tobias 2000: 12.

Type material. Holotype, ♀ (ZISP), "[**Russia**], 10 km z Anivy, smles, Sachalin, 15.vii. [1]981, Belokobylskij", "*Opius sakhalinicus* sp. n., det. Tobias, [19]95"; "Holotypus *Opius sakhalinicus* Tobias".

Additional material. 1 ♀ (ZISP) "[Russia], o. Kunamir, Yu.-Kurilsk, r. lesky, 19.viii.1989, A. Lelej", "*Psyttalia sakhalinicus* Tob., Tobias det. 2001".

Comparative diagnosis. See *P. romani* (Fahringer).

Description. Holotype, ♀, length of body 4.6 mm, of fore wing 4.8 mm.

Head. Antenna with 45 segments, bristly and erect setose and 1.3 times as long as fore wing; third segment 1.4 times as long as fourth segment, length of third, fourth and penultimate segments 2.8, 2.0 and 2.3 times their width, respectively (Figs 82, 87–88); length of maxillary palp 1.3 times height of head; length of eye in dorsal view 2.5 times temple (Fig. 84); temple in dorsal view shiny, smooth and with sparse setae; OOL: diameter of ocellus: POL = 9:5:6; area behind stemmaticum flat (Fig. 84); face coarsely punctate with interspaces about equal to diameter of punctures, with satin sheen and sparsely punctulate with a medio-longitudinal convexity dorsally and widened ventrally (Fig. 83); frons slightly depressed behind antennal sockets and in front of anterior ocellus, shiny, smooth and glabrous but laterally setose and punctulate (Fig. 84); labrum slightly depressed; clypeus transverse, convex, and its ventral margin concave, obtuse and thick (Fig. 83); width of clypeus 5.0 times its maximum height and 0.7 times width of face; hypoclypeal depression wide and deep (Figs 79, 83); malar suture indistinct except for deep depression near eye, punctate-rugose between malar suture and clypeus (Fig. 86); mandible not twisted, apically moderately narrowed and with both teeth wide; mandible normal basally and with narrow ventral carina (Fig. 86); occipital carina remains far removed from hypostomal carina and dorsally largely absent; hypostomal carina rather wide ventrally.

Mesosoma. Length of mesosoma 1.2 times its height; dorsal pronope small, round; pronotal side largely smooth, but anterior and posterior grooves present and largely smooth (Fig. 79); propleuron flattened; epicnemial area smooth dorsally; precoxal sulcus medially medium-sized and only medially distinctly crenulate, absent posteriorly (Fig. 79); remainder of mesopleuron smooth and shiny; pleural sulcus smooth ventrally; mesosternal sulcus deep, narrow and finely crenulate; postpectal carina absent; mesoscutum very shiny and glabrous (Fig. 80); notauli only anteriorly as pair of nearly smooth impressions and absent on disc; scutellar sulcus deep and with 4 short crenulae, parallel-sided medially; scutellum slightly convex and smooth, but laterally sparsely punctulate and setose (Fig. 80); metanotum without a longitudinal carina medially and finely crenulate posteriorly; surface of propodeum smooth except for rugose area near distinct and reversed Y-shaped median carina (Fig. 80), lateral grooves shallow and irregularly rugose and anterior groove somewhat widened medially (Fig. 80).

