

Revision of *Speolepta* (Diptera: Mycetophilidae), with descriptions of new Nearctic and Oriental species

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Abstract—The cave-living and monobasic fungus gnat genus *Speolepta* Edwards is reviewed with a description of the first Nearctic species, *Speolepta vockerothi* **sp. nov.**, from Canada (caves in Ontario and British Columbia) and the United States (Alaska). Its morphology, life history, and biology are documented and compared with the single European species *Speolepta leptogaster* (Winnertz). A further new species, *Speolepta orientalis* **sp. nov.**, is described based on a single male from northern Vietnam, representing the first record of this genus from the Oriental Region.

Résumé—Une révision du genre cavernicole *Speolepta* Edwards est proposée. Le genre est pour la première fois répertorié dans la région Néarctique avec la description de *Speolepta vockerothi* **sp. n.** découvert à la fois au Canada (Ontario et Colombie Britannique) et aux États-Unis (Alaska). Des données sur la morphologie, le mode de vie et la biologie de cette espèce sont fournies. La description d'une seconde espèce nouvelle, *Speolepta orientalis* **sp. n.**, est basée sur un unique mâle collecté dans le nord Vietnam, ce qui constitue la première mention du genre dans la région Orientale.

Introduction

Speolepta Edwards (Diptera: Mycetophilidae) has received attention among entomologists because of its troglomorphic biology (*e.g.*, Matile 1962; Jefferson 1976), unique within the family Mycetophilidae *s. str.*, with all its life stages found in caves or other underground cavities. Although a large assemblage of adult fungus gnats (Sciarioidea) are known to seek underground environments for hibernation or aestivation (*e.g.*, Matile 1970; Kjærandsen 1993), this unusual habitat for the immature stages is only shared with certain species in Keroplatidae, the Australian glowworms being among the most studied (*e.g.*, Baker 2010).

However, the original description of the type species, *Speolepta leptogaster* (Winnertz), was not based on material collected in caves – rather the female type specimen was caught flying in a moist forest in central Europe (Winnertz 1864).

The genus has to date remained monotypic, with a single European species, although Plassmann (1977) described a second European species diagnosed on a larger radial cell compared with that of *S. leptogaster*. The wings of *S. leptogaster*, however, show considerable variation in the venation of the radial sector, where R₄ can be anything from absent to forming cells of variable sizes (Winnertz 1864; De Man 1884; Matile 1962). Hence, Plassmann's species has been regarded as a junior synonym of *S. leptogaster* (see Matile 1983).

The larva of *S. leptogaster* was described in detail by Schmitz (1912) and Madwar (1937). Matile (1962) described all life stages and Plachter (1981) added information about egg microstructure. The species is found throughout Western Europe, but has not been recorded from the European part of Russia. The phylogenetic placement of *Speolepta* was briefly discussed by Väisänen (1986).

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Vockeroth (1981) was the first to notice the existence of an undescribed Nearctic species of *Speolepta*, on the basis of three, Ontario, Canada, specimens in the Canadian National Collection of Insects (see also Peck 1988). We (S.A.M.) discovered a new population deep in a “sea cave” along the Georgian Bay shore of the Bruce Peninsula, Ontario (photodocumented in Marshall 2006), and J.K. found *Speolepta* in an outdoor (epigeal) sample from Alaska. Shaw and Davis (2000) added records from caves on Vancouver Island, British Columbia, Canada, and speculated about the existence of several undescribed Nearctic species.

Despite all these records, the Nearctic *Speolepta* has remained unnamed. Here we take the opportunity to reexamine the known North American material of *Speolepta* and describe a new species in honour of J.R. Vockeroth. We compare its morphology with the European *S. leptogaster* and, on the basis of new field observations from Rover’s Cave, Ontario, in 2008–2010, compare its biology with that known for *S. leptogaster*. Finally, we record this genus from the Oriental Region and describe another new species collected in northern Vietnam.

Material and methods

Male terminalia of selected specimens were cleared in 10% solution of KOH and placed in a microvial with glycerol (pinned specimens) or in ethanol. The type material of *Speolepta vockerothi* is deposited in the following collections: Canadian National Collection of Insects, Ottawa, Canada (CNCI); University of Guelph Insect Collection, School of Environmental Sciences

(formerly Department of Environmental Biology), University of Guelph, Canada (DEBU); Hungarian Natural History Museum, Budapest (HNHM); The Natural History Museum, London (BMNH); private collection of Jan Ševčík, Ostrava, Czech Republic (JSOC). The morphological terms principally follows Söli (1997). Other acronyms used in this article are MZLU (Museum of Zoology, Lund University), S.A.M. (Stephen A. Marshall), and J.K. (Jostein Kjærandsen).

Although the population of flies in our Rover’s Cave study site seems high and dozens of flies were seen on each visit, collections were limited to small numbers necessary for morphological examination and taxonomic description to avoid damage to this restricted population. Most of the material collected and killed for study, including the immature stages, is stored in ethanol; six adult specimens are pinned and two are slide mounted in Canada Balsam.

Speolepta

Speolepta Edwards, 1925: 566. Type species: *Polylepta leptogaster* Winnertz, 1864.

