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Description of three new *Pipunculus* Latreille, 1802 species (Diptera: Pipunculidae) from Central Europe and Turkey

Milan Kozánek[1], Daniel Valaška[1], Ján Kodada[2]

[1]VirNat s.r.o., Na Medzi 1C, Bratislava, SK-831 06, Slovakia, [2]Department of Zoology, Faculty of Natural Sciences, Comenius University in Bratislava, Ilkovičova 6, Bratislava, SK-842 15, Slovakia

Corresponding author: Dr. Milan Kozánek, VirNat s.r.o., Na Medzi 1C, SK-831 06, Bratislava, Slovakia. E-mail: milan@scientica.sk

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Abstract: Extensive sampling of Pipunculidae in the frame of faunistic research in former Czechoslovakia as well as several other European countries over the last two decades has resulted in the discovery of several unknown species of this family. In this work, we present descriptions of three new species of the genus *Pipunculus* Latreille, 1802. *Pipunculus adami* Kozánek, sp. nov. and *P. lindae* Kozánek, sp. nov. are described from Slovakia and the Czech Republic, *P. anatolicus* Kozánek, sp. nov. is described on the basis of specimens from Turkey. The detailed redescription of the male of *P. wolfi* Kowarz, 1887, including the so far unknown male terminalia, is presented. The key taxonomic characters are visualized as interactive microphotographs provided with browsing software.

Key words: big-headed flies, taxonomy, microphotographs, visualisation, characters.

Introduction

The research of European Pipunculidae accelerated after the 1980s when a number of works revising world, European or regional fauna of pipunculid genera were published (Kozánek 1981, De Meyer 1989, Albrecht 1990, Jervis 1992, Földvári & De Meyer 1999). A substantial step ahead brought the works of Kehlmaier who revised European fauna of Eudorylini (Kehlmaier 2005), *Chalarus* Walker, 1834 (Kehlmaier & Assmann 2008), *Verrallia* Mik, 1899 (Kehlmaier 2006), *Jassidophaga* Aczel, 1939 (Kehlmaier 2006), and *Pipunculus* Latreille, 1802 (Kehlmaier 2008). Our knowledge on the pipunculid distribution in European countries is not uniform. While the pipunculid fauna of Western, Northern, and Central European countries is well studied, South ern and Eastern European countries need more precise faunistic research. Two new *Pipunculus* from Slovakia and the Czech Republic described in present work demonstrate that continuing faunistic studies can reveal new unknown species even in countries with long tradition of Pipunculidae research.

The significant progress in the research of Pipunculidae taxonomy and phylogeography over the last decades has allowed the implementation of modern methods of molecular biology, but the description of new species and identification is still based on the visualization of key morphological characters. Drawings of these characters, mainly male and female terminalia, are still widely used. To eliminate differences in the quality of the drawings, several authors used composed microphotographs created by stacking of several focal planes (Kehlmaier et al. 2019, Motamedinia et al. 2020). In this study we use interactive microphotographs for visualization of key characters of described species. The principle of this method is based on the combination of high resolution stacked microphotography with browsing software allowing manipulation of the object.

Material and methods

The described species are the result of the study of extensive Pipunculidae material collected by Malaise trap and sweeping net from the Czech Republic, Slovakia and Turkey. The Malaise traps collecting medium was 70% ethanol denaturized with isopropyl alcohol. Collected specimens were desiccated by transferring through 98% ethanol—98% ethanol : ethylacetate (1 : 1)—ethylacetate desiccating series. The type series of the described species and the studied material of *P. wolfi* are deposited in the Slovak National Museum, Bratislava, Slovakia (SNM). The description of each presented species is completed by interactive microphotographs of their respective key characters. In order to create stacked microphotographs, a macroscope Zeiss Axio Zoom V16 with PlanApo Z 1.5× lens equipped with Canon EOS r5 was used. Each stacked microphotography was created by stacking of 30–80 focal planes using the image stacking software ZereneStacker (https://zerenesystems.com/cms/stacker). Each micrograph is equipped with the browsing software Krpano version 1.20.8 (https://krpano.com/home/), which enables the observation of detailed structures of the object. Photos were finalized and edited in Zoner Photo Studio X (https://www.zoner.eu/) imaging software. The terminology used in this study is based on Kehlmaier (2005) and Skevington (2002) and follows recent taxonomic papers of the family (Kehlmaier et al. 2019, Motamedinia et al. 2020).

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Results

***Pipunculus adami* Kozánek, sp. nov.**
Figs 1–18

Type locality. Slovakia, Kamenica nad Hronom, 47°49′31.80″N, 18°44′55.02″E.

Material examined. *Holotype.* 1 male, SNM: Slovakia, Kamenica nad Hronom, 47°49′31.80″N, 18°44′55.02″E, 18.vii.2010, Malaise trap, leg. O. Majzlan and Ľ. Vidlička. *Paratypes.* 9 males, 1 female, SNM: Slovakia, Kamenica nad Hronom, 47°49′31.80″N, 18°44′55.02″E, 11.vii.2010 (2 males, 1 female), 18.vii.2010 (3 males), 22.vii.2010 (2 males), 1.viii.2010 (2 males), Malaise trap, leg. O. Majzlan and Ľ. Vidlička.

Differential diagnosis. *Pipunculus adami* Kozánek, sp. nov. can be affiliated to the *P. elegans* species group by having the membranous area of syntergosternite 8 regularly ovate (not narrowing in the lower part), by its reduced pollinosity on the scutum and abdominal tergites, and by the phallus with its ejaculatory ducts being short and straight. Males of *P. adami* Kozánek, sp. nov. can be separated from the rest of European *P. elegans* species group by its large membranous area, being more roundish than ovate, the broad and blunt surstyli, the broad phallic guide, and by the hind tibiae with 4–5 long light setae anteromedially. Female can be distinguished by the following characters: pulvilli long, base of ovipositor rather robust, dorsally semiglobular, piercer straight, rather stout and short, about as long as 1.5× length of base.