77

1.0 mm

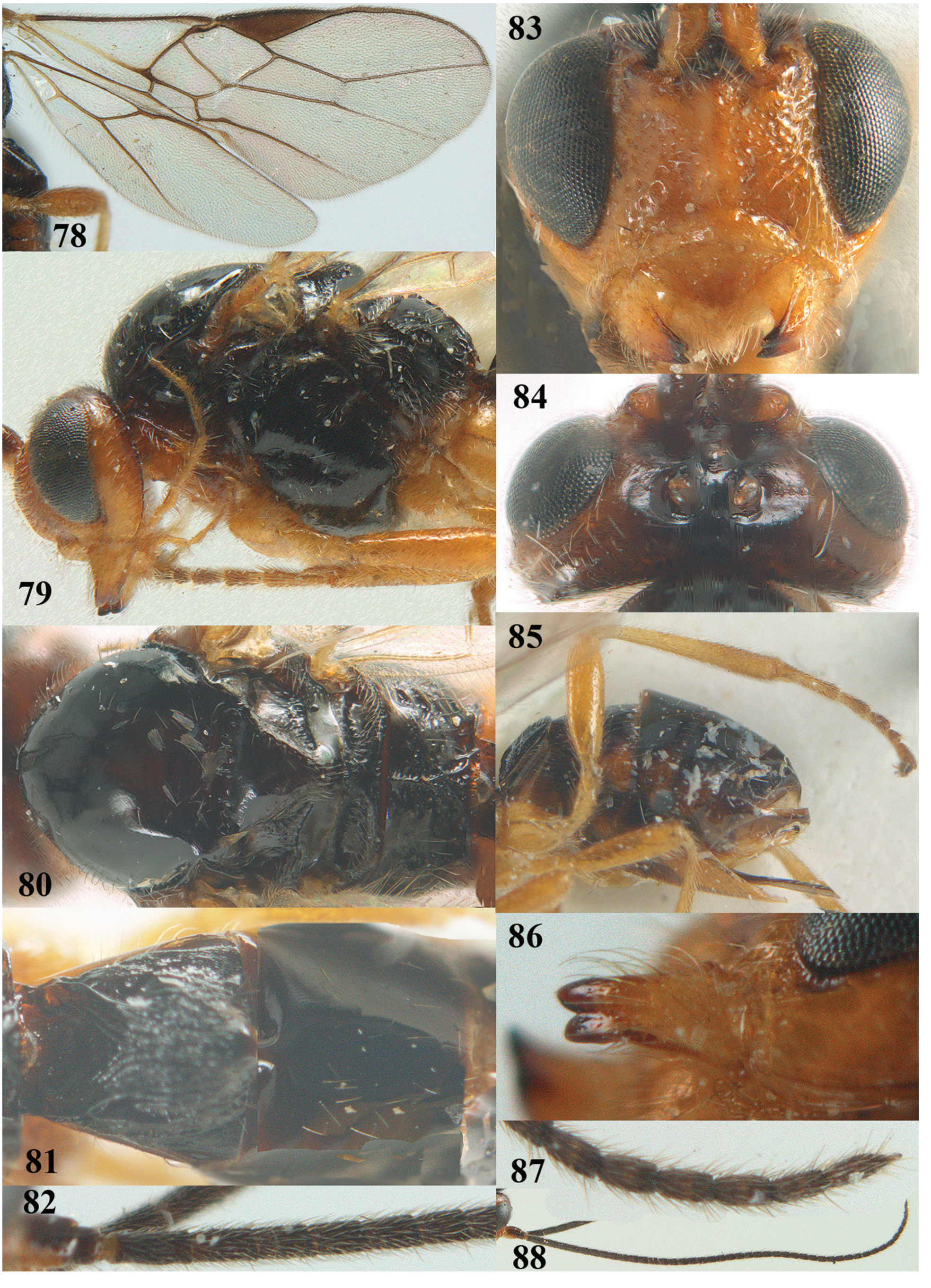
Figure 77. *Psyttalia sakhalinica* (Tobias), ♀, holotype, habitus lateral.

Wings. Fore wing: 1-SR distinctly longer than wide and linear with 1-M (Fig. 78); pterostigma triangular and r linear with postero-basal border (Fig. 78); 1-R1 ending at wing apex and 1.4 times as long as pterostigma (Fig. 78); r linear with 3-SR and medium-sized; r-m not tubular; r:3-SR:SR1 = 5:22:44; 2-SR:3-SR:r-m = 15:22:7; 1-M and SR1 straight; m-cu distinctly antefurcal and slightly curved, 2-M+CU1 rather widened (as apex of M+CU1: Fig. 78); cu-a distinctly postfurcal and 1-CU1 widened; 1-CU1:2-CU1= 2:11; first subdiscal cell closed; CU1b medium-sized; only apex of M+CU1 sclerotized. Hind wing: 1-M straight; M+CU:1-M:1r-m = 30:24:11; cu-a straight; m-cu absent; SR slightly indicated.

Legs. Length of femur, tibia and basitarsus of hind leg 3.9, 8.3 and 5.4 times as long as width, respectively (Fig. 85); hind femur and tibia with long setae.

Metasoma. Length of first tergite 1.1 times to its apical width, convex medio-posteriorly, its surface strongly and densely rugose (Fig. 81), dorsal carinae strong in its basal half and with depressed area below; second suture slightly indicated; basal depressions of second tergite large and tergite 0.9 times as long as third tergite; second and following tergites smooth, shiny and sparsely setose; combined length of second and third metasomal tergites 0.25 times total length of metasoma; length of setose part of ovipositor sheath 0.53 times fore wing, 3.8 times first tergite, 2.3 times hind femur and 1.7 times hind tibia; hypopygium about 0.5 times as long as metasoma, distinctly acute apically and reaching apex of metasoma (Fig. 85).