Remarks. Edwards (1925) established the rather enigmatic, monobasic genus *Speolepta* on the basis of two main characters: the seventh abdominal segment being large and vein Sc ending free. Its systematic position has remained ambiguous and contentious. Edwards placed it with some doubt in Gnoristini, because it has a wing membrane without macrotrichia, the mediotergite bare and vein R₁ relatively long; characters usually associated with the tribe. Chandler (1980) figured the mid-tibial organ of some mycetophilid genera and pointed out its presence in *Phthinia* Winnertz and *Speolepta*,

Key to species

- 1 Stem of M-fork relatively long, ratio of the stem to M₁ distinctly more than 0.5, Sc long, reaching to the level of base of Rs, vein Tb short, about as long as stem of M (Fig. 2D); male terminalia with distinct apicomedial process on gonocoxites (Fig. 3) *Speolepta vockerothi* sp. nov.
- M-ratio around 0.5 or less, Sc shorter, vein Tb distinctly longer than stem of M (Fig. 6); posterior margin of gonocoxites concave, without apicomedial process (Figs. 1, 7). 2
- 2 Cu branching almost at the level of Rs (Fig. 6); gonocoxites about as long as broad, dorsally fused (Fig. 7) *Speolepta orientalis* sp. nov.
- Cu branching more distally; gonocoxites rectangular, about 1.2 times as long as broad, dorsally separated (Fig. 1) *Speolepta leptogaster* (Winnertz)

suggesting their possible relationship. Plachter (1981) studied the structure of the eggs in several taxa, including *S. leptogaster*, and showed that its structure is of the same type as *Phthinia*. Väisänen (1986) discussed the position of *Speolepta* in more detail and strengthened its possible relationships with *Paratinia* Mik and *Phthinia*, both traditionally placed in the tribe Sciophilini. Most subsequent authors have followed Väisänen (1986) and included *Speolepta* in Sciophilini. Söli (1997) considered a large seventh segment to be a plesiomorphic character within Mycetophilidae, present also in some genera in Sciophilini, and tentatively assigned *Speolepta* to that tribe. However, molecular analyses by Rindal *et al.* (2009) gave support to the original placement of *Speolepta* in Gnoristini.

***Speolepta leptogaster* (Winnertz)**

(Fig. 1)

Polylepta leptogaster Winnertz, 1864: 746.
Speolepta dissona Plassmann, 1977: 30.

Emended diagnosis. Most aspects of the morphology of both sexes and all life stages of this species were described by Matile (1962). However, the characteristic shape of the gonocoxite and the internal structures of the male terminalia have not been illustrated in detail. We include a photographic plate (Fig. 1) to enable direct comparison with the new species (Figs. 3, 6). Notable is the rectangular shape of the gonocoxite (Fig. 1A–1B) with a flat ventral side that is invaginated and incised apicomediaally (Fig. 1C–1D). The dorsal side is entirely open (Fig. 1B, 1D), leaving only the strong gonocoxal apodemes greatly prolonged anteriorly to meet the elongated aedeagal apparatus beyond the base of the gonocoxite (Fig. 1G). One pair of slender and very long parameres run posteriorly to about 1.5 the length of the gonocoxite (Fig. 1B). The small, narrowly rectangular aedeagus is situated anteriorly below the base of the parameres (Fig. 1G).

Material examined from caves and other underground environments

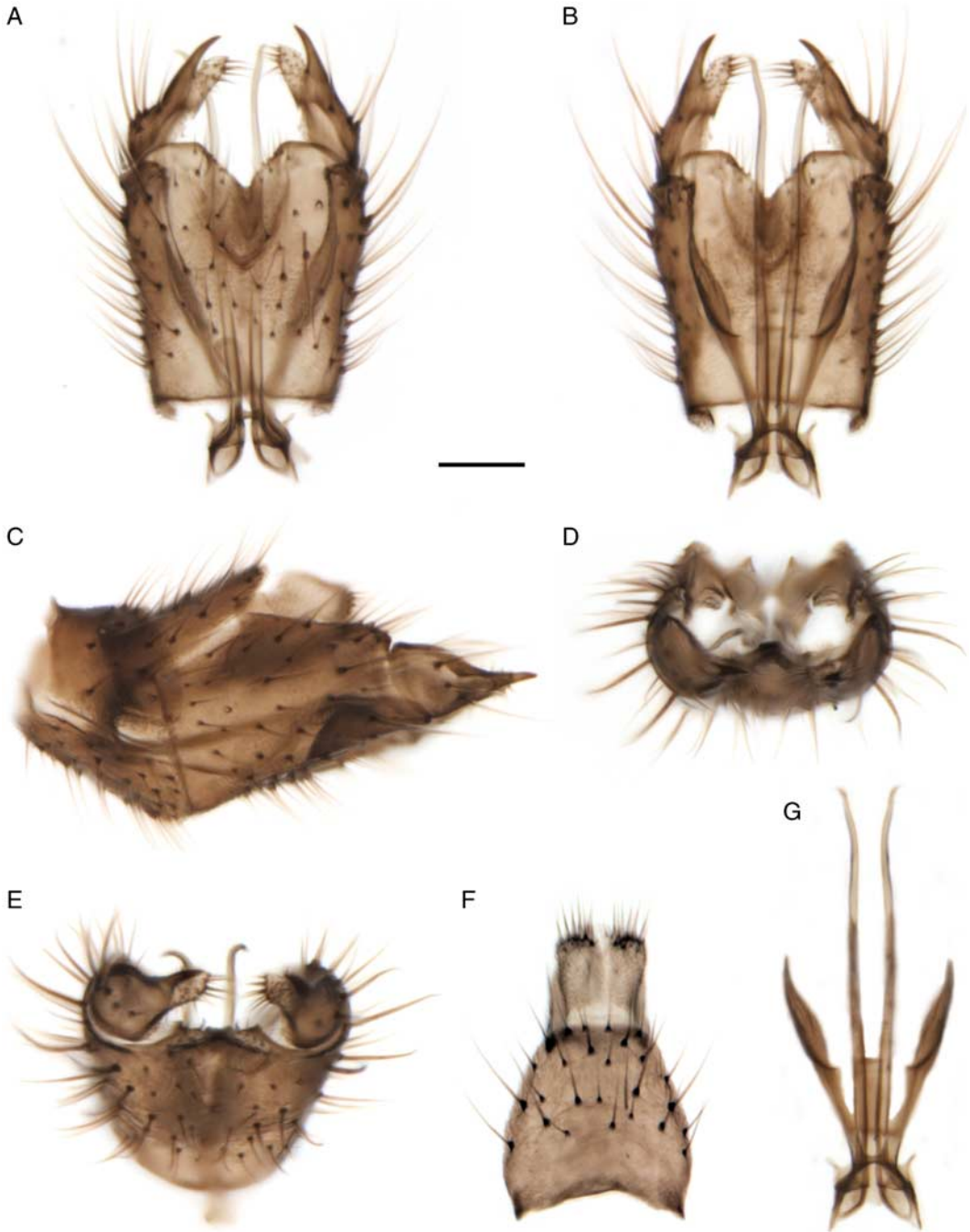
NORWAY: **AK**, Eidsvoll, Byrud, in mine galleries called “Byrud smaragdgruver [T mine]”, 60°25′07″N, 11°11′43″E, 15.ii.1992, J.K. (two larvae, MZLU); **BU**, Nedre Eiker, Svarttjern,