Description of male. *Head* (Fig. 1, Fig. 2, Fig. 3). Frons densely silver-grey pollinose, medially with indistinct spot of reduced pollinosity. Face silver-grey pollinose. Ocellar triangle black, equilateral. Occiput greyish pollinose, in upper margin with reduced pollinosity, with narrow strip of brownish pollinosity behind ocellar triangle. Eyes meeting for distance more or less equal to the length of frons (17–18 facets). Frontal facets of compound eyes not enlarged. Scape and pedicel with brown pollinosity. Pedicel dorsally and ventrally with 4–5 light long bristles. Flagellum brown pollinose, blunt. Arista dark brown, posterior side of its broadened base brownish pollinose.

Thorax. Postpronotal lobe dark brown to black, greyish pollinose. Prescutum laterally greyish pollinose, medially matt black. Scutum in front one-third to one-half laterally greyish, medially brownish pollinose, posteriorly shining black. Scutellum shining black laterally with greyish pollinosity with row of rather dense and long whitish hairs. Subscutellum black with greyish pollinosity. Pleura dark with greyish pollinosity. Wing clear, transparent, covered with microtrichia, which can be reduced to various degree in medial cells (cup, bm, br). Pterostigma present. Crossvein r-m reaches cell dm shortly behind one-quarter of cell length. Vein M_{1+2} undulating (Fig. 4). For wing measurements see Tab. 1. Halter light, basally dark brown. Coxa black, greyish pollinose. Trochanter dark brown. Femur black, yellowish in apical quarter. Tibia dark brown, yellowish in basal third, anteromedially with 4–5 long light setae. Tarsus dark. Pulvillus as long as or slightly shorter than distitarsus (Fig. 5, Fig. 6).

Abdomen. Tergite 1 entirely greyish pollinose, laterally with tuft of 10–12 long light bristles. Terga 2–5 shining, black with sparse longer light hairs, posterolaterally with greyish pollinosity. Terga 2–4 equally long, tergum 5 about 1.5× longer than any previous tergite (Fig. 7, Fig. 8). Syntergosternite 8 subshining black, brownish pollinose. Membraneous area large, roundish (Fig. 9). Surstyli broad, irregular, and strongly curved (Fig. 10). Right surstylus longer, left surstylus short, simple (Fig. 11, Fig. 12). Phallic guide rather broad (compared with other species of *P. elegans* group), sharply pointed, phallus trifid, ejaculatory ducts short (Fig. 13).

Description of female. *Head* (Fig. 14, Fig. 15, Fig. 16). Frons subparallel, distinctly narrowing in hind one-third. Frons greyish pollinose, in lower half with subshining short gap-shaped patch, in upper half with subshining long M-shaped pattern. Ocellar triangle equilateral. Occiput uniformly densely greyish pubescent. Compound eyes with front 10–11 rows of enlarged facets. Scape and pedicel with dark brown pollinosity, pedicel dorsally and ventrally with 4–5 long dark bristles. Flagellum brown pollinose shortly acute. Arista brown, posterior side of its broadened base brownish pollinated.

Thorax. Postpronotal lobe densely greyish pollinose. Prescutum greyish pollinose medially with reduced pollinosity. Scutum shining black, narrowly greyish pollinose in anterior margin. Scutum covered with sparse whitish hairs. Anterior margin narrowly greyish pollinose, otherwise shining, black, covered with sparse light hairs. Subscutellum black with grey pollinosity. Pleura dark greyish pollinose. Wing clear, transparent, covered with microtrichia. Pterostigma present. Crossvein r-m reaches cell dm shortly behind one-quarter of cell length. Vein M_{1+2} undulating. For wing measurements see Tab. 1. Coxa black, greyish pollinose. Trochanter light brown. Femur black narrowly yellow at base and apex. Tibia dark, yellowish in basal quarter. Tarsus dark. Pulvillus longer than distitarsus.

Abdomen. Tergite 1 greyish pollinose laterally with fringe of long light bristles. Terga 2–6 shining, black, sparsely covered with light hairs. Terga 2–5 posterolaterally and lateral margin of tergum 6 greyish pollinose. Base of ovipositor semi-ovoid, shining, dark brown to black, sparsely pollinose in anterior margin. Piercer dark, straight, continually is tapering to the apex (Fig. 17, Fig. 18).

Etymology. The species name is dedicated to the grandson of the first author – Adam Strečko.