Colour. Black, but head (except dark brown frons and vertex but excluding orbita) and propleuron, propleuron ventrally, tegulae, scapus ventrally, sternites (except



Figures 78–88. *Psyttalia sakhalinica* (Tobias), ♀, holotype. **78** wings **79** head and mesosoma lateral **80** mesosoma dorsal **81** first–third metasomal tergites dorsal **82** base of antenna **83** head anterior **84** head dorsal **85** hind leg and hypopygium lateral **86** mandible lateral **87** apex of antenna **88** antenna.

medially) and second-seventh tergites laterally largely orange brown; palpi, mandible (but teeth dark brown) and legs brownish yellow, but apical half of tarsi infuscate; metasoma apically, remainder of propleuron and mesopleuron anteriorly dark brown; pterostigma and veins dark brown; fore wing membrane slightly infuscate.

Variation. Length of fore wing 4.8–5.0 mm; antenna of ♀ with 44–45 segments; first tergite 1.0–1.1 times as long as its apical width, more or less flattened; precoxal sulcus nearly smooth to distinctly crenulate medially; face punctate to densely punctate-rugose; hind femur 3.5–3.9 times as long as wide; setose part of ovipositor sheath 0.51–0.53 times as long as fore wing and 1.6–1.7 times hind tibia; second tergite black or orange brown anteriorly.

Distribution. Russia Far East.

Biology. Unknown.

Psyttalia spectabilis **van Achterberg, sp. n.**

http://zoobank.org/7F3B01AA-ADD9-4EA0-908B-52654CA14FB5

Figs 89–99

Material. Holotype, ♀ (RMNH), "Museum Leiden, **Japan**[: Honshu], Gaga Spa-Zaô, Miyagi Pref., 31.vii.1981, A. Takasu". Paratype: 1 ♀ (RMNH) with same data as holotype.

Comparative diagnosis. The new species runs in the keys to Palaearctic Opiinae by Fischer (1972) to *Diachasma mysticum* (= *Rhogadopsis mystica* (Fischer, 1963) comb. n.) from Japan. It differs from *R. mystica* by having the head and mesosoma (except propodeum and metapleuron) brownish yellow (*vs* head, except clypeus, and mesosoma black in *R. mystica*), vein CU1b of fore wing much shorter than vein 3-CU1 (Fig. 90; *vs* vein CU1b about as long as vein 3-CU1); pterostigma distinctly triangular (Fig. 90; *vs* elongate); medio-posterior depression of mesoscutum absent (*vs* present); vein r of fore wing continuous with vein 3-SR (Fig. 90; *vs* vein r of fore wing rather angled with vein 3-SR); vein SR1 of fore wing about 1.8 times vein 3-SR (Fig. 90; *vs* vein SR1 of fore wing about 2.7 times vein 3-SR) and length of body 5–6 mm (*vs* about 3 mm). In the key by Fischer (1987) the new species runs to the Oriental *P. walkeri* (Muesebeck). The new species differs by having lateral crenulate grooves on the propodeum (Fig. 93; *vs* absent and instead with carina in *P. walkeri*), propodeum and first–fifth tergites largely black (*vs* reddish yellow or partly infuscate), hind tibia (except ventrally) and tarsus dark brown, contrasting with ivory hind femur (Fig. 99; *vs* hind femur, tibia and tarsus similar pale yellow), pterostigma dark brown (*vs* pale yellow), length of body 5–6 mm (*vs* 2–3 mm) and vein 2-CU1 of fore wing at same level as vein M+CU1 (Fig. 90; *vs* vein 2-CU1 distinctly below level of vein M+CU1).

Description. Holotype, ♀, length of body 5.6 mm, of fore wing 5.2 mm.

Head. Antenna with 52+ segments (its apex missing), bristly and erect setose and 1.4 times as long as fore wing; third segment 1.2 times as long as fourth segment, length of third and fourth segments 2.6 and 2.1 times their width, respectively (Figs