in limestone cave inside lower entrance, 59°46′28″N, 010°03′09″E, 17.ii.1992, J.K. (one larva, MZLU); **HOY**, Bergen, Haukeland, 60°21′16″N, 005°27′19″E, 60 m from entrance inside a mine gallery, 21.iii.1991, J.K. (1 ♂, MZLU); **VE**, Larvik, N Tinvik, 59°02′38″N, 010°01′01″E, inside opening of WW2 bunker, 22.v.2005, J.K. (one larva, five pupae, MZLU). **GREAT BRITAIN:** S. Wales, Llygad Llchwyr, 30.xi.1951, L.A. Hawes (1 ♂, BMNH).

Material examined from other habitats

NORWAY: **HOI**, Kvinnherad, Rosendal, riverside at Avlsgården, Baroniet, 59°59′10″N, 6°01′26″E, 30 m a.s.l., 11–15.v.1990, Malaise trap, J.K. (1 ♀, 2 ♂, MZLU); **HOY**, Bergen, Haukeland, 60°21′16″N, 005°27′19″E, outside large mine, 9.v–28.vi.1991, Malaise trap, J.K. (3 ♂, MZLU); Bømlo, Vorland, Langevåg, 59°36′27″N, 5°12′40″E, 11.ii.2002–12.ii.2003, Malaise trap, J.K. (7 ♀, 5 ♂, MZLU); Etne, Skånevik skyttarbane, 59°43′33″N, 5°54′06″E, 140 m a.s.l., 3.ix.2009, sweep net, J.K. (1 ♀, 1 ♂, MZLU); Fjell, Vindenes, 60°25′19″N, 4°59′43″E, 30 m a.s.l., 5.ix.1978, light trap, T. Andersen (1 ♀, MZLU); Os, Raudli, 60°16′28″N, 5°29′08″E, 200 m a.s.l., 23–30.v.1991 (1 ♀, 1 ♂); 6–13.vi.1991 (4 ♀, 3 ♂); 13–20.vi.1991 (2 ♀, 2 ♂); 20–27.vi.1991 (3 ♀, 1 ♂); 27.vi.–4.vii.1991 (1 ♀); 15–22.viii.1991 (1 ♂); 29.viii.–5.ix.1991 (4 ♀, 1 ♂); 5–12.ix.1991 (3 ♀, 3 ♂) (all Malaise trap, G.A. Halvorsen *et al.*, MZLU); Os, Sæleli, 60°15′41″N, 5°28′23″E, 200 m a.s.l., 20–27.vi.1991, Malaise trap, G.A. Halvorsen *et al.* (1 ♂, MZLU); Øygarden, Dalsvann, Alvøy, 60°36′13″N, 4°49′00″E, 5.vi.1987, light trap, T. Andersen (1 ♀, MZLU); Sveio, Førde, Solheimshaugen, 59°36′53″N, 5°28′32″E, 40 m a.s.l., 3–10.vi.1991 (1 ♂); 27.vii.–3.ix.1991 (1 ♂) (both Malaise trap, J.K., MZLU); 15.vi.1991, sweep net, J.K. (1 ♀, 1 ♂, MZLU). **MRI**, Sunndal, Jordalsgrenda, Jordalsøra, Hamrene, 62°46′18″N, 8°19′12″E, 140 m a.s.l., 31.v.–13.vii.2004 (9 ♀, 13 ♂); 26.viii.–6.ix.2004 (1 ♂) (both Malaise trap, J.B. Jordal, MZLU); 14.vi.–3.vii.2005 (2 ♂); 12–25.viii.2005 (1 ♀) (both window trap, J.B. Jordal, MZLU). **SFI**, Aurland, Vassbygdevatnet (lower end of lake), 60°52′34″N, 7°15′51″E, 60 m a.s.l., 4.viii.1969, sweep net, T. Andersen (1 ♀, MZLU). **TEY**, Porsgrunn, Hitterødbekken, 59°04′26″N, 9°38′59″E, 50 m a.s.l.,

Fig. 1. Male terminalia of *Speolepta leptogaster* Winnertz (preterminal segments, tergite 9, and cerci removed except in C). (A) Ventral view, (B) dorsal view, (C) lateral view, including segment 8, tergite 9, and cerci, (D) caudal view, (E) ventrocaudal view, (F) tergite 9 and cerci, dorsal view, (G) aedeagal apparatus including gonocoxal apodemes, parameres, and aedeagus, dorsal view. Scale bar = 0.01 mm.



13.vi.–11.vii.1988, Malaise trap, G.E.E. Søli (3 ♀, MZLU). **SWEDEN:** LU, Jokkmokk, Kaltisbäcken 1 km NNE Messaure, 66°41'26"N, 20°22'37"E, 250 m a.s.l., Loc. 20, 19–30.vi.1968, air suction trap, K. Müller (1 ♀, 3 ♂, MZLU). **SK**, Lund, Høje Å (stream) at Värpinge, 55°42'03"N, 13°08'50"E, 11 m a.s.l., 23–28.v.2004, yellow pan trap, J.K. (1 ♂, MZLU); Klippan, Skärallid NR (ravine with stream), 56°02'04"N, 13°14'23"E, 80 m a.s.l., 26.ix.1983, sweep net, H. Andersson (1 ♂ m MZLU). **SM**, Högsby kommun, Getebro, 57°01'00"N, 16°10'00"E, 67 m a.s.l., 29.vii.–31.viii.2004, Malaise trap, N. Franc *et al.* (1 ♀, MZLU). **FAROE ISLANDS:** Streymoy, Kvivik, 62°07'16"N, 7°04'22"W, 100 m a.s.l., 4–8.vii.1990 (1 ♂); 13–17.vii.1990 (1 ♂) (both Malaise trap, L.L. Jørgensen, MZLU). **CZECH REPUBLIC:** **Bohemia**, Jizerské Hory Mts, Jedlový důl, 670 m, 6–28.vii.2005 (1 ♂), 1–22.ix.2005 (2 ♂), Mt. Poledník, 29.viii.–5.x.2004 (1 ♂) (all J. Preisler & J. Vonička, Malaise trap, JSOC), Krkonoše Mts., Bílé Labe, 16–30.viii.2007 (1 ♂), Labský důl, 1040 m, 24–27.viii.2006 (1 ♂) (both J. Vaněk, Malaise trap, JSOC); **Moravia & Silesia**, Hrubý Jeseník Mts, Velká kotlina, glacial cirque, 9–26.vi.2006 (1 ♂), Rejvíz, peat-bog, 20.v.–1.vii.2005 (1 ♀) (both J. Roháček & J. Ševčík, Malaise trap, JSOC). **SLOVAKIA:** Pol'ana Mts., Hrončecký grúň, 7.v.–4.vii.2006 (1 ♂) (yellow pan traps), Kyslinky – Pod Dudášom, 15.vi.2009 (1 ♂), Predná Pol'ana Mt. – Bystré waterfall, 17.vi.2009 (1 ♂), Spády waterfall, 18.vi.2009 (1 ♂), 4.vii.2006 (1 ♂) (all J. Ševčík, JSOC).

***Speolepta vockerothi* sp. nov.**

(Figs. 2–5, 8A)

Diagnosis. Adults of both sexes can be separated from the Palaearctic species, *S. leptogaster*, by wing vein ratios with Sc₂ branched distinctly more proximally (at about two-third the length of Sc from h in *S. vockerothi* compared with three-fourth the length in *S. leptogaster*) and the M-fork longer (stem about one-third the length of M₁ and subequal to length of vein tb in *S. vockerothi*, distinctly less than one-third of M₁ and shorter than vein tb in *S. leptogaster*). The male differs in several aspects. The mid-tibial sense organ is short and rather vestigial

compared with that of *S. leptogaster*. The male terminalia are built from the same “groundplan” but show major allometric changes between the two species. In *S. vockerothi*, tergite 9 is distinctly shorter (Fig. 3C), the gonocoxite is more gently rounded (Fig. 3A, 3B), with a broad bridge merging with the smaller aedeagal apparatus dorsally, ventrally with a larger apicomedial V-shaped incision, which is expanded posteriorly into a distinct medioventral process (Fig. 3A). Both apical branches of the gonostylus (Fig. 8A) are distinctly more dilated and curved medially in *S. vockerothi*, the ventral branch forming a broad membranous rounded spatula in dorsoventral view. The aedeagal apparatus (Fig. 3G) is more compact, with two pairs of short parameres, basally fused with the gonocoxal apodemes. We are not able to find any significant differences between the female terminalia of the two species.

Etymology. The new species is dedicated to J.R. Vockeroth to acknowledge his rich contributions to the study of Nearctic fungus gnats and to honour his discovery of this new species some 30 years ago.

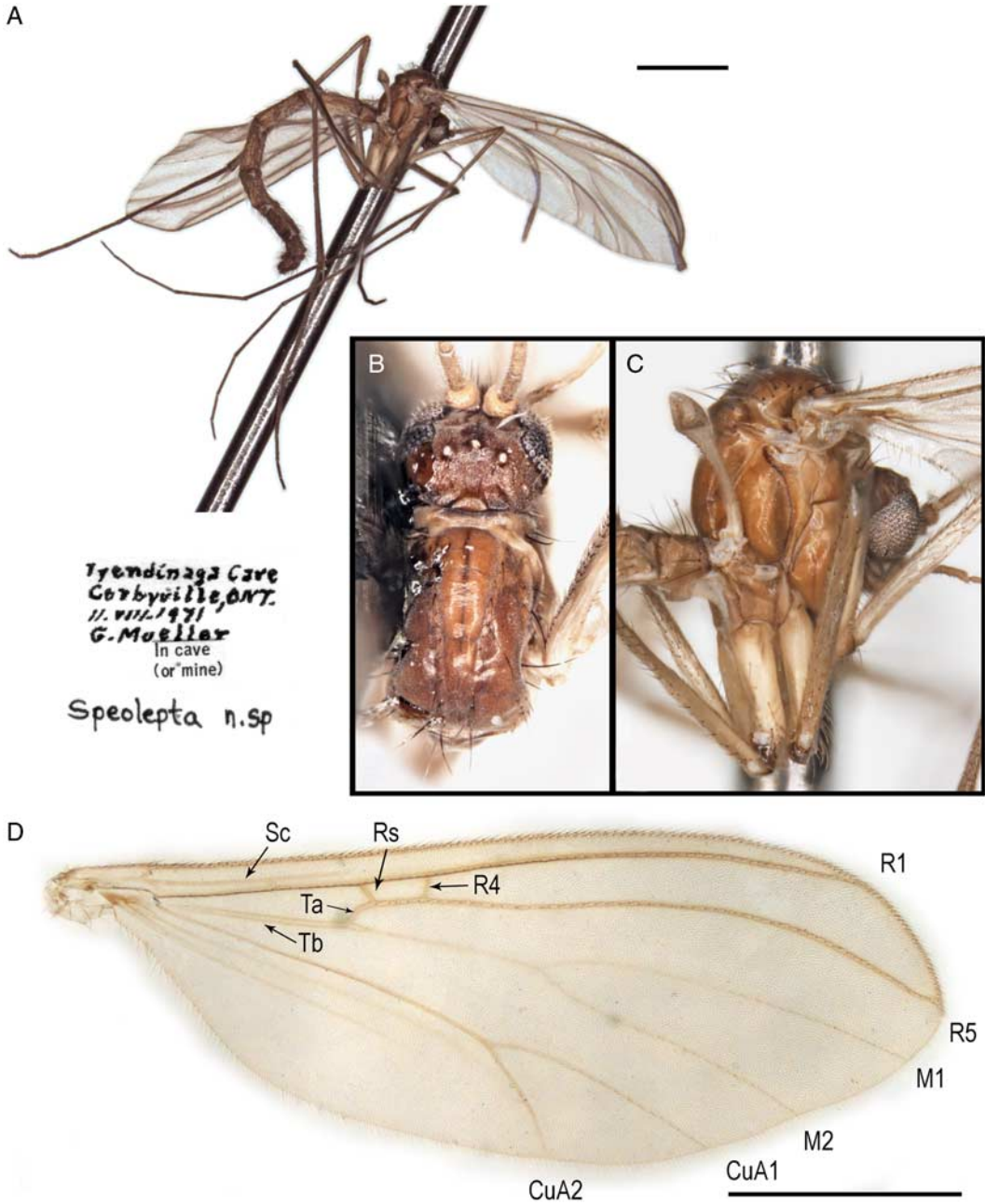
Description

Male. Body length 5.5–5.8 mm. General coloration dark brownish grey, legs brownish yellow (Fig. 2A).

Head. Dark brown. Three ocelli, almost in straight line, forming a shallow triangle. Lateral ocelli slightly larger than median one, the former separated from eye margin by distance of about twice their diameter. Clypeus setose, apically pointed, separated from face. Length of antenna 3.1 mm. Scape and pedicel dark brown, slightly wider than long. Flagellum dark brown, cylindrical, relatively narrow (0.05 mm), with 14 elongate flagellomeres covered with short setae. First flagellomere longest (0.35 mm), basally yellow. Relative lengths of flagellomeres 1 to 14 are 1, 0.7, 0.7, 0.6, 0.6, 0.6, 0.6, 0.5, 0.5, 0.5, 0.4, 0.4, 0.4, 0.5. Ratio of length to width for first flagellomere is 7.5, that for seventh is 4.2.

Mouthparts. Light brown, palpus mostly yellowish. Palpus slightly tapered, with five palpomeres, sparsely covered with setae. Palpomeres 1 and 2 short. Palpomere 3 with one to two sensilla placonica medially, without discernible sensory groove. Palpomere 5 (apical) about as long as palpomeres 3 and 4 combined, 10 times as long as

Fig. 2. Holotype of *Speolepta vockerothi* sp. nov. (A) habitus of the originally pinned male, including labels (specimen now slide-mounted permanently in Canada balsam), (B) head and thorax, dorsal view, (C) head and thorax, lateral view, (D) right wing, slide-mounted in dorsal view. Scale bar = 0.1 mm.

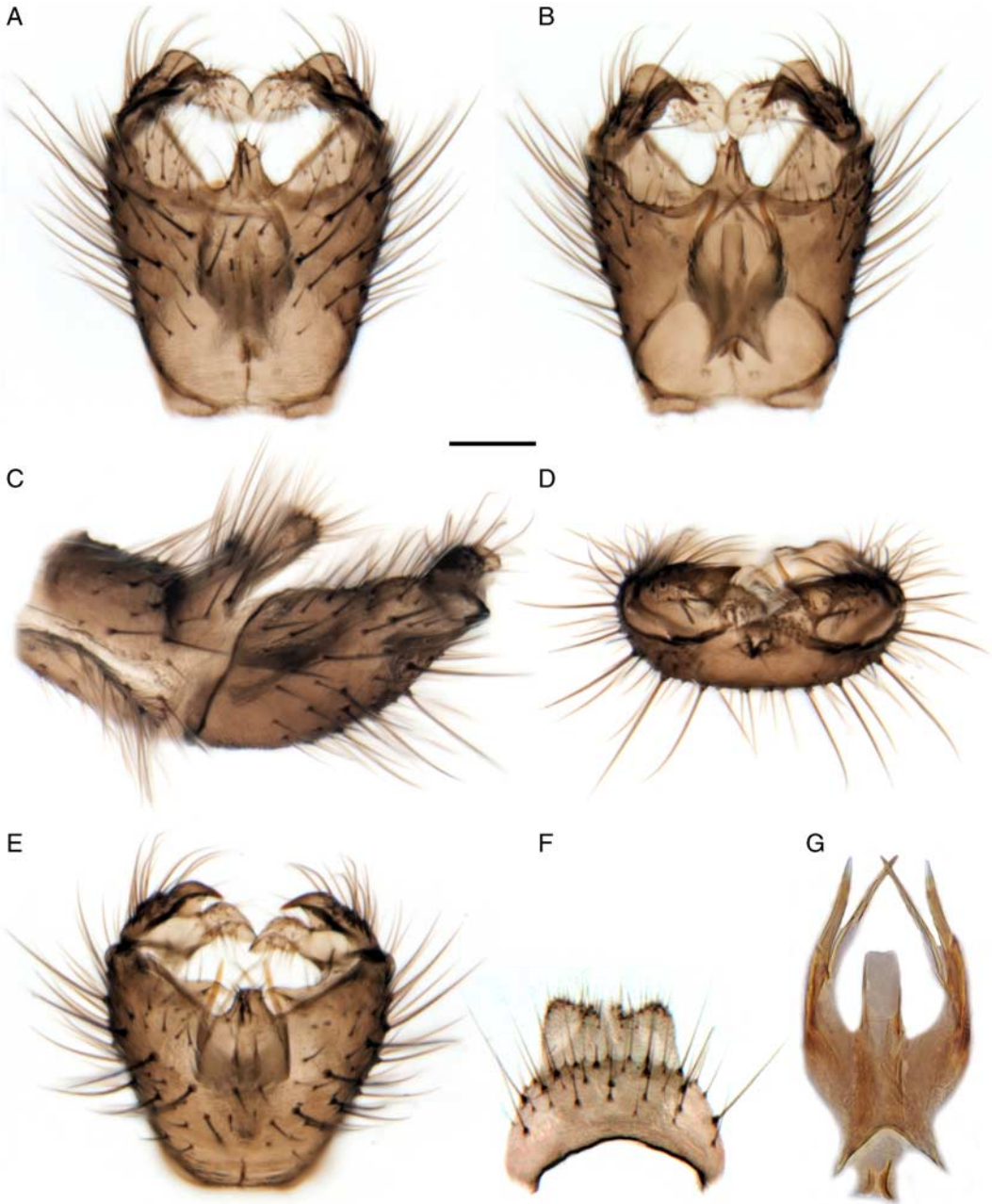


wide. Relative lengths of palpomeres 1 to 5 are 1, 1, 2.5, 4, 7.

Thorax (Fig. 2B–2C). Dark brown. Scutum with a few short acrostichals, long dorsocentrals, and lateral bristles (slightly longer than scutellum).

Scutellum with several short and two long apical bristles, the latter almost twice as long as scutellum. Mediotergite, laterotergite, anepisternum, and preepisternum 2 bare. Proepisternum and antepronotum with several dark setae.

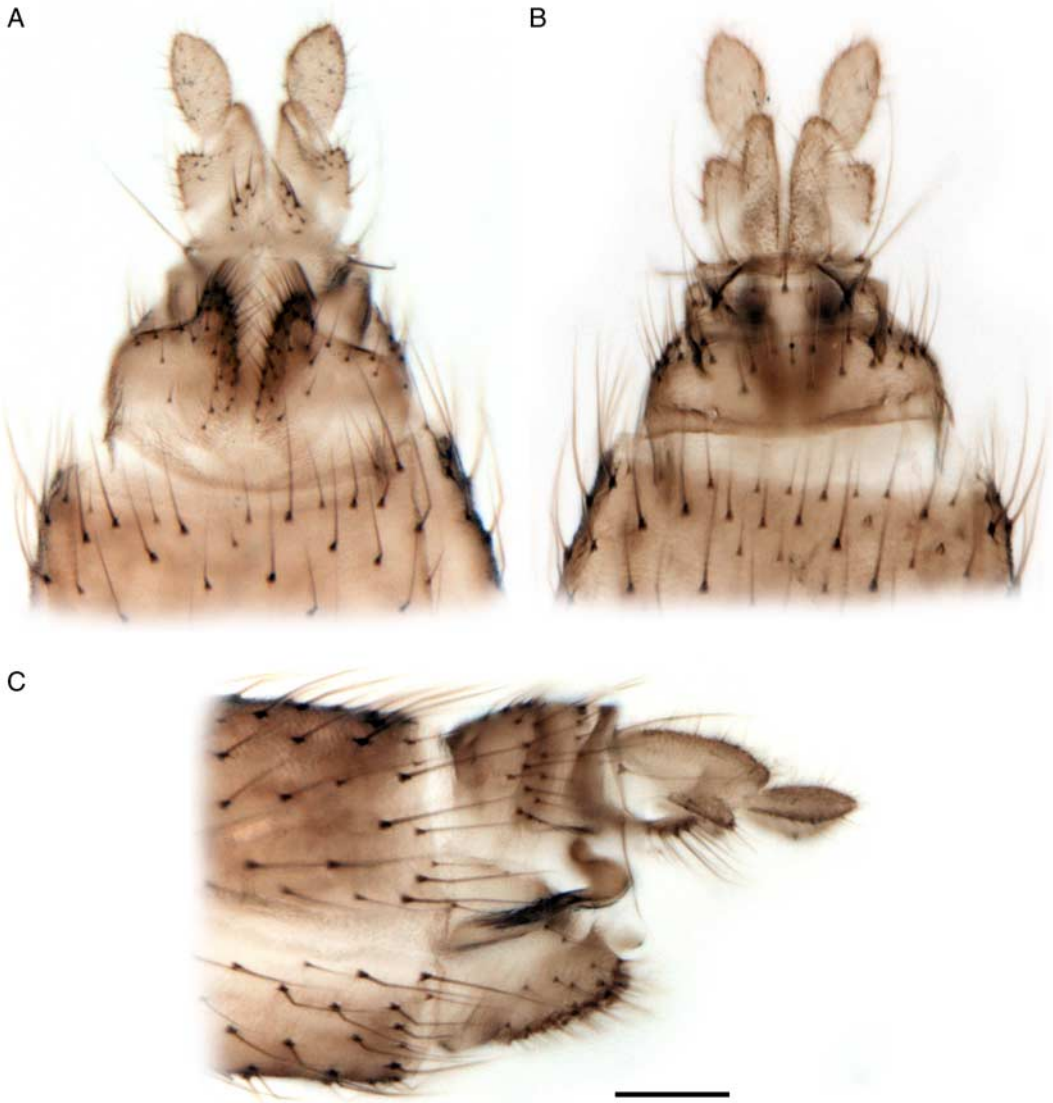
Fig. 3. Male terminalia of *Speolepta vockerothi* **sp. nov.** (holotype) (preterminal segments, tergite 9, and cerci removed except in C and F). (A) ventral view, (B) dorsal view, (C) lateral view, including segment 8, tergite 9, and cerci, (D) caudal view (E) ventrocaudal view, (F) tergite 9 and cerci, dorsal view, (G) aedeagal apparatus including gonocoxal apodemes, parameres, and aedeagus, dorsal view. Scale bar = 0.01 mm.



Wings (Fig. 2D). Hyaline, unmarked, membrane densely covered with microtrichia, no macrotrichia. Wing length 4.4 mm. Costa slightly produced beyond R_5 (up to one-fifth of distance

between tips of R_5 and M_1). Sc long, entirely bare, ending free slightly beyond R_s , Sc_2 branching at about two-third its length. R_4 present, forming R cell with R_s , which is at most twice as long as

Fig. 4. Female terminalia of *Speolepta vockerothi* **sp. nov.** (paratype). (A) ventral view, (B) dorsal view, (C) lateral view. Scale bar = 0.01 mm.



high (its length and shape is variable even within one specimen). Shape of R cell trapezoidal (broader in front). Cross-vein ta short, curved, with setae only on apical fourth. Vein tb subequal in length to stem of M. Stem of M bare, rather faint, about half length of M_1 . Apical two-thirds of both M_1 and M_2 with macrotrichia. Stem of Cu fork bare, about 1.5 times as long as CuA_1 , both fork veins with macrotrichia. CuP distinct but apically faint, slightly longer than A_1 . A_1 bare,

reaching well beyond Rs. Halter brownish yellow, as long as second abdominal tergite.

Legs. Yellowish, elongate, covered with dark trichia and setae. No distinct bristles, but longer setae in rows along ventral side of femora. Apex of foretibia with well developed anteroapical depressed area. Mid tibia with more or less distinct sensory organ in form of short, slightly swollen longitudinal pit with minute “double-trichoid” sensillae, situated one-third from base

Fig. 5. Live specimens of *Speolepta vockerothi* **sp. nov.** Rover's Cave, Bruce County, Ontario. (A) male, (B) female, (C) pupa, (D) prepupal larva, (E) larva showing precipitate-filled gut, (F) larva apparently grazing on precipitate.



of tibia. First tarsomere of foreleg 1.2 times as long as foretibia and slightly shorter than tibia in mid- and hind legs. One spur on foretibia, two spurs of subequal length on both mid- and hind tibia; spurs on fore- and midtibia as long as maximum tibial diameter, in hind leg about twice as long as tibial diameter.

Abdomen. Dark brown, all tergites and sternites covered with long dark setae. Segments 7 and 8 relatively long; relative lengths of tergites 1 to 8 are 1:2.5:2.5:2.4:2.1:1.6:1:0.5.

Terminalia (Figs. 3, 8A). Tergite 9 short, about three times as broad as long (Fig. 3C, 3F). Gonocoxite (Fig. 3A, B) gently dilated apically

with rounded corners; dorsally with broad bridge merging directly to aedeagal apparatus; ventrally with wide apicomedial, V-shaped incision medially expanded posteriorly into distinct, setose process. Gonostylus (Fig. 3A, 3B, 3D, 3E, 8A) with two apically dilated and incurved branches; dorsal one bare and hooked into acute tip; ventral one setose, forming broad, membranous rounded spatula. Aedeagal apparatus (Fig. 3G), compact, with two pairs of short parameres, basally fused with short gonocoxal apodemes; aedeagus long rectangular.

Female. Similar to male in most characters. Antennae shorter than in male, only about 0.5 times as long as wing. Midtibia without sensory organ. Terminalia (Fig. 4) as in female of *S. leptogaster*, with no apparent differences.

Variation. There is some variation in body size, length of flagellomeres, and shape of R cell among the specimens studied.

Holotype male (mounted in Canada balsam on slide): **CANADA: ON**, Tyendinaga Caves [in cave II, 136a], Hastings Co., Corbyville, 44°16'58"N, 077°16'50"W, 135 m a.s.l., 11–12 August 1971, G. Mueller (CNCI, JKJ-SPM-054783).

Paratypes: Canada: ON, Same data as holotype (1 ♀, slide, CNCI, JKJ-SPM-054784); Cave in Driftwood Cove, Bruce Co., 5 km S Tobermory, 45°14'27.59"N, 81°34'11.82"W, 4.vii.2008, S.A. Marshall (2 ♂, 3 ♀, in alc., DEBU and JSOC); same locality, 13.vii.1996, S.A. Marshall (1 damaged ♂, DEBU); same locality, 11.vii.1998, S.A. Marshall (3 ♀, DEBU); Desbarats Cave (46°20'40.22"N, 83°55'20.77"W), Algoma Co., Desbarats, 25.vii.71, G. Mueller (1 ♂, CNCI #91). **BC**, Vancouver Island, Pellucidar Cave, 7.vii.2002, P. Shaw (1 ♂, in alc., CNCI). **USA: Alaska**, On Alaska highway from Anchorage to Gridwood, 60°59'N, 149°31'W, vii.1964, K.M. Sommerman (1 ♂, MZLU).

Additional material: Several larvae, pupae, and pupal exuviae from the cave at Driftwood Cove are held by DEBU and JSOC.

Comments: Peck (1988) mentioned the CNCI specimens along with a third specimen (from Hope Bay Cave, Ontario, Canada, a sea cave on the Georgian Bay side of the Bruce Peninsula); this specimen probably corresponds to the following label in the CNCI *Speolepta* drawer: "one male loaned to Matile III 82". Peck (1988) also indicated that the species occurs elsewhere in Ontario and in New Hampshire. These records were based on

CNCI specimens identified by Vockeroth (S. Peck, personal communication) but no further Ontario specimens were located in CNCI, and the New Hampshire record is apparently based on a female specimen with the following data: New Hampshire, Mount Washington, Lakes of the Clouds, 5000', 9.viii.1954, Becker, Munroe and Mason (CNCI).

The Nearctic species remained known only from the CNCI specimens until one of us (S.A.M.) discovered a population in a "sea cave" on Georgian Bay in July 1996. At that time the species was observed and photographed as adults and pupae; a photograph of an adult emerging from pupae hanging from the cave ceiling by silken threads was published in Marshall (2006). A further collecting trip was made to this, relatively inaccessible cave on 4 July 2008, at which time several adults, pupae and prepupal larvae were observed, photographed, and collected. Several trips to the cave in late July and August of 2008 and 2009 yielded no further specimens and immature larvae were found for the first time during a visit to the cave on 14 June 2010.

Speolepta orientalis sp. nov.

(Figs. 6–7, 8B)

Diagnosis. The single known male of this species can be separated from the other two known species of *Speolepta* by Sc₂ branching at about the half of the distance of Rs from the vein h (Fig. 6, cf. two-third in *S. vockerothi* and three-fourth in *S. leptogaster*) and the base of Cu fork placed more proximally, almost at the level of Rs. The male terminalia (Fig. 7) are distinctly shorter than in the other two species, about as long as broad. Also tergite 9 is the shortest of the three species. Gonocoxites roundly concave posteriorly, without a median process, basally with a deep triangular excavation and distinct midventral suture. The dorsal branch of gonostylus bears several distinct setae on its medial margin (Fig. 8B). The aedeagal complex has a pair of short blunt parