

Revision of the Palaearctic species of the *formosus* species group of *Spilomicrus* Westwood, 1832 (Hymenoptera, Diapriidae)

Ревизия палеарктических видов группы *formosus* рода *Spilomicrus* Westwood, 1832 (Hymenoptera, Diapriidae)

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Ключевые слова: паразитоиды, фауна, таксономия, определительная таблица, Япония, Палеарктика.

Abstract. The Palaearctic species belonging to the *Spilomicrus formosus* species group are revised. *Spilomicrus pelion* Nixon, 1980, **stat.rev.**, is removed from synonymy with *S. crassiclavis* Kieffer, 1911. The female of *S. pelion* and the male of *S. crassiclavis* have been found for the first time, and their diagnostic features are described and illustrated. The new species, *S. arkadyi* **sp.n.**, is described from Japan. The Palaearctic species of the *S. formosus* species group are keyed and illustrated, and the diagnoses of all species are updated. The diagnosis and the composition of this species group are discussed.

Резюме. Проведена ревизия палеарктических видов группы *Spilomicrus formosus*. Вид *Spilomicrus pelion* Nixon, 1980, **stat.rev.**, исключен из синонимии с *S. crassiclavis* Kieffer, 1911. Впервые обнаружены самка *S. pelion* и самец *S. crassiclavis*, и их диагностические признаки описаны и проиллюстрированы. Описан новый вид *S. arkadyi* **sp.n.** из фауны Японии. Приведена определительная таблица и иллюстрации палеарктических видов группы *S. formosus*, а также обновлена диагностика всех видов. Обсуждаются диагностика и состав этой группы видов.

Introduction

The genus *Spilomicrus* is one of the few Diapriidae genera which have been revised almost throughout the Holarctic Region [Masner, 1991; Notton, 1999; Chemyreva, 2018, 2021, 2023; Hübner, Chemyreva, 2024; Chemyreva, Ku, 2025]. To date it comprises about 85 described Holarctic species, about 60 of which occur only in the Palaearctic Region and four species (*S. antennatus* (Jurine), *S. formosus* Jansson, *S. sanbornei* Masner and *S. stigmatalis* Westwood) were recorded from both: the Nearctic and Palaearctic Regions. Masner [1991] suggested subdividing the Nearctic species into four species groups which can also be adopted for the Palaearctic fauna with some notes and clarifications [Chemyreva, 2015b].

The *S. formosus* species group is one of the most distinct and morphologically well-defined groups of *Spilomicrus* in the Palaearctic fauna [Notton, 1999; Chemyreva, 2021].

Masner [1991] defined three characters that characterize the *S. formosus* species group: presence of malar sulcus, pointed clypeus, and mandible with lower tooth stronger and longer than upper tooth. Among the additional characteristics, he mentioned the following: parallel or bulging temples; relatively short, highly convex, almost campanulate metasoma beyond petiole; comparatively primitive fore wing venation with tubular basal vein; and females with usually long 6–8-merous clava. However, taking into account the species composition of the *S. formosus* species group and the morphological characteristics of the species included in the group, Masner interpreted this group of species more broadly than subsequent authors, for example Notton [1999] or Chemyreva [2021]. Thus, Masner included in this group the species *S. superbus* Masner, which is very close to the species *S. kumaonensis* Sharma and *S. pilosiventris* Chemyreva [Chemyreva, 2015a]. However, these three species differ significantly from all other species of the genus *Spilomicrus* in the sculpture and pubescence of T2 and S2, and, apparently, form a separate group of species or even a subgenus within the genus *Spilomicrus* [Chemyreva, 2018, 2023]. In addition, the clypeus of these three species does not agree with the diagnostic features of the *S. formosus* species group, which are key to identifying this group of species [Notton, 1999]. Considering the above, the *S. formosus* species group, according to published data, currently includes six Holarctic species, three of which are found in the Palaearctic Region [Masner, 1991; Notton, 1999].

In this article, based on new data, I revise the diagnoses of Palaearctic species of the *S. formosus* species group and describe a new species from this group from the fauna of Japan.

Material and methods

The material used in this study was mainly collected in Japan, Russia and a few European countries by various collectors. Type specimens of the new species are deposited in the collections of the Canadian National Collection of Insects, Arachnids and Nematodes, Ottawa, Canada (CNC). Other material is housed in the Zoological Institute of the Russian Academy of Sciences, St. Petersburg, Russia (ZISP), the National Museum, Prague, Czech Republic (NMPC), and the Hungarian Natural History Museum, Budapest, Hungary (HNHM). Additionally, the type specimens of *Spilomicrus crassiclavis* and *S. pelion* from the Natural History Museum, London, U.K. (NHMUK) were examined in the course of this research. The morphological terms and abbreviations used herein follow those in Masner and García [2002], Yoder [2004], Chemyreva and Kolyada [2013], Chemyreva [2015b] and the Hymenoptera Anatomy Ontology [Yoder et al., 2010], but the “anterior incision of mesopleuron” is considered here as an *epicnemial pit*. The measurements were taken as in Yoder [2004], Chemyreva [2018]. The following abbreviations are used in the text: MGS — multiporous gustatory sensilla; T2–T7 — metasomal tergites; A1–A13 — antennomeres; POL — posterior ocellar line, the shortest distance between the posterior ocelli; LOL — lateral ocellar line, the shortest distance between one of the posterior (lateral) ocellus and the anterior (median) ocellus; OOL — ocellar-ocellar line, the shortest distance between the posterior (lateral) ocellus and the eye; YPT — yellow pan traps. New records are asterisked (*).

All photographs were obtained using a Leica M165 stereomicroscope equipped with a Leica DFC450 camera and a Nikon stereo microscope SMZ25 equipped with objective lens Plan Apo 1.6 × and digital camera DS-10. The most of types photos were obtained using a Canon EOS 60D camera with a 68 mm lens. Image stacking was performed with Helicon Focus 7.6 and Zerene Stacker.

The full-size photo-tables used in this paper, along with the original images of the new species, are provided as an online supplement on Zenodo (<https://doi.org/10.5281/zenodo.22159770>).

The present work is registered in ZooBank (www.zoobank.org) under urn:lsid:zoobank.org:pub:41830817-DFB6-4843-AC00-68796E994CEA

Taxonomy

Diapriidae Haliday, 1833

Diapriinae Haliday, 1833

Spilomicrini Ashmead, 1893

Spilomicrus Westwood, 1832

Spilomicrus formosus species group: Masner, 1991

Palearctic species included: *Spilomicrus arkadyi* sp.n., *S. crassiclavis* Kieffer, 1911, *S. formosus* Jansson, 1942, *S. pelion* Nixon, 1980, *stat.rev.* and *S. sanbornei* Masner, 1991.

Diagnosis. Clypeus, if bordered, subcircular and about as high as wide, without clypeal flange ventrally, but with sharply pointed or rounded ventral projection protruding over mandibles (Figs 11, 30, 33); in lateral view face forms

even curve with clypeus fused dorsally with upper part of face (Fig. 39); epistomal sulcus almost completely smoothed; tentorial pits reduced, very tiny to absent; malar sulcus always present, but narrow, complete to reduced next to eye; mandibles and pleurostomal distance comparatively short and distinctly shorter than the shortest distance between eyes; mandible with lower tooth stronger and longer than upper tooth; fore wing with costal vein (C) entirely strongly sclerotized to tubular; T2 bare and smooth at anterior margin (Figs 29, 34).

Distribution. Holarctic Region.

Remarks. The features mentioned by Masner [1991], such as the shape of the metasoma and the presence of a tubular basal vein, cannot be used in diagnosis of this species group, as these characteristics are only found in *S. formosus* and *S. crassiclavis* in the Palearctic fauna.

Spilomicrus arkadyi sp.n.

Figs 1–10.

<https://zoobank.org/NomenclaturalActs/9FC0E7CF-0246-4B5A-AAF5-51D08D237935>

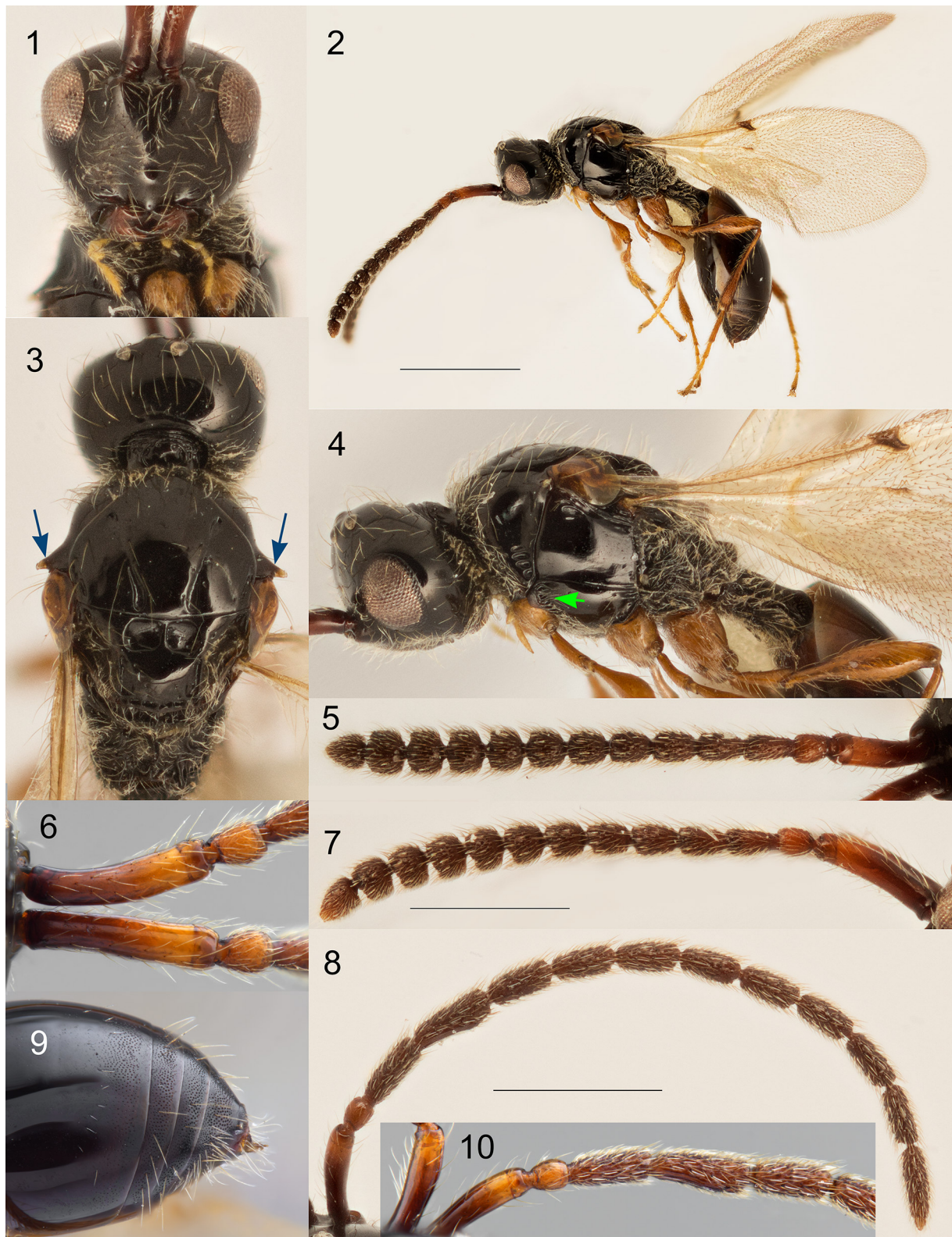
Type material. *Holotype.* Female. JAPAN. Honshu, Iwate, Iwaizumi, Hitsutori, 800 m, 11–17.VIII.1991, A. Smetana leg. (CNC). *Paratype.* JAPAN. Hokkaido, Sapporo, Hitsujigaoka, 21–27.VII.1989, K. Maeto and M. Sharkey legs, 1♂ (CNC).

Diagnosis. The new species differs from other Palearctic *Spilomicrus* species by the combination of the following features: clypeus circular, weakly convex, with pointed projection protruding medially over mandibles; epistomal sulcus absent (Fig. 1); tentorial pits very small; malar sulcus narrow and very shallow; female antenna with non-abrupt clava; A1 in both sexes smooth (Figs 6, 10); A8–A13 with MGS brush, not flattened on ventral side (Fig. 7); A13 distinctly narrower than A12 (Fig. 5), with shallow ventral pit; male A3 slightly shorter than A4, A4 weakly excavated, with carina extending 0.7 of segment length (Fig. 10); male A13 1.4 times as long as A12; mesoscutum weakly convex and mesosoma weakly arched, 0.9 times as high as wide (Figs 3, 4); dorso-posterior angles of pronotum (stigma) strongly projecting laterally and extending laterally beyond tegula (Fig. 3, arrow); notauli complete, shallow medially (Fig. 3); lateral side of pronotum with row of several deep, short and broad horizontal grooves (Fig. 4); sternaulus extending from epicnemial pit to posterior margin of mesopleuron as low carina (Fig. 4); stigmal vein comparatively long, distinctly longer than width of marginal vein (Fig. 4); T2 widely micropunctate along posterior margin (Fig. 9).

Description. *Holotype.* Female (Figs 1–7, 9). Body length 3.8 mm; fore wing length 2.5 mm; antenna length 2.0 mm. Body mainly black; tegula, apical part of A1 and A2, legs and venation pale brown; palpi yellow; mandible and A3–A13 dark brown.

Head in dorsal view transverse, 1.3 times as wide as long, equal to mesosoma width; in lateral view 1.3 times as high as long. Head smooth, shiny with scattered long setae. Frons smooth. Tentorial pits very small. Malar sulcus narrow and very shallow (Fig. 1). Clypeus circular, weakly convex, with pointed projection protruding medially over mandibles. Epistomal sulcus absent. Pleurostomal distance 2.2 times shorter than width of head. Mandibles short, weakly overlapping, bidentate with upper tooth shorter. Eye height 0.47 times head height and 1.5 times malar space length; eye covered with scattered long setae. Ocelli large and prominent; LOL 1.8 times as long as width of anterior ocellus; POL 0.7 times as long as OOL. Occipital flange narrow and smooth. Postgenal cushion dense.

Antenna. A1 cylindrical, weakly curved, smooth and shiny, with pale long setae (Fig. 6). Apical rim of A1 simple. A2 not



Figs 1–10. *Spilomicrus arkadyi* sp.n., holotype, female (1–7, 9) and paratype, male (8, 10). 1 — face; 2 — habitus in lateral view; 3, 4 — head and mesosoma in dorsal (3) and lateral (4) views; 5, 7, 8 — antennae in dorsal (5, 8) and lateral (7) views; 6 — A1 and A2 in dorsal view; 9 — apex of metasoma in lateral view; 10 — A1–A5 of male. Scale bars: 1.0 mm (2); 0.5 mm (7, 8).

Рис. 1–10. *Spilomicrus arkadyi* sp.n., голотип, самка (1–7, 9) и паратип, самец (8, 10). 1 — лицо; 2 — внешний вид сбоку; 3, 4 — голова и мезосома сверху (3) и сбоку (4); 5, 7, 8 — антенны сверху (5, 8) и сбоку (7); 6 — A1 и A2 сверху; 9 — вершина метасомы сбоку; 10 — A1–A5 самца. Масштаб: 1.0 мм (2); 0.5 мм (7, 8).

compressed, in lateral and dorsal views elongate, broadened apically and attenuate at base. Antenna with non-abrupt clava; A8–A13 with MGS brush, not flattened on ventral side. In lateral view, connection between A9–A13 situated dorsally (Fig. 7). A13 distinctly narrower than A12, with shallow ventral pit. Ratios of length to width (as well as ratios of its lengths to each other) of antennal segments in dorsal view: A1 25: 5; A2 7: 4.5; A3 8: 4.5; A4 8: 4.5; A5 7: 5; A6 7: 5; A7 7: 6; A8 7: 6; A9 6: 6.5; A10 6: 6.5; A11 6: 6.5; A12 7: 6; A13 7: 5.5 (Fig. 5).

Mesosoma 1.5 times as long as high, 1.3 times as long as wide and 0.9 times as high as wide. Neck bare, with irregular sculpture. Cervical pronotal area short, without ridge, densely pubescent; pronotal cushion dense. Pronotal shoulder distinctly prominent and rounded. Side of pronotum with row of several deep, short and broad horizontal grooves (Fig. 4); pronotal spiracle open on the top of high conical projection (Fig. 3, arrow). Propleuron smooth, with long, sparse pubescence. Mesopleuron smooth, with two deep longitudinal grooves under tegula, shining and bare at medial area. Epicnemial pit very narrow. Sternaulus extending from epicnemial pit to posterior margin of mesopleuron as low carina, area below it smooth and bare (Fig. 4). Lobe between sternaulus and fore coxa sculptured (Fig. 4, arrow). Acetabular carina sharp, dislocated posteriorly in medial part and divided with deep mesodiscrimen. Postacetabular sulcus present. Mesopleural epicoxal carina and sulcus developed only laterally. Mesonotum transverse, 1.3 times as wide as long. Notauli complete, shallow medially. Humeral sulcus complete and deep (Fig. 3). Scutellum flattened, with two large circular anterior scutellar pits. Axilla without grooves. Axillar depression pubescent. Lateral scutellar pits deep, broad and parallel to each other. Posterior scutellar pits quite large and deep (Fig. 3). Metascutellum pubescent and sculptured, with moderately projecting median and one lateral carinae. Median propodeal keel strongly projecting upward anteriorly; propodeum entirely coarsely rugose, with dense white pubescence. Posterior margin of propodeum in dorsal view weakly arcuate (Fig. 3). All legs slender; only hind legs without delimited trochantelli.

Fore wings clear, 2.8 times as long as wide. Marginal vein 2.3 times as long as wide; stigmal vein as long as marginal vein. Costal vein sclerotized and depigmented. Basal vein nebulous.

Metasoma. Petiole cylindrical, 1.3 times as long as wide, with few longitudinal grooves and with pubescence which denser on ventral side. T2 mainly bare but densely micropunctate along posterior margin (Fig. 9). T3–T5 entirely with dense punctation and a few scattered setae. T5 expanded laterally with numerous recumbent setae. T6–T7 small, covered with long setae (Fig. 9). S2 smooth, with sparse cushion at base; its posterior surface with numerous sparse setae. Following three sternites entirely with deep punctation and few long setae. Apical sternite with dense deep punctation and numerous long setae apically.

Male (Figs 8, 10). Body length 2.8 mm; antenna length 2.6 mm. Similar to female, but differs by features of antennal structures and petiole. All antennomeres covered with numerous short semirecumbent setae (Fig. 10). A4 weakly excavated, with carina extending 0.7 of segment length (Fig. 10). Ratios of length to width (as well as ratios of its lengths to each other) of antennal segments in dorsal view as: A1 20: 4.5; A2 6: 4.5; A3 12: 5; A4 15: 6; A5 12: 5; A6 11: 5; A7 11: 5; A8 11: 5; A9 11: 5; A10 11: 5; A11 11: 4; A12 11: 4; A13 15: 4 (Fig. 8). Petiole more elongated, about 2.5 times as long as wide.

Etymology. This species is named in honour of Professor Arkady Stepanovich Lelej, well-known Russian hymenopterist, in celebration of his 80th birthday.

Spilomicrus crassiclavis Kieffer, 1911

Figs 11–25.

Spilomicrus crassiclavis: Kieffer, 1911: 788, 797.

Spilomicrus crassiclavis: Notton, 1999: 132. Redescription.

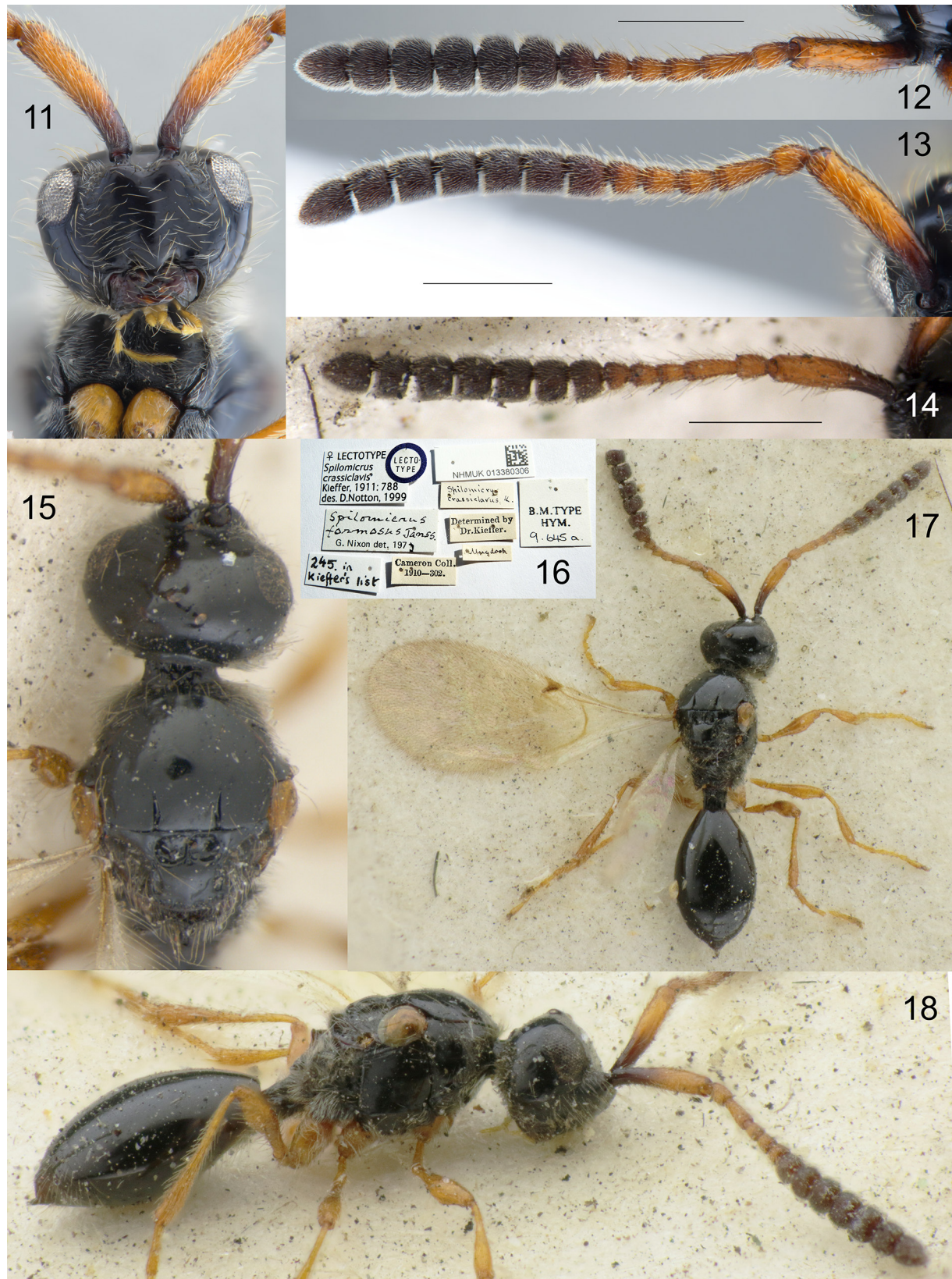
Type material examined. Lectotype: "Cameron Coll./ 1910-302," "Mugdock," "Determined by/ Dr Kieffer," "*Spilomicrus/ crassiclavis*, K.", "*Spilomicrus/ formosus* Janss./ G. Nixon det. 1972," "♀ Lectotype/ *Spilomicrus/ crassiclavis/* Kieffer, 1911: 788/ des. D. Notton, 1999", "NHMUK 013380306" (NHMUK).