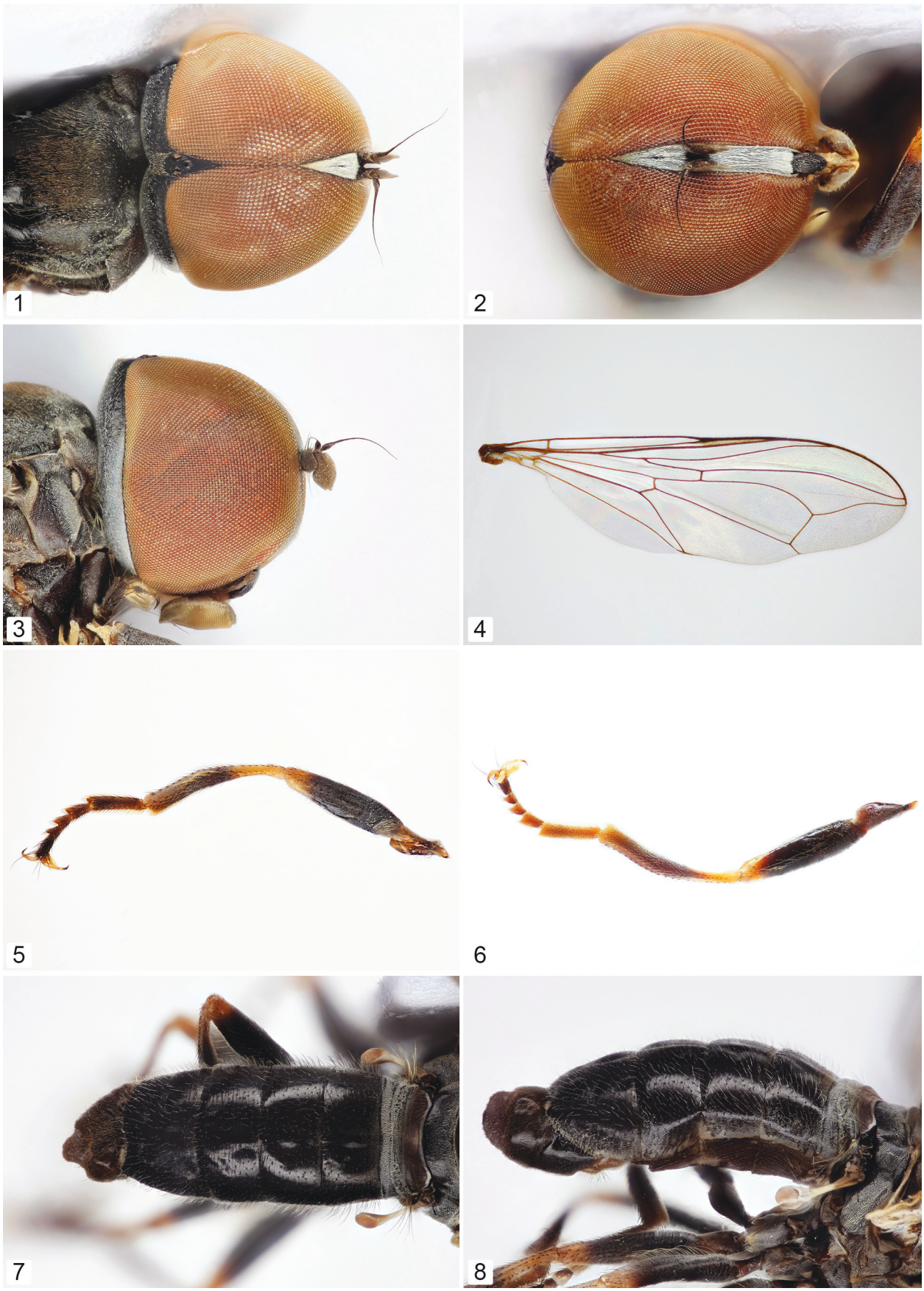
***Pipunculus anatolicus* Kozánek, sp. nov.**
Figs 19–27

Type locality. Turkey, Mugla, university campus, 37°09′38″N, 28°22′11″E.

Material examined. *Holotype.* 1 female, SNM: Turkey, Mugla, Univ. campus, 37°09′38″N, 28°22′11″E, 730 m a.s.l., xi.2015–iv.2016, Malaise trap, leg. M. Barták and Š. Kubík. *Paratypes.* 1 female, SNM: Turkey, Mugla, Univ. campus, 37°09′38″N, 28°22′11″E, 730 m a.s.l., xi.2015–iv.2016, Malaise trap, leg. M. Barták and Š. Kubík. 2 males, SNM: Turkey, Mugla, Univ. campus, 37°09′39″N, 28°22′20″E, 710 m a.s.l., xi.2012–iii.2013, Malaise trap, leg. M. Barták and Š. Kubík.

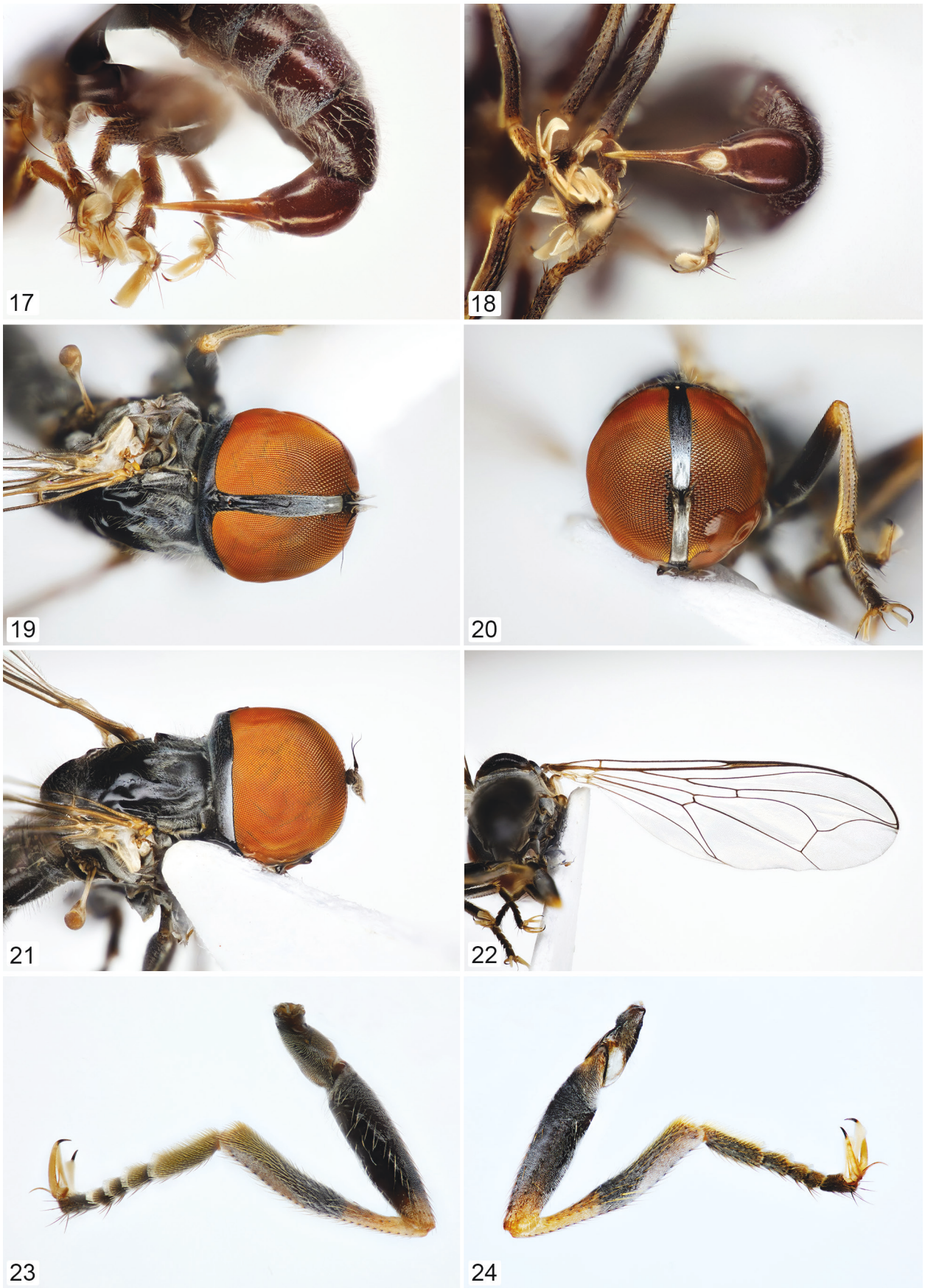
Differential diagnosis. *Pipunculus anatolicus* Kozánek, sp. nov. is described on the female specimens only. It can be affiliated to the *P. elegans* species group having scutum with reduced pollinosity. From females of the remaining representatives of this species group, it can be distinguished by a very short, straight piercer, which is about as long as the base of ovipositor, and by vein M_{1+2} strongly undulating.

Desription of female. *Head* (Fig. 19, Fig. 20, Fig. 21). Frons sub-parallel, slightly converging in upper half. Frons greyish pollinose. Anterior third of frons densely pollinose, pollinosity is continually reduced, with shining narrow medial line



Figures 1–8. Details on diagnostic characters. **Fig. 1.** *Pipunculus adami* Kozánek, sp. nov., male head, dorsal view. **Fig. 2.** *P. adami* Kozánek, sp. nov., male head, frontal view. **Fig. 3.** *P. adami* Kozánek, sp. nov, male head, lateral view. **Fig. 4.** *P. adami* Kozánek, sp. nov., male right wing. **Fig. 5.** *P. adami* Kozánek, sp. nov., male right hind leg, anterior view. **Fig. 6.** *P. adami* Kozánek, sp. nov., male right hind leg, posterior view. **Fig. 7.** *P. adami* Kozánek, sp. nov., male abdomen, dorsal view. **Fig. 8.** *P. adami* Kozánek, sp. nov., male abdomen, lateral view.

Figures 9–16. Details on diagnostic characters. **Fig. 9.** *Pipunculus adami* Kozánek, sp. nov., male syntergosternite 8, caudal view. **Fig. 10.** *P. adami* Kozánek, sp. nov., male epandrium, dorsal view. **Fig. 11.** *P. adami* Kozánek, sp. nov, male epandrium, left lateral view. **Fig. 12.** *P. adami* Kozánek, sp. nov., male epandrium, right lateral view. **Fig. 13.** *P. adami* Kozánek, sp. nov., male hypandrium, ventral view. **Fig. 14.** *P. adami* Kozánek, sp. nov., female head, dorsal view. **Fig. 15.** *P. adami* Kozánek, sp. nov., female head, frontal view. **Fig. 16.** *P. adami* Kozánek, sp. nov., female head, lateral view, lateral view.



Figures 17–24. Details on diagnostic characters. **Fig. 17.** *Pipunculus adami* Kozánek, sp. nov., ovipositor, lateral view. **Fig. 18.** *P. adami* Kozánek, sp. nov., ovipositor, dorsal view. **Fig. 19.** *P. anatolicus* Kozánek, sp. nov, female head, dorsal view. **Fig. 20.** *P. anatolicus* Kozánek, sp. nov., female head, frontal view. **Fig. 21.** *P. anatolicus* Kozánek, sp. nov., female head, lateral view. **Fig. 22.** *P. anatolicus* Kozánek, sp. nov., female right wing. **Fig. 23.** *P. anatolicus* Kozánek, sp. nov., female right hind leg, posterior view. **Fig. 24.** *P. anatolicus* Kozánek, sp. nov., female right hind leg, anterior view.

Table 1. Morphometric data for key characters measured on four *Pipunculus* Latreille, 1802 species. Measured values are given in millimeters.

	***Pipunculus adami* sp. nov.**		***P. anatolicus* sp. nov.**	***P. lindae* sp. nov.**	***P. wolfi* Kovarz, 1887**
	Males	Females	Females	Females	Males
N	8	1	3	2	4
Head					
Length of frons	0.43–0.47	0.45	1.08–1.14	1.01–1.06	0.48–0.52
Eyes touching distance	0.47–0.54				0.33–0.38
Length of ocellar triangle	0.09–0.11				0.12–0.14
Width of frons above antennae	0.05		0.13–0.15	0.11	
Maximal width of frons	0.08		0.18–0.19	0.15–0.17	
Length of flagellum	0.11–0.13		0.27–0.3	0.25–0.26	
Width of flagellum	0.06–0.07		0.1–0.11	0.09–0.1	
Right Wing					
Length of wing	4.84–5.42	4.1	4.8–5.09	4.29–4.41	5.34–5.61
Width of wing	1.26	1.42–1.45	1.42	1.52–1.73	1.48–1.68
Length of 3rd costal section	0.98–1.04	0.66	1.02–1.08	0.44–0.45	0.99–1.17
Length of 4th costal section	0.63–0.74	0.39	0.56–0.65	0.52–0.56	0.65–0.8
Abdomen					
Length of 5th tergite	0.59–0.68				0.66–0.71
Width of 5th tergite	0.97–1.06				0.89–1.03
Length of syntergosternite 8	0.34–0.43				0.59–0.63
Width of syntergosternite 8	0.69–0.79				0.73–0.78
Length of epandrium	0.5–0.63				0.48–0.62
Width of epandrium	0.42–0.54				0.35–0.39
Total length of ovipositor	1.54		0.78–0.81	1.17–1.22	
Length of ovipositor base	0.86		0.41–0.44	0.5–0.52	
Length of piercer	0.68		0.36–0.4	0.65–0.68	

bellow frontal triangle and laterally with arrow shaped pattern of reduced pollinosity. Ocellar triangle subshining black, equilateral. Occiput in upper one-third subshining black with sparse greyish pollinosity, its lower half densely grey pollinose. Compound eyes with 15–17 front rows of moderately enlarged facets. Scape and pedicel dark, brown pollinose, pedicel dorsally with 3–4 shorter ventrally with 5–6 longer light bristles. Flagellum brownish, marginally greyish pollinose, acuminate. Arista black.

Thorax. Postpronotal lobe dark, greyish pollinose. Prescutum laterally dense, medially more sparsely greyish pollinose. Scutum shining black with greyish pollinosity in anterior one-third and along posterior margin. Postpronotal lobes, prescutum, and anterior one-third of scutum with longer light hairs. Subscutellum black, greyish pollinose. Scutellum shining black with sparse long light hairs. Pleura with dense greyish pollinosity. Wing clear, transparent, covered with microtrichia which are reduced in medial cells (cup, bm, br). Pterostigma present. Crossvein r-m reaches cell dm shortly behind one-quarter of cell length. Vein M_{1+2} strongly undulated (Fig. 22). For wing measurements see Tab. 1. Halter light, basally darkened, halter knob light brown. Coxa black, sparsely greyish pollinose. Trochanter dark brown. Femur black, narrowly yellowish at base and apex. Tibia dark brown, yellowish in basal one-third to one-half. Hind tibiae mediolaterally with with 3–4 stronger light setae. Tarsus black. Pulvillus is slightly longer than distitarsus (Fig. 23, Fig. 24).

Abdomen. Tergite 1 greyish pollinose, laterally with fringe of long white bristles. Tergite 2 in anterodorsal one-third with sparse brownish pollinosity. Terga 2–6 shining, black, narrowly greyish pollinose in lateral margins (Fig. 25, Fig. 26). Base of ovipositor cylindrical, black, with sparse light pollinosity. Posterior margin of base shining dark brown. Piercer short, slim, stiletto shaped, brownish (Fig. 27).

Etymology. The species name is derived from the historical name of the country of species origin (Anatolia).

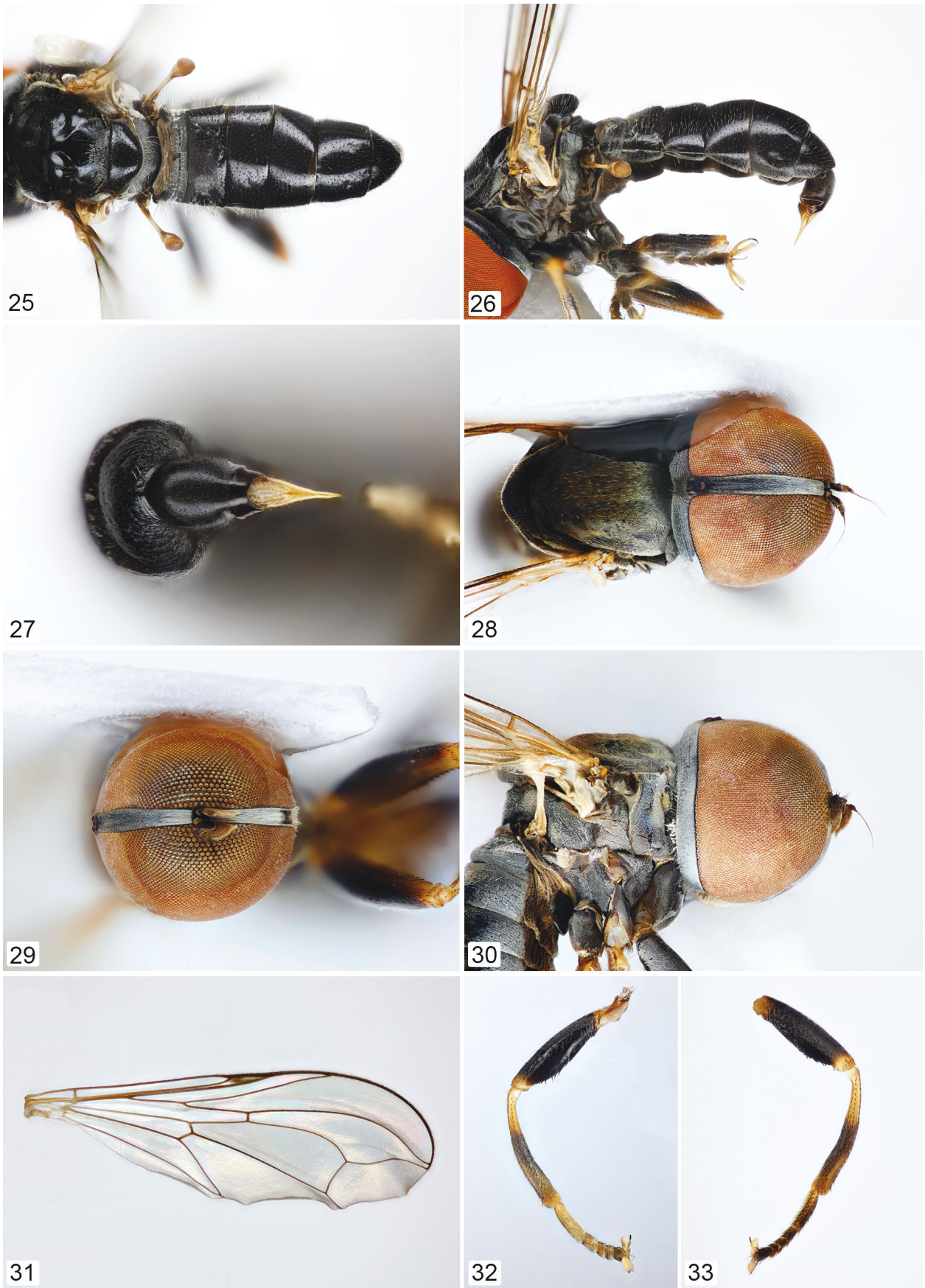
***Pipunculus lindae* Kozánek, sp. nov.**
Figs 28–36

Type locality. Slovakia, Krížna dolina, Vysoké Tatry Mts, 49°09′28.44″N, 19°56′41.58″E, 1196 m a.s.l.

Material examined. *Holotype.* 1 female, SNM: Slovakia, Vysoké Tatry Mts, Krížna dolina, 49°09′28.44″N, 19°56′41.58″E, 1196 m a.s.l., 29.vi.2009, MT, leg. O. Majzán and Ľ. Vidlička. *Paratype.* 1 female, SNM: Czech Republic, Šumava Mts., Rokytecká slať, forest, 49°00′59″N, 13°25′05″E, 1100 m a.s.l., 16.vi.–21.vii.1999, Malaise trap, leg. M. Barták.

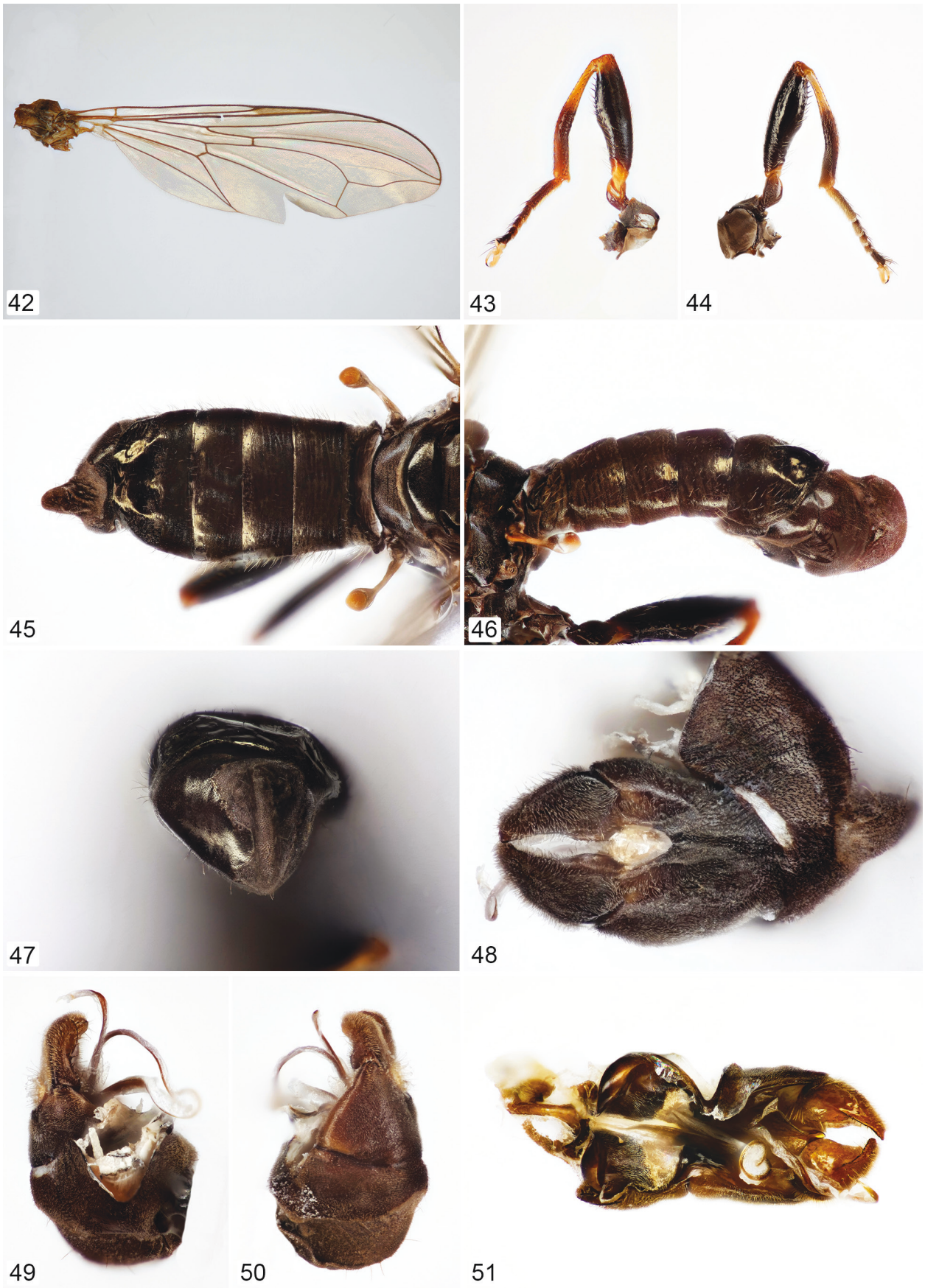
Differential diagnosis. *Pipunculus lindae* Kozánek, sp. nov. belongs to the *P. campestris* species group. The species resembles *P. lichtwardti* Kozánek, 1981 (Fig. 37, Fig. 38), from which it differs in mesonotum being anterolaterally greyish pollinose with no admixture of brown pollinosity, terga 4–6 dorsally shinning black at most with very narrow strip of pollinosity on anterior margin, shape of ovipositor with base cylindrical and piercer sharply separated from base.

Description of female. *Head* (Fig. 28, Fig. 29, Fig. 30). Frons sub-parallel, slightly converging in upper half, greyish pollinose. Posterior one-third with pattern consisting of narrow medial line and broader lateral stripes of reduced pollinosity. Ocellar triangle subshining black, equilateral. Occiput uniformly greyish pubescent with narrow strip of brownish pubescence behind ocellar triangle. Compound eyes with 10–12 front rows of moderately enlarged facets. Scape light brown, in upper mar-



Figures 25–33. Details on diagnostic characters. **Fig. 25.** *Pipunculus anatolicus* Kozánek, sp. nov., female abdomen, dorsal view. **Fig. 26.** *P. anatolicus* Kozánek, sp. nov., female abdomen, lateral view. **Fig. 27.** *P. anatolicus* Kozánek, sp. nov, ovipositor, dorsal view. **Fig. 28.** *P. lindae* Kozánek, sp. nov., female head, dorsal view. **Fig. 29.** *P. lindae* Kozánek, sp. nov., female head, frontal view. **Fig. 30.** *P. lindae* Kozánek, sp. nov., female head, lateral view. **Fig. 31.** *P. lindae* Kozánek, sp. nov., female right wing. **Fig. 32.** *P. lindae* Kozánek, sp. nov., female right hind leg, posterior view. **Fig. 33.** *P. lindae* Kozánek, sp. nov., female right hind leg, anterior view.

Figures 34–41. Details on diagnostic characters. **Fig. 34.** *Pipunculus lindae* Kozánek, sp. nov., female abdomen, dorsal view. **Fig. 35.** *P. lindae* Kozánek, sp. nov., female abdomen, lateral view. **Fig. 36.** *P. lindae* Kozánek, sp. nov., female ovipositor, dorsal view. **Fig. 37.** *P. lichtwardti* Kozánek, 1981, female abdomen, lateral view. **Fig. 38.** *P. lichtwardti* Kozánek, 1981, female ovipositor, dorsal view. **Fig. 39.** *P. wolfi* Kowarz, 1887, male head, dorsal view. **Fig. 40.** *P. wolfi* Kowarz, 1887, male head, frontal view. **Fig. 41.** *P. wolfi* Kowarz, 1887, male head, lateral view.



Figures 42–51. Details on diagnostic characters. **Fig. 42.** *Pipunculus wolfi* Kowarz, 1887, male right wing. **Fig. 43.** *P. wolfi* Kowarz, 1887, male right hind leg, anterior view. **Fig. 44.** *P. wolfi* Kowarz, 1887, male right hind leg, posterior view. **Fig. 45.** *P. wolfi* Kowarz, 1887, male abdomen, dorsal view. **Fig. 46.** *P. wolfi* Kowarz, 1887, male abdomen, lateral view. **Fig. 47.** *P. wolfi* Kowarz, 1887, male syntergosternite 8, caudal view. **Fig. 48.** *P. wolfi* Kowarz, 1887, male epandrium, dorsal view. **Fig. 49.** *P. wolfi* Kowarz, 1887, male epandrium, left view. **Fig. 50.** *P. wolfi* Kowarz, 1887, male epandrium, right view. **Fig. 51.** *P. wolfi* Kowarz, 1887, male hypandrium, ventral view.

gin with dark seta. Pedicel dark brown to black, in upper half with four dark brown setae, in lower half brown. Inner side of pedicel shining brown. Flagellum light brown, shortly acuminate. Arista shining brown, base dorsally brownish pollinose.

Thorax. Postpronotal lobe dark, densely greyish pubescent. Mesonotum anteriorly and laterally greyish pubescent with sparse longer light hairs, brownish pubescent on disc and hind margin. All pleural sclerites with greyish pubescence. Scutellum subshining black with sparse brownish pollinosity in anterior margin. Hind margin of scutellum with few shorter light hairs. Subscutellum densely greyish pubescent. Wing clear, transparent, covered with microtrichia which are reduced along cells bm/br common section of vein M. Pterostigma present. Crossvein r-m reaches cell dm at basal one-third of cell length. Vein M_{1+2} distinctly undulating (Fig. 31). For wing measurements see Tab. 1. Trochanter yellowish. Femur black, narrowly yellow at base and apex. Tibia dark, yellowish in basal one-quarter and along anterior margin. Tarsus dark. Pulvilli slightly longer than distitarsus (Fig. 32, Fig. 33).

Abdomen. Tergite 1 greyish pollinose medially with admixture of brownish pollinosity. Tergite 2 subshining black, in anterior half with silver, medially brownish, pollinosity. Tergite 3 narrowly greyish-brown pollinose along anterior margin. Terga 2–6 broadly greyish pubescent laterally (Fig. 34, Fig. 35). Base of ovipositor shining black, sharply separated from long straight light brown piercer (Fig. 36).

Etymology. The species name is dedicated to the granddaughter of the first author – Linda Strečková.

***Pipunculus wolfi* Kowarz, 1887**
Figs 39–51

Pipunculus wolfi Kowarz, 1887: 152

Material examined. 1 male, 1 female, SNM: Czech Republic, Šumava Mts, Nová Hůrka, spruce forest, 49°09′21″N, 13°20′00″E, 880 m a.s.l., 24.vi.–28.vii.2000, Malaise trap, leg. M. Barták. 1 male, SNM: Czech Republic, Krkonoše Mts, Zrcadlový potok, nr. brook, 50°38′1.9″N, 14°43′54.6″E, 670 m a.s.l., 1.ix.–13.x.2009, Malaise trap, leg. J. Vaněk. 1 female, SNM: Czech Republic, Krkonoše Mts, Upská jáma (Obří důl), 50°44′0.8″N, 15°43′32″, 1100 m a.s.l., Malaise trap, leg. J. Vaněk. 1 male, SNM: Czech Republic, Vráž u Písku, damp meadow, 400 m a.s.l., 49°24′13″N, 14°07′15″E, 400 m a.s.l., 31.v.–4.vi.2004, Malaise trap, leg. M. Barták. 1 female, SNM: Czech Republic, Vráž u Písku, damp meadow, 400 m a.s.l., 49.23°N, 14.08°E, 27.v.–2.vi.1996, Malaise trap, leg. M. Barták.

Differential diagnosis. This large species is related to *Pipunculus lenis* Kuznetzov, 1991, from which it differs in the following characters: abdominal terga laterally with no trace of grey pollinosity, brownish pollinose, surstyli broad, shortly pointed, base of phallic guide very broad.

Redescription of male. *Head* (Fig. 39, Fig. 40, Fig. 41). Frons densely light brown pollinose, in upper part with minute frontolateral hairs. Frontal patch posteriorly long acuminate, in lower half brownish in upper brownish-grey pollinose, medially with indistinct gap of reduced pollinosity. Face light brown pollinose. Ocellar triangle shining black, equilateral. Occiput greyish pollinose, in upper one-third and narrowly in hind margin with brown pollinosity. Eyes meeting for distance more or less equal to the length of frons (17–18 facets). Frontal facets of compound eyes not enlarged. Scape and pedicel dark brown. Flagellum brown, acute. Pedicel dorsally and ventrally with 4–5 long bristles. Arista black, posterior side of broadened base pollinose.

Thorax. Postpronotal lobe dark with lighter upper margin. Prescutum, scutum, scutellum and subscutellum black. Prescutum and scutum with two mediolateral rows of long dark bristles, brown pollinose, laterally with grey pollinosity. Scutellum brown pollinose. Subscutellum brown pollinose, laterally with admixture of grey pollinosity. Pleura dark, grey pollinose with admixture of brown pollinosity. Wing clear, transparent, very slightly brownish infuscated, uniformly covered with microtrichia. Pterostigma present. Crossvein r-m reaches cell dm shortly behind quarter of its length. Vein M_{1+2} undulating (Fig. 42). For wing measurements see Tab. 1. Halter with light brown knob. Coxae dark, grey pollinose. Trochanter brown. Femur black, narrowly yellowish at base and apex. Hind femur in apical one-third with double row of 8–9 spines. Tibia brown, yellowish in basal third, light brown at apex. Tarsus dark brown. Pulvilli as long as distitarsus (Fig. 43, Fig. 44).

Abdomen. Tergite 1 dark, brownish pollinose, laterally with tuft of 10–12 long light bristles. Terga 2–4 brownish pollinose, narrowly shining black at hind margin. Tergum 5 brownish pollinose anterior half, otherwise shining black. All terga with sparse, long, light hairs (Fig. 45, Fig. 46). Syntergosternite 8 subshining black, sparsely brown pollinose. Membranous area large, key-hole shaped with distinct keel (Fig. 47). Surstyli broad, almost symmetrical, shortly tipped at the apex (Fig. 48, Fig. 49, Fig. 50). Aedeagal guide broad, shortly pointed. Aedeagus trifid, ductuli long (Fig. 51).

Discussion

The European species of the genus *Pipunculus*, with the emphasis on Central European fauna, were first summarized by Kozánek (1981) who also provided the key for species known at that time. Kuznetzov (1991, 1993) further described several new *Pipunculus* species mainly from the European part of Russia. In a study of Finnish Pipunculidae, Kehlmaier (2008) advanced our knowledge of European species of the genus *Pipunculus* to a qualitatively new level. He solved a number of systematic uncertainties, provided detailed descriptions of all European species, and developed a modern key widely using stable morphological characters mainly on external terminalia. Despite the progress achieved in the last decades, our knowledge on European *Pipunculus* taxonomy, distribution, and biology is far from complete. Deficiencies in knowledge of the local Pipunculidae fauna still persist and extensive faunistic research in Southern and Eastern European countries is still needed. Continuing faunistic research focused on the biodiversity mainly in conserved areas can reveal the existence of new rare species. *Pipunculus adami* Kozánek, sp. nov. and *P. lindae* Kozánek, sp. nov. described in this work were also collected as a part of a research program focused on the entomofauna of conserved areas in Slovakia (Kováčovské kopce NR and Vysoké Tatry NP) and the Czech Republic (Šumava NP).

A detailed visualization of morphological characters is an essential requirement for exact description of species as well as the development of determination keys. The effort for continuous improvement of visualization techniques is obvious also in Pipunculidae research. Schematic drawings were used as a gold standard technique for visualization of key pipunculid morpho-

logical characters until Jervis (1992) in his revision of European *Chalarus* used scanning electron microscopy photographs. SEM photographs provide detailed information about the studied morphological characters but are difficult to use in routine taxonomic work. Stacked microphotography (stacking a series of focal planes taken in different depth of focus) provide visualization of the entire body or morphological characters and is increasingly used in pipunculid research (Kehlmaier et al. 2019, Motamedinia et al. 2020). Interactive photography, presented in this paper, is a fusion of high-resolution stacked microphotography and viewing software. It provides image quality comparable to SEM photographs. The interactive photography allows the observation of visualized morphological characters in detail. This novel method substantially increases the informative level of description and can also be effectively used in the creation of identification keys.

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