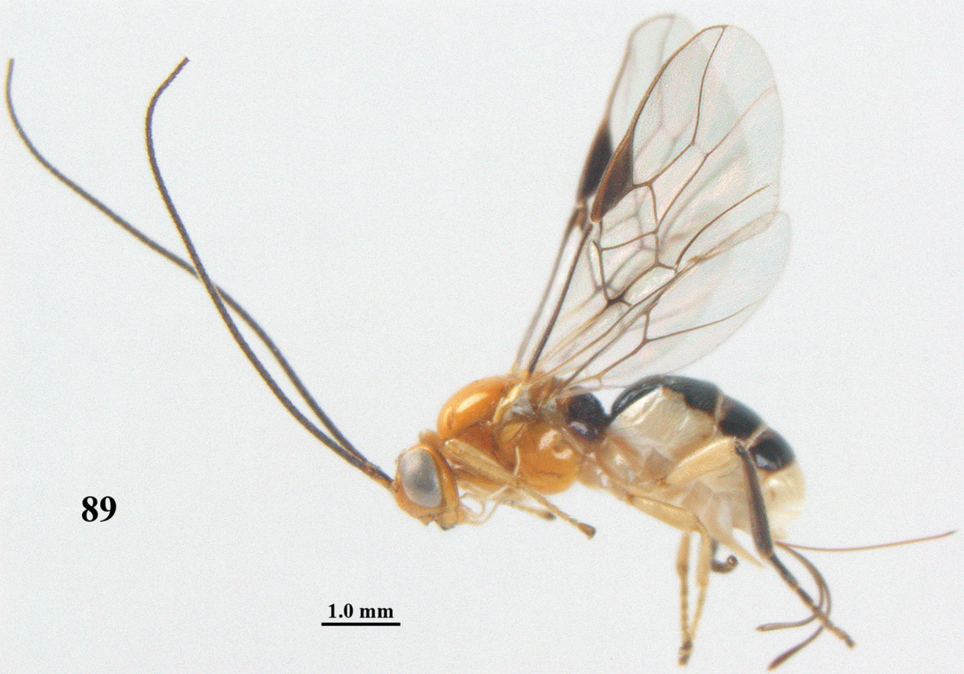
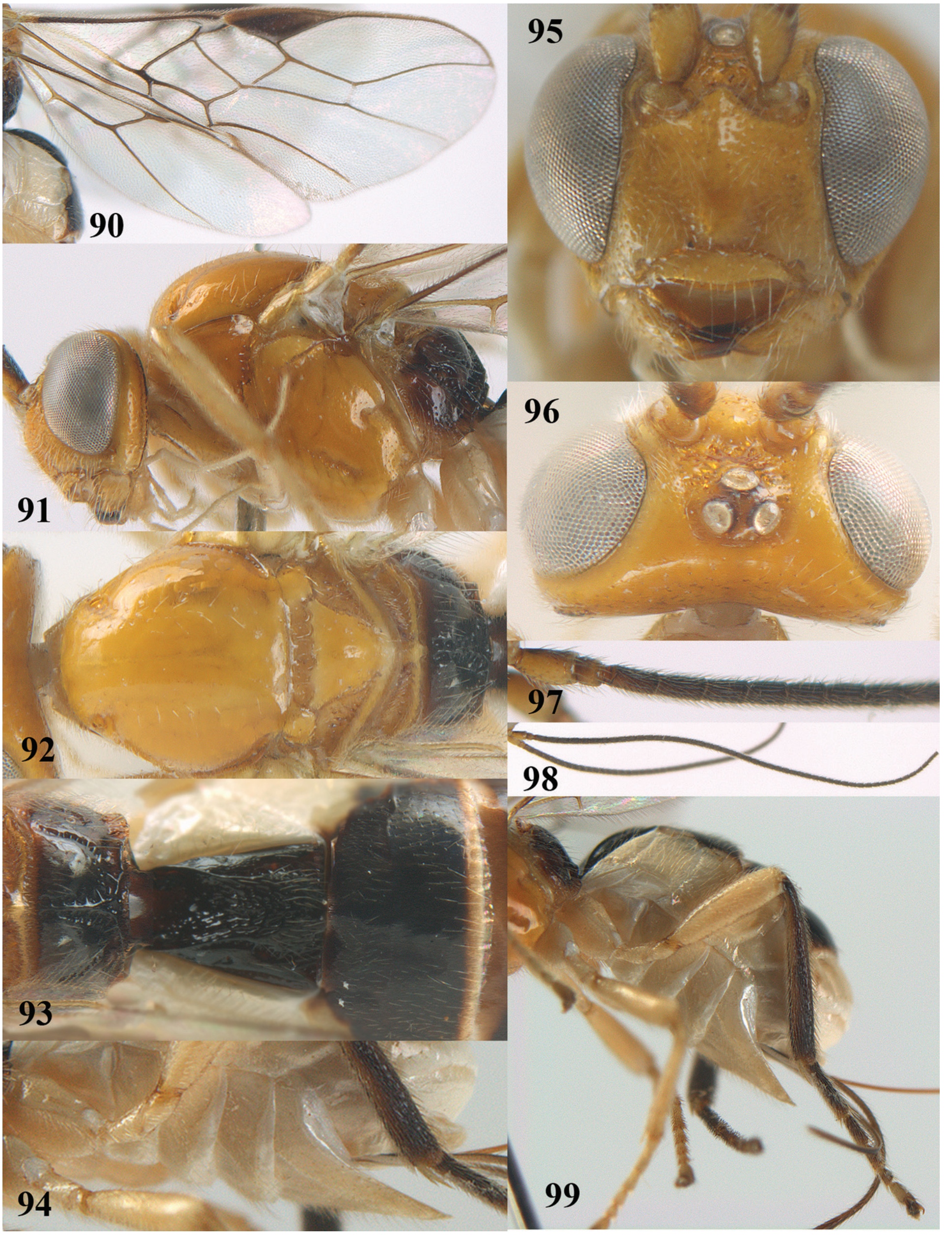


Figure 89. *Psyttalia spectabilis* sp. n., ♀, holotype, habitus lateral.

97–98); length of maxillary palp 1.2 times height of head; length of eye in dorsal view 4.6 times temple (Fig. 96); temple in dorsal view shiny, largely smooth and with sparse punctures; OOL: diameter of ocellus: POL = 9:5:4; area behind stemmaticum with groove, widened laterally (Fig. 96); face moderately punctate with interspaces wider than diameter of punctures, except submedially, shiny and medio-longitudinal convexity mainly smooth and ventrally widened (Fig. 95); frons moderately depressed behind antennal sockets, shiny, rugose and glabrous but laterally setose and punctulate, in front of anterior ocellus with narrow groove and narrow smooth ridge (Fig. 96); labrum flat; clypeus transverse, convex, coarsely punctate and its ventral margin slightly convex and thin (Fig. 95); width of clypeus 4.0 times its maximum height and 0.8 times width of face; hypoclypeal depression wide and deep (Figs 91, 95); malar space narrow (Fig. 95); malar suture indistinct except for deep depression near eye, between malar suture and clypeus punctate; mandible not twisted, apically moderately narrowed, punctate and with both teeth wide; mandible normal basally and with narrow ventral carina (Fig. 91); occipital carina remains far removed from hypostomal carina and dorsally largely absent; hypostomal carina rather wide ventrally.

Mesosoma. Length of mesosoma 1.3 times its height; dorsal pronope small, round; pronotal side largely smooth, but anterior and posterior grooves present and coarsely crenulate (Fig. 91); propleuron flattened; epicnemial area smooth dorsally; precoxal sulcus medially medium-sized and only medially distinctly crenulate, absent anteriorly and posteriorly (Fig. 91); remainder of mesopleuron smooth and shiny; pleural sulcus very



Figures 90–99. *Psyttalia spectabilis* sp. n., ♀, holotype. **90** wings **91** head and mesosoma lateral **92** mesosoma dorsal **93** propodeum and first–third metasomal tergites dorsal **94** hypopygium lateral **95** head anterior **96** head dorsal **97** base of antenna **98** antenna **99** hind leg and hypopygium lateral.

finely crenulate ventrally; mesosternal sulcus deep, narrow and finely crenulate; postpectal carina absent; mesoscutum shiny and glabrous (Fig. 92); notauli only anteriorly as pair of nearly smooth impressions and absent on disc, but notaulic courses indicated by setae and punctulation; scutellar sulcus deep and with 5 long crenulae, parallel-sided medially; scutellum rather convex and smooth, but laterally sparsely punctulate and setose (Fig. 92); metanotum with a short medio-longitudinal carina anteriorly and its posterior face finely crenulate; surface of propodeum smooth except for crenulate grooves near distinct and reversed Y-shaped median carina (Fig. 93), lateral grooves deep and coarsely regularly crenulate, and anterior groove somewhat widened medially (Fig. 93).

Wings. Fore wing: 1-SR longer than wide and slightly angled with 1-M (Fig. 90); pterostigma wide triangular and r nearly linear with postero-basal border (Fig. 90); 1-R1 ending at wing apex and 1.3 times as long as pterostigma (Fig. 90); r nearly linear with 3-SR and medium-sized; r-m not tubular; r:3-SR:SR1 = 5:20:42; 2-SR:3-SR:r-m = 13:20:6; 1-M straight; SR1 distinctly curved; m-cu distinctly antefurcal, subparallel with 1-M and straight, 2-SR+M slender (as apex of M+CU1: Fig. 90); cu-a distinctly postfurcal and 1-CU1 widened; 1-CU1:2-CU1= 5:31; first subdiscal cell closed; CU1b medium-sized; only apex of M+CU1 sclerotized. Hind wing: 1-M straight; M+CU:1-M:1r-m = 30:35:13; cu-a straight; m-cu absent; SR entirely absent.

Legs. Length of femur, tibia and basitarsus of hind leg 3.4, 8.2 and 4.9 times as long as width, respectively (Fig. 99); hind femur and tibia with long setae and densely setose.