Other material examined. Japan, Honshu, Aichi Pref., Toyone, 1300 m, Mt. Chausu, 16.VII.1992, sweeping, K. Yamagishi leg., 1♀, 4♂♂ (CNC); same locality and collector, 9.VII.1995, 1♂ (CNC); Honshu, Iwate Pref., Iwaizumi, Hitsutori, 800 m, 11–17.VIII.1991, A. Smetana leg., 1♂ (CNC).

Diagnosis. Body robust, about 2.2–3.2 mm, black, with brightly colored appendages. This species clearly differs from all known European *Spilomicrus* by the combination of the following features: head in dorsal view transverse with temples gradually receding behind eyes (Figs 15, 22, 24); malar sulcus deep and complete; in front view, anterior margin of clypeus triangular, pointed, with the tip curved toward mandibles (Fig. 11); female antenna with abrupt 7-segmented clava, A8–A12 strongly transverse, A7–A12 flattened ventrally, with distinct MGS brush; A13 slightly longer than A12 (Figs 12–14), without ventral pit; male A4 as long as A3, with weak emargination (Fig. 21) and low carinae extending over basal 0.7 of A4 and very slightly not reaching its base (Figs 20, 21); male A13 1.4 times as long as A12 (looks distinctly longer) (Fig. 20); A1 in both sexes smooth; mesosoma short, highly arched, especially in males (Figs 23, 25); in lateral view lower part of pronotum smooth; sternaulus absent (Figs 23, 25); notauli slightly convergent to slightly divergent anteriorly, developed in posterior one-fourth or one-third of mesonotum (Figs 15, 22, 24); stigmal vein comparatively long, slightly longer than width of marginal vein; T2 totally smooth postero-medially, without micropunctures.

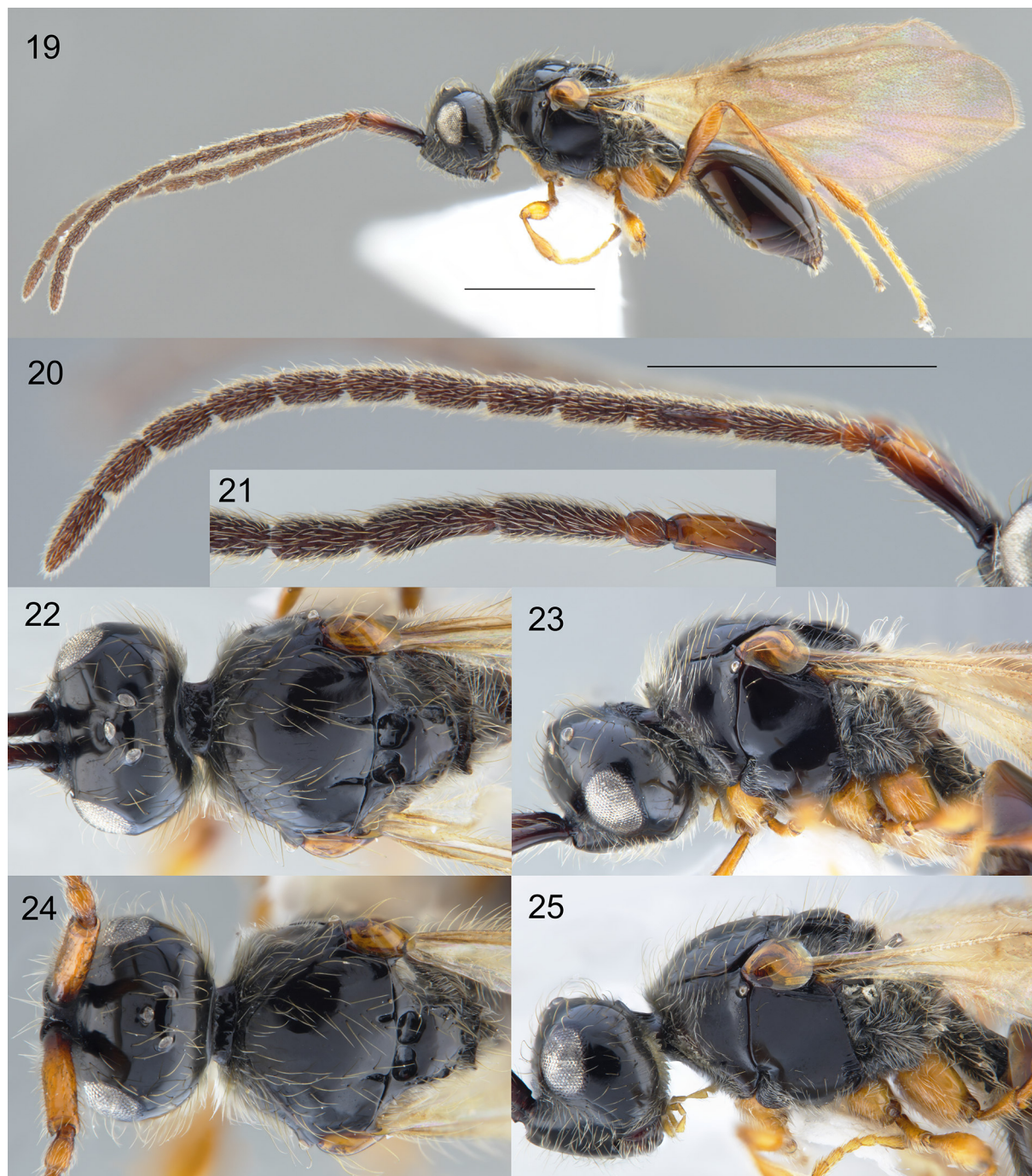
Distribution. U.K., Norway, Sweden, Denmark, the Czech Republic, Japan [Notton, 1999].

Remarks. The species *Spilomicrus crassiclavis* was described by Kieffer [1911] based on females and males. Later Nixon [1980] checked the male syntype of *S. crassiclavis* and reasonably synonymized it with *S. hemipterus* Marshall. He also described two males as *S. pelion*. In the most recent revision of the European species of the *S. formosus* species group, Notton [1999] revised the syntype of the female *S. crassiclavis*, which, as it turned out, is not conspecific with *S. hemipterus* and the male syntype of *S. crassiclavis*. Notton designated the female syntype *S. crassiclavis* as lectotype and suggested that males of *S. pelion* and the female of *S. crassiclavis* belong to one species. Although these males and females have several significant differences — notauli deep and distinct in *S. crassiclavis* (absent or visible as shallow trace in *S. pelion*), sternaulus absent in *S. crassiclavis* (complete in *S. pelion*), and some other — each morph was represented by a single sex [Notton, 1999]. This, possibly, was a reason to suggest that the females described as *S. crassiclavis* and males described as *S. pelion* actually belong to a single species demonstrating such significant sexual dimorphism. However, I have three males and three females belonging to the *S. formosus* species group and collected together in the European part of Russia. These males correspond completely with the description and type appearance of *S. pelion*, but the females are not similar to *S. crassiclavis* (Figs 11–18, 40–45). This material suggests that the synonymy of *S. pelion* under *S. crassiclavis* was erroneous and *S. pelion* should be restored from synonymy with *S. crassiclavis* and treated as a valid species.



Figs 11–18. *Spilomicrus crassiclavis* Kieffer, females, including lectotype (14–18). 11 — face; 12, 13, 14 — antennae in dorsal (12) and lateral (13, 14) views; 15 — head and mesosoma in dorsal view; 16 — labels; 17, 18 — habitus in dorso-lateral (17) and lateral (18) views. Scale bars: 0.5 mm (12–14); 1.0 mm (17, 18).

Рис. 11–18. *Spilomicrus crassiclavis* Кieffer, самки, включая лектотип (14–18). 11 — лицо; 12, 13, 14 — антенны сверху (12) и сбоку (13, 14); 15 — голова и мезосома сверху; 16 — этикетки; 17, 18 — внешний вид сверху (17) и сбоку (18). Масштаб: 0.5 мм (12–14); 1.0 мм (17, 18).



Figs 19–25. *Spilomicrus crassiclavis* Kieffer, male (19–23) and female (24, 25). 19 — habitus in lateral view; 20 — antenna in lateral view; 21 — A2–A5 in dorsal view; 22–25 — head and mesosoma in dorsal (22, 24) and lateral (23, 25) views. Scale bars: 1.0 mm.

Рис. 19–25. *Spilomicrus crassiclavis* Kieffer, самец (19–23) и самка (24, 25). 19 — внешний вид сбоку; 20 — антенна сбоку; 21 — A2–A5 сверху; 22–25 — голова и мезосома сверху (22, 24) и сбоку (23, 25). Масштаб: 1.0 мм.

Then the questions arise: why are the males of *S. crassiclavis* and the female of *S. pelion* totally absent in European material, and what do the males of *S. crassiclavis* look like? My suggestions regarding the first question are given in the conclusion, while the males of *S. crassiclavis* were found by me in Japanese material from CNC together with the corresponding females. The females correspond completely with the description and type appearance of *S. crassiclavis* (Figs 11–18), while males do not differ from females significantly and were collected simultaneously with the corresponding females (Figs 19–25).

Spilomicrus formosus Jansson, 1942

Figs 26–32.

Spilomicrus formosus: Jansson, 1942: 215.

Spilomicrus formosus: Notton, 1999: 134. Type citation and redescription.

Material examined. Austria, 2♂♂ (NMPC). Czech Republic, 19♀♀, 27♂♂ (NMPC). Slovakia, 4♂♂ (NMPC). Hungary, 1♀ (HNHM). Russia, Novgorod Prov., Tychkino Vill., 4–17.VI.1998, V. Tobias leg., 2♀♀. Leningrad Prov., Kameshki Vill., 1.VIII.1972, D. Kasparyan leg., 1♀. Moscow Prov., Moscow City, Bitsa Park, 9 and 18.VIII.1998, V. Kolyada leg., 2♀♀; Moscow City, Losiny Ostrov National Park, 13 and 20.VII.1993, V. Kolyada leg., 2♂♂. Vladimir Prov., Kirzhach River, Petushinskiy Distr., 22.VII.1912, Stadnik leg., 1♂. Samara Prov., Neftegorsk Distr., 5 km N of Pokrovka, 3.VII.2009, V. Chemyreva leg., 1♀. Belgorod Prov., Vicinity of Borisovka, Vorskla River, 20–24.VI.2012, V. Chemyreva leg., 2♀♀, 2♂♂. Krasnoyarsk Terr., Kuraginskii Distr., upper part of Sisim River, 13.VII.2012, V. Chemyreva leg., 1♂. Chukotka Peninsula, 180 km N of Omolon Vill., Omolon River, 19–20.VIII.1976, V.G. Marshakov leg., 1♀. Magadan Prov., 50 km N of Magadan, 13.VIII.1975, V.G. Marshakov leg., 1♂. Khabarovsk Terr., Vaninskii Distr., Vysokogorny, 10.VII.1983, D. Kasparyan leg., 1♂. Primorskii Terr., Vicinity of Novokachalinsk, Lake Khanka, 30.VI.1990, S. Belokobylskij leg., 1♂; Ussuriyskii Nature Reserve, 1.VIII.1993, S. Belokobylskij leg., 1♂; 15 km SSW of Nezhino, 16–18.VII.1993, S. Belokobylskij leg., 1♂; vicinity of Spassk-Dal'niy, 9–10.VII.1995, S. Belokobylskij leg., 1♂. Sakhalin Prov., vicinity of Novoaleksandrovsk, 14.VII.1981, S. Belokobylskij leg., 1♂; same locality, 7.IX.1973, D. Kasparyan leg., 1♀. Kazakhstan, 25 km NE of Ust'-Kamenogorsk, VII.1973, M.A. Kozlov leg., 1♂. All in ZISP.

Diagnosis. Body robust, 1.9–3.2 mm, black, with brightly colored appendages. This species clearly differs from all known European *Spilomicrus* by the combination of the following features: head in dorsal view transverse, with temples almost bulging behind eyes (Fig. 28); malar sulcus narrow and complete; in front view, ventral margin of clypeus angularly projecting medially, and curved posteriorly over mandibles (Fig. 30); female antenna comparatively slender, with cylindrical 8-segmented clava (Fig. 26); A8–A12 subquadrate or elongate; A6–A12 or A7–A12 flattened ventrally, with distinct MGS brush; A13 distinctly longer than A12, without pit ventrally; male A3 about as long as A4, A4 not curved or excavated basally, with low, non-prominent carina in basal one-fourth to one-half (Fig. 27); A1 in both sexes smooth; mesosoma short, highly arched (Fig. 32); lower part of pronotum in lateral view smooth (Fig. 31); notauli slightly divergent anteriorly and always developed at least in posterior one-third (Figs 28, 29); sternaulus absent (Fig. 31); stigmal vein about as long as width of marginal vein; T2 totally smooth postero-medially, without micropunctures.

Variation. Notauli reaching to 0.3–0.5 of mesonotum length. Females. Body length 2.2–3.0 mm. A12 and A11 subquadrate to 1.4 times as long as wide; A3 1.2–1.8 times as long as A2. Petiole transverse to 1.2 times as long as wide; T2 5.2–8.9 times as long as petiole. Males. Body length 2.1–3.2 mm. A2 and anterior part of A1 yellow to reddish brown, A3–A13 yellowish brown to dark brown. A3 slightly longer

than A4 or vice versa. A4 with carina extending for 0.25–0.50 of A4 length. Petiole distinctly transverse to subquadrate; T2 5.6–7.6 times as long as petiole.

Distribution. Ireland [Notton, 1999], U.K. [Nixon, 1980; Notton, 1999], Belgium [Notton, 1999], Denmark [Masner, 1991; Notton, 1999], Germany [Nixon, 1980; Notton, 1999], Sweden [Masner, 1991; Notton, 1999], *Austria, Czech Republic [Masner, 1991; Notton, 1999], Slovakia [Masner, 1991; Notton, 1999], *Hungary, Finland [Hellén, 1963; Masner, 1991; Notton, 1999], Russia [Hellén, 1963; Notton, 1999], *Kazakhstan, Japan [Masner, 1991; Notton, 1999], Canada [Masner, 1991; Notton, 1999], USA [Masner, 1991; Notton, 1999].

Spilomicrus pelion Nixon, 1980, stat.rev.

Figs 33–50.

Spilomicrus pelion: Nixon, 1980: 17.

Spilomicrus pelion: Notton, 1999: 132. Type citation and redescription (as male of *S. crassiclavis*).

Type material examined. Paratype: "Paratype ♂/ *Spilomicrus/ pelion*/ Nixon, 1980: 17/ det. D. Notton 2010", "Kent:/ Eynsford./ 7.vi.1930/ G. Nixon", "*Spilomicrus/ pelion* Nixon/ Paratype ♂, 1979", "NHMUK 013380307" (NHMUK).

Other material examined. Russia, Samara Prov., Stavropolskiy Distr., vicinity of Zhiguli Vill., 53.3899N, 49.2942E, YPT, 19–22. VI.2011, V. Chemyreva leg., 3♀♀, 3♂♂ (ZISP).

Diagnosis. Body robust, about 1.9–3.7 mm, black, with brightly colored appendages. This species clearly differs from all known European *Spilomicrus* by the combination of the following features: head in dorsal view transverse with temples gradually receding behind eyes (Figs 35, 45); malar sulcus shallow next to eye and deep next to mandible (Figs 33, 46); in front view, anterior margin of clypeus subtriangular, pointed, with the tip curved toward mandibles (Figs 33, 46); female antenna with non-abrupt clava with about 7 segments, A8–A12 transverse, A7–A12 flattened ventrally, with distinct MGS brush; A13 very slightly longer than A12 (Figs 47, 48), with shallow ventral pit; male A4 about 1.2 times as long as A3, without emargination (Figs 39, 49, 50) and with low carina extending over basal 0.7 of A4 and reaching its base; A13 as long as A12 (but looks shorter) (Figs 39, 49); A1 in both sexes entirely coriaceous (Figs 42, 50); mesosoma moderately arched in lateral view with mesoscutum moderately convex (Figs 36, 37, 41, 43); lower part of pronotum in lateral view smooth or with few shallow elongate depressions (Fig. 43); sternaulus complete (Fig. 43); notauli absent (Figs 44, 45); stigmal vein short, distinctly shorter than width of marginal vein; T2 with small area of micropunctures postero-medially (Fig. 40, arrow).

Distribution. U.K., Norway, Denmark, the Czech Republic [Notton, 1999], *Russia (European part).

Remarks. The species distribution given above is based on my own material and the assumption that all males studied by Notton [1999] are actually belong to this species. In Notton's material, all females and males were collected in different localities and/or in different times, which increases the confidence that they do not belong to the same species.

Spilomicrus sanbornei Masner, 1991

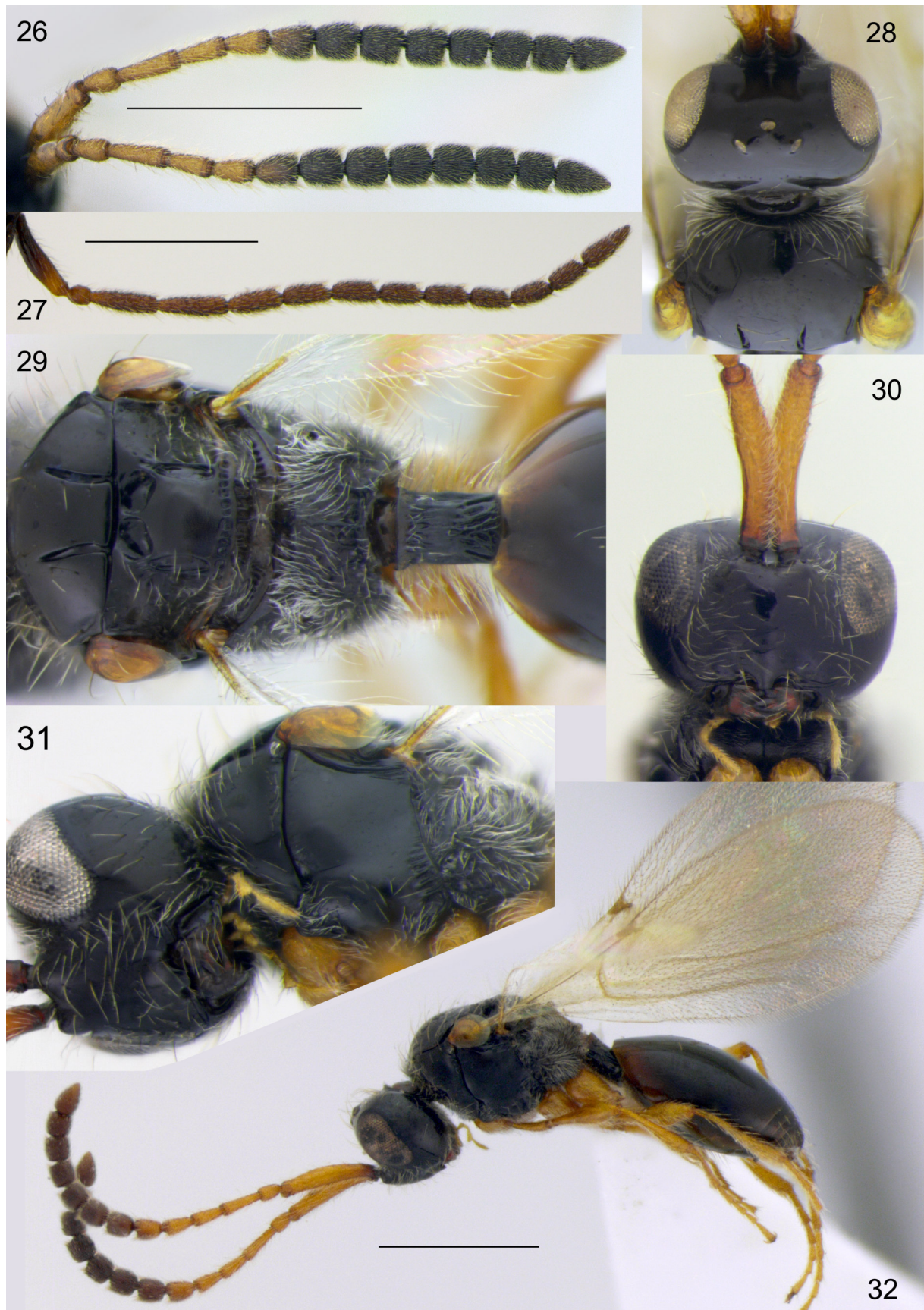
Figs 51, 52.

Spilomicrus sanbornei: Masner, 1991: 117, 145.

Spilomicrus sanbornei: Notton, 1999: 136. Redescription.

Type material examined. Holotype: female, "Thunder Bay/ ONT 22–29.VII.80/ Malaise trap, M. Sanborne," "Holotype/ *Spilomicrus/ sanbornei* ♀/ Msn./ CNC No. 20353," "CNC 881166" (CNC), Figs 51, 52.

Diagnosis. Relatively small wasp (1.3–2.5 mm) with body not robust, black, with brightly colored appendages.



This species distinctly differs from all the known European *Spilomicrus* by the combination of the following features: head in dorsal view strongly transverse, with temples parallel behind eyes (Figs 5–7 in Masner [1991]); malar sulcus deep; clypeus convex, ventrally with rounded projection curved toward mandibles (Figs 5–7 in Masner [1991] and Figs 5, 6 in Notton [1999]); female antenna with abrupt 5-segmented clava (Figs 51, 52); A13 as long as to slightly shorter than A12, with shallow pit ventrally; male A4 with moderately deep and curved emargination over basal 0.45–0.50 and short carinae extending 0.5 of segment length and not reaching its base (Figs 41, 42 in Masner [1991] and Figs 14, 15 in Notton [1999]); A1 smooth dorsally and weakly coriaceous ventrally in both sexes; mesosoma depressed, not more than 0.8 times as high as wide, mesoscutum weakly convex (Fig. 52); lower part of pronotum in lateral view smooth (Fig. 52); notauli deeply impressed but only in posterior quarter of mesonotum (Fig. 51); sternaulus absent; median propodeal keel low, very weakly raised anteriorly (Fig. 16 in Notton [1999]); stigmal vein short, distinctly shorter than width of marginal vein (Fig. 51); T2 with small area of micropunctures postero-medially.

Distribution. England [Notton, 1999], Canada [Masner, 1991], USA [Masner, 1991].

Remarks. In the Palaearctic Region, this species is still reported only from England [Notton, 1999]. I did not find any specimens of this species in other collections. Type photos are available on the CNC website (<https://www.cnc.agr.gc.ca/taxonomy/Gallery.php>) and are given in Figs 51, 52.

KEY TO THE PALAEARCTIC SPECIES OF THE *FORMOSUS* SPECIES GROUP OF *SPILOMICRUS*

Females

1. Antennae with abrupt 5-segmented clava (Fig. 52); in front view, ventral margin of clypeus rounded, blunt (Figs 5, 6 in Notton [1999]); mesosoma depressed, no more than 0.8 times as high as wide, mesoscutum weakly convex (Fig. 52); median propodeal keel low and very weakly raised anteriorly (Fig. 16 in Notton [1999]) (Nearctic, Europe) *S. sanbornei* Masner
- Antennae with non-abrupt (Figs 5, 7, 47, 48) or 7–8-segmented clava (Figs 12–14, 19); in front view, ventral margin of clypeus triangular, pointed (Figs 11, 23, 33, 46); mesosoma less depressed, at least 0.9 times as high as wide, mesoscutum strongly convex; median propodeal keel distinctly raised upward anteriorly and forming distinct triangular projection (Figs 18, 36, 41) 2
2. Antenna with abrupt 7–8-segmented clava (Figs 12–14, 26); sternaulus absent (Figs 23, 25, 31); A13 without pit ventrally; T2 without micropunctures postero-medially 3
- Antenna with non-abrupt clava (Figs 5, 7, 41, 47, 48); sternaulus complete (Figs 4, 36, 43); A13 with shallow pit ventrally; T2 with small or wide area of micropunctures postero-medially along its posterior margin (Figs 9, 40) 4
3. Antennal clava 7-segmented, A8–A12 strongly transverse (Figs 12–14); notauli slightly convergent anteriorly or

subparallel, developed in posterior fourth or third of mesonotum (Figs 15, 24) (Europe and Japan)

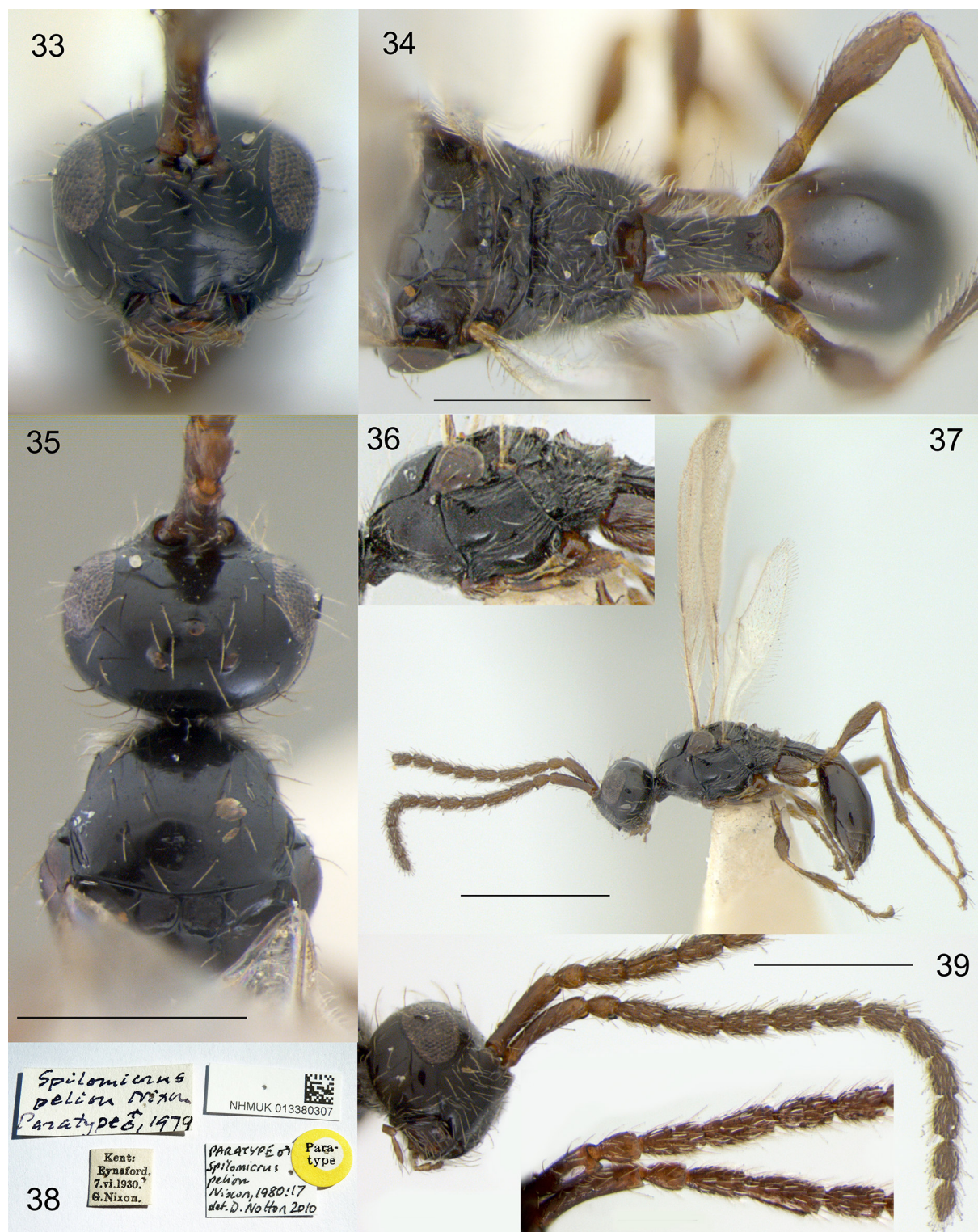
- *S. crassiclavis* Kieffer
- Antennal clava 8-segmented, A8–A12 subquadrate or elongate (Fig. 26); notauli distinctly divergent anteriorly and always developed at least in posterior third of mesonotum (Fig. 29) (everywhere in Palaearctic and Nearctic)
- *S. formosus* Jansson
4. Notauli absent (Figs 44, 45); antennae stout, A7 and A8 distinctly transverse (Figs 47, 48); lower part of pronotum in lateral view almost smooth (Fig. 43); T2 with small area of micropunctures postero-medially (Fig. 40) (Europe) ..
- *S. pelion* Nixon
- Notauli complete with deep pit anteriorly (Fig. 3); antennae slender, A7 and A8 elongate (Fig. 5); lower part of pronotum in lateral view with horizontal grooves (Fig. 4); T2 widely micropunctate along posterior margin (Fig. 9) (Japan) *S. arkadyi* sp.n.

Males

1. In front view, ventral margin of clypeus rounded, blunt (Figs 5, 6 in Notton [1999]); A4 with moderately deep, curved emargination and with carinae not reaching base of A4 (Fig. 14 in Notton [1999]); mesosoma distinctly depressed, no more than 0.8 times as high as wide, mesoscutum weakly convex (Fig. 52); median propodeal keel low, and very weakly raised anteriorly (Fig. 16 in Notton [1999]) *S. sanbornei* Masner
- In front view, ventral margin of clypeus triangular, acuminate (Figs 11, 23, 33, 46); A4 with at most a shallow emargination and with carinae reaching base of A4 (Figs 8, 10, 21); mesosoma less depressed, at least 0.9 times as high as wide, mesoscutum strongly convex; median propodeal keel distinctly raised upward anteriorly and forming distinct triangular projection (Fig. 36) 2
2. Eye bare; A4 with carina not overreaching basal half of the segment *S. formosus* Jansson
- Eye sparsely setose; A4 with carina overreaching 0.7 of the segment 3
3. Notauli complete with deep pit anteriorly (Fig. 3); lower part of pronotum in lateral view with horizontal grooves (Fig. 4) *S. arkadyi* sp.n.
- Notauli absent or partly developed without pit anteriorly (Figs 22, 35); lower part of pronotum in lateral view smooth (Fig. 23) 4
4. A1 smooth (Figs 20, 21); A3 as long as A4 (Fig. 21); A13 1.4 times as long as A12 (looks distinctly longer) (Fig. 20); notauli developed in posterior third of mesonotum (Fig. 22); sternaulus absent (Fig. 23) *S. crassiclavis* Kieffer
- A1 entirely coriaceous (Fig. 50); A3 distinctly shorter than A4 (Figs 39, 50); A13 as long as A12 (but looks shorter) (Figs 39, 49); notauli absent or very shallow (trace) (Fig. 35); sternaulus complete (Figs 36, 37) *S. pelion* Nixon

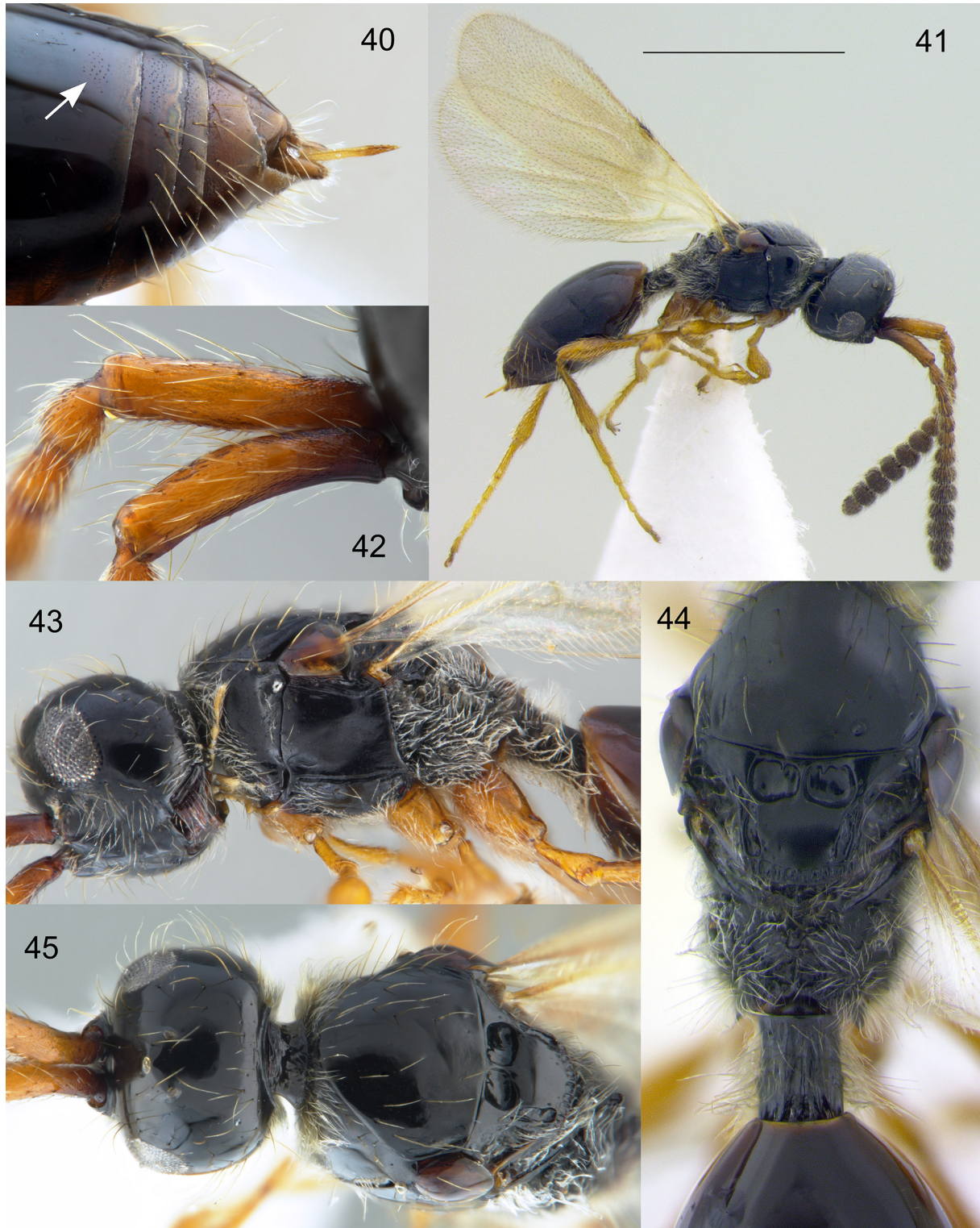
Figs 26–32. *Spilomicrus formosus* Jansson, female (26, 28–32) and male (27). 26 — antennae in lateral (upper) and dorsal (lower) views; 27 — antenna in lateral view; 28 — head in dorsal view; 29 — mesosoma and base of metasoma in dorsal view; 30 — face; 31 — head and mesosoma in ventro-lateral view; 32 — habitus in lateral view. Scale bars: 1.0 mm.

Рис. 26–32. *Spilomicrus formosus* Jansson, самка (26, 28–32) и самец (27). 26 — антенны сбоку (верхняя) и сверху (нижняя); 27 — антенна сбоку; 28 — голова сверху; 29 — мезосома и основание метасомы сверху; 30 — лицо; 31 — голова и мезосома вентро-латерально; 32 — внешний вид сбоку. Масштаб: 1.0 мм.



Figs 33–39. *Spilomicrus pelion* Nixon, male, paratype. 33 — face; 34 — mesosoma and base of metasoma in dorsal view; 35 — head and mesosoma in dorsal view; 36 — head and mesosoma in lateral view; 37 — habitus in lateral view; 38 — labels; 39 — antennae. Scale bars: 0.5 mm (34, 35, 39); 1.0 mm (37).

Рис. 33–39. *Spilomicrus pelion* Nixon, самец, паратип. 33 — лицо; 34 — мезосома и основание метасомы сверху; 35 — голова и мезосома сверху; 36 — голова и мезосома сбоку; 37 — внешний вид сбоку; 38 — этикетки; 39 — антенны. Масштаб: 0.5 мм (34, 35, 39); 1.0 мм (37).



Figs 40–45. *Spilomicrus pelion* Nixon, female. 40 — apex of metasoma in lateral view; 41 — habitus in lateral view; 42 — A1 in lateral view; 43, 45 — head and mesosoma in dorsal (45) and lateral (43) views; 44 — mesosoma and base of metasoma in dorsal view. Scale bar: 1.0 mm.

Рис. 40–45. *Spilomicrus pelion* Никсон, самка. 40 — вершина метасомы сбоку; 41 — общий вид сбоку; 42 — A1 сбоку; 43, 45 — голова и мезосома сверху (45) и сбоку (43); 44 — мезосома и основание метасомы сверху. Масштаб: 1.0 мм.



Figs 46–50. *Spilomicrus pelion* Nixon, female (46–48) and male (49, 50). 46 — face; 47–49 — antennae; 50 — A1–A4.
Рис. 46–50. *Spilomicrus pelion* Nixon, самка (46–48) и самец (49, 50). 46 — лицо; 47–49 — антенны; 50 — A1–A4.

Conclusion

This revision is primarily taxonomic. Although I have highlighted some unique finds, the material presented in this study is extremely limited and is not enough to trace the ranges of the studied species in the Palaearctic Region. For instance, I have found no specimens of *Spilomicrus crassiclavis* in Russia, and *S. pelion* is represented by only one series of specimens from the European part of Russia. I was surprised that the CNC collection, which boasts rich material on the Japanese fauna of *Spilomicrus*, also has few specimens of *S. formosus* species group. Among the thousands of *Spilomicrus* specimens collected in Japan by various collectors during the 1980s and 1990s, only two males of *S. formosus* [Notton, 1999], two females and six males of *S. crassiclavis* [Notton, 1999; current study], and two specimens of the new species were discovered. Notton's excellent revision of this species group is based on material from many European museums [Notton, 1999]. However, it also was based on only 15 females (most likely all *S. crassiclavis*) and five males (most likely all *S. pelion*), described as *S. crassiclavis*. Therefore, it can be concluded that both species, *S. crassiclavis* and *S. pelion*, are rare in Europe, and that *S. formosus* and *S. crassiclavis* are

rare in the Eastern Palaearctic. This may explain why no male *S. crassiclavis* and female *S. pelion* have been described in the European fauna yet. While this is almost the only possible explanation the absence of females of *S. pelion* in Europe, it cannot be ruled out that the European population of *S. crassiclavis* is parthenogenetic.

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Appendix (Online supplement)

Supplement to the paper "Revision of the Palaearctic species of the *formosus* species group of *Spilomicrus* Westwood, 1832 (Hymenoptera, Diapriidae)"

Appendix 1. The full-size photo-tables used in this paper, along with ZIP archive (240 MB) containing the original images of the holotype and paratype of the new species, *Spilomicrus arkadyi*.

<https://doi.org/10.5281/zenodo.22159770>

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Figs 51, 52. *Spilomicrus sanbornei* Masner, female, holotype in dorsal (51) and lateral (52) views. Scale bar: 1.0 mm.

Рис. 51, 52. *Spilomicrus sanbornei* Маснер, самка, голотип, вид сверху (51) и сбоку (52). Масштаб: 1.0 мм.

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