Metasoma. Length of first tergite 1.1 times to its apical width, convex medio-posteriorly, convexity surrounded by crenulate groove, its surface densely punctate-rugose (Fig. 93), dorsal carinae strong in its basal half and with depressed area below; second suture slightly indicated; basal depressions of second tergite medium-sized and tergite 0.7 times as long as third tergite, both smooth (except some punctulation) and largely setose; following tergites smooth, shiny and sparsely setose; combined length of second and third metasomal tergites 0.26 times total length of metasoma; sixth tergite membranous medio-posteriorly; length of setose part of ovipositor sheath 0.46 times fore wing, 2.9 times first tergite, 2.0 times hind femur, 1.4 times hind tibia and 0.9 times metasoma; hypopygium 0.35 times as long as metasoma, acute apically and reaching apex of metasoma (Fig. 94).

Colour. Brownish yellow; propodeum, first tergite, second tergite except laterally, third tergite except posteriorly, fourth and fifth tergites (but anteriorly and posteriorly brownish) black; metapleuron chestnut brown; palpi, legs (but hind tibia and tarsus mainly dark brown) and remainder of metasoma ivory; tegulae pale yellowish; antenna (but scapus and pedicellus mainly yellow), pterostigma and veins dark brown; fore wing membrane subhyaline.

Variation. Paratype: length of fore wing 4.3 mm; antenna with 52 segments; first tergite 1.1 times as long as its apical width and only superficially punctate medially; hind femur 3.8 times as long as wide; setose part of ovipositor sheath 0.47 times as long as fore wing and 1.5 times hind tibia; hind tibia ivory ventrally and propodeum chestnut brown.

Distribution. Japan.

Biology. Unknown.

Etymology. The name refers to the showy combination of colours of this species: “spectabilis” is Latin for “showy, notable”.

Notes. *Rhogadopsis mystica* (Fischer, 1963) comb. n. was originally described in the genus *Opius* Wesmael and up to now only known of the male holotype. It was later included in *Diachasma* Foerster, 1863, by Fischer (1972). The latter is an obvious misfit because the clypeus is truncate ventrally (*vs* convex in *Diachasma*) and it has a distinct hypoclypeal depression below it (*vs* absent or as a narrow slit in *Diachasma*), vein 3-SR of fore wing longer than vein 2-SR and vein m-cu of hind wing absent (according to the original description veins 2-SR and 3-SR equal, but in the figured fore wing 3-SR 1.2 times longer than 2-SR; *vs* in *Diachasma* vein 3-SR usually shorter than vein 2-SR and if subequal then vein m-cu of hind wing at least present as a distinctly pigmented trace). Tobias (1998) included it in the subgenus *Aulonotus* Ashmead of *Opius* Wesmael. *Aulonotus* Ashmead is a synonym of *Xynobius* Foerster, 1863 (Li et al. 2013), but it is unlikely that it belongs there because the dorsal carinae are weakly developed, the marginal cell of the hind wing is wide and vein 3-SR of fore wing slightly longer than vein 2-SR (Fischer 1963). According to the original description vein m-cu of fore wing is distinctly curved and gradually merging into vein 2-CU1, vein 1r-m of hind wing is weakly oblique and 0.7 times as long as vein 1-M, hind wing comparatively wide and medio-longitudinal carina of propodeum present anteriorly, what agrees well with the definition of *Rhogadopsis* Brèthes, 1913 (Li et al. 2013). It can be separated from other *Rhogadopsis* species by its complete notauli combined with the antefurcal vein m-cu, short vein 1-SR and distally widened first subdiscal cell of the fore wing.

Excluded species

Rhogadopsis mediocarinata (Fischer, 1963), comb. n.

Figs 100–110

Opius mediocarinatus Fischer, 1963: 297 (examined).
Opius (*Lissosema*) *mediocarinatus*: Fischer 1972: 360–361.
Opius (*Psyttalia*) *mediocarinatus*: Tobias 1998: 611.
Psyttalia mediocarinata: Tobias 2000: 12.
Opius (*Lissosema*) *longurius* Chen & Weng, 2005: 99–101, 197 (examined). **Syn. n.**
Rhogadopsis longuria: Li et al. 2013: 154–157 (redescription).
Opius (*Psyttalia*) *vacuus* Tobias, 1998: 612 (examined). **Syn. n.**
Opius vacuus: Tobias 2000: 15.

Type material. Holotype of *O. longurius*, ♀ (FAFU), "[**China**:] **Fujian**, Wuyi Mt., Sangang, 30.vi.1988, Zhang Xia-bin". Holotype of *O. vacuus*, ♀ (ZISP), "[**Russia**], Primorskij kraj, Spassk, les, poljany, 19.viii.1991, Belokobylskij", "*Opius vacuus* sp. n., det. Tobias '95", "Holotypus *Opius vacuus* Tobias". Paratype of *O. mediocarinatus*. ♀ (MTMA) from Japan (Honshu: Kamikochi) examined.

Comparative diagnosis. The combination of lacking the medio-posterior depression of the mesoscutum (Fig. 103) and the slender first metasomal tergite with a long

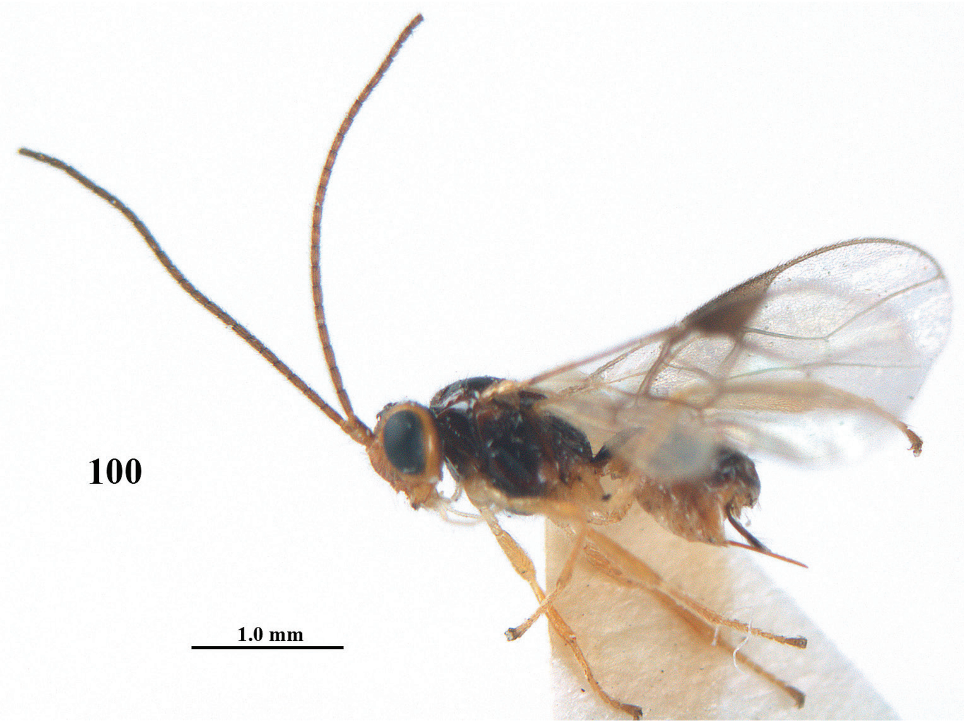


Figure 100. *Rhogadopsis mediocarinata* (Fischer), ♀, holotype of *Opius vacuus* Tobias, habitus lateral.

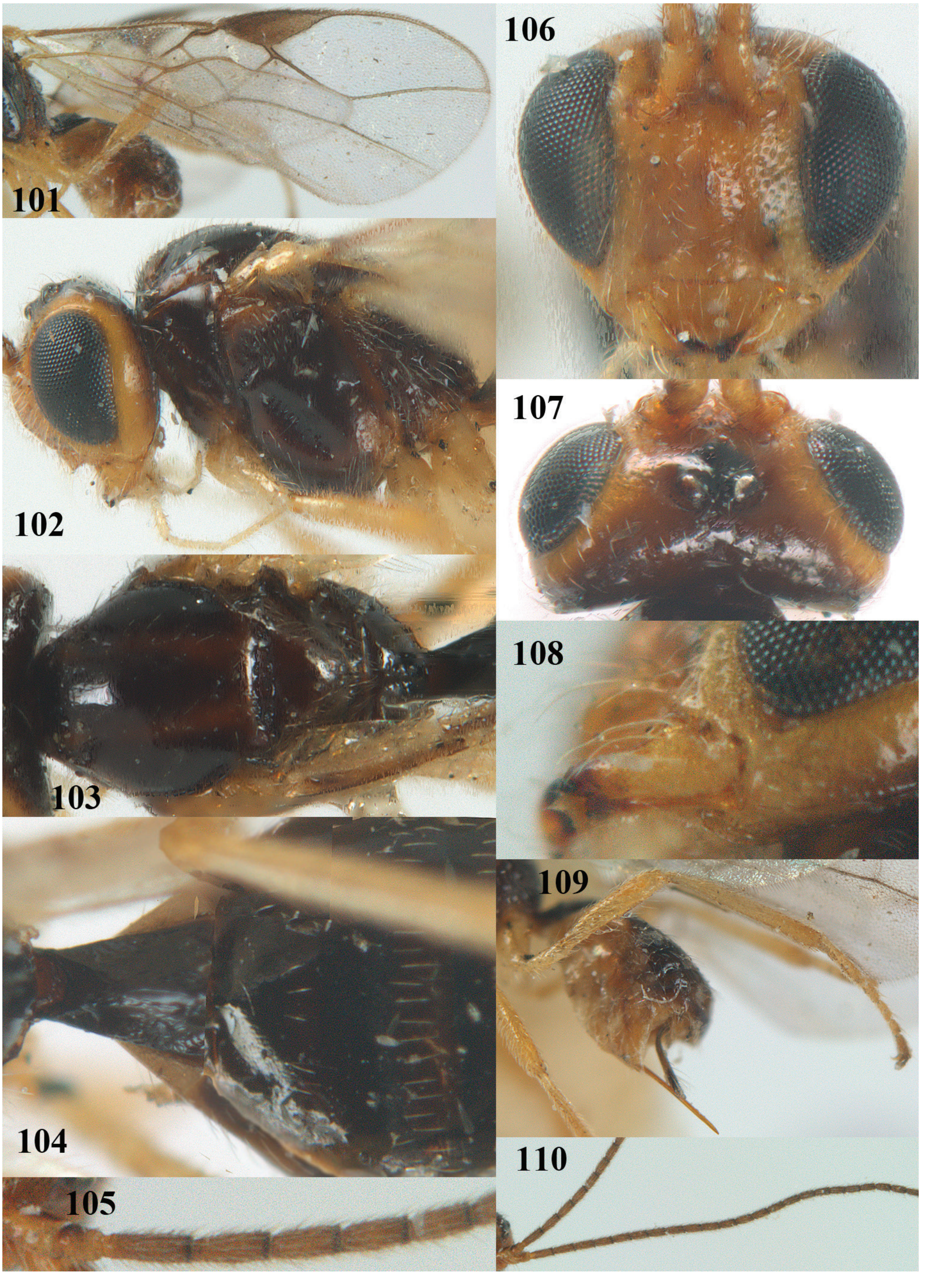
median carina (Fig. 104) makes this species easy to separate from all other species of *Rhogadopsis* in China.

Distribution. China (Fujian (as *longurius*), Hunan (as *longuria*), *Shaanxi), Russia Far East, Japan, Korea. The record from Spain (Avinent and Jiménez 1987) needs reconfirmation.

Biology. Unknown.

Notes. The inclusion of *Opius mediocarinatus* Fischer from Japan in *Psyttalia* by Tobias (1998, 2000) is an obvious misfit; it is also excluded by Wharton (2009). It has a short (hardly protruding) ovipositor (Fig. 100), vein m-cu of fore wing 0.65 times as long as vein 1-M, vein m-cu of fore wing angled with vein 2-CU1, and a normal second tergite and hypopygium. It belongs to the genus *Rhogadopsis* Brèthes, 1913, as defined by Li et al. (2013) and is one of the easier identifiable species of the genus because of the shape and sculpture of the first tergite.

The holotype of *O. vacuus* is a very typical *R. mediocarinata* because of the reduced posterior groove of the pronotal side, the striped mesoscutum and the elongate first metasomal tergite with the distinct median carina. Vein 1r-m of the hind wing is rather short (0.55 times as long as vein 1-M), but obviously this vein is rather variable in this species and vein 1-M of hind wing has a weak bend subapically.



Figures 101–110. *Rhogadopsis mediocarinata* (Fischer), ♀, holotype of *Opius vacuus* Tobias. **101** wings **102** head and mesosoma lateral **103** mesosoma dorsal **104** first–third metasomal tergites dorsal **105** base of antenna **106** head anterior **107** head dorsal **108** mandible lateral **109** hind leg and hypopygium lateral **110** antenna.

Addendum

Psyttoma latilabris (Chen & Weng, 2005) is similar to a *Psyttalia* species because of the enlarged and apically acute hypopygium of ♀, but differs because of the medially protruding scutellum (above level of mesoscutum), the narrow hind wing with short vein 1r-m, the wide face and hind femur (length about 3.0 times its width). In ZJUH is material of this species present from *Xinjiang province (NW. China: 1 ♀ 1 ♂, Shihezi, 12.vii.2001, Hongying Hu, Nos 200304217 and 20036001; 1 ♂, Wulumuqi, 3.viii.2001, Hongying Hu, No. 20036044; 2 ♂ Badanbohu, 7.viii.2001, Hongying Hu, Nos 20036055 and 20036060; 2 ♂, Nongqishi, 12.vii.2001, Hongying Hu, No. 20036093). To date, this species is known from Shandong and Hubei provinces (Li et al. 2012).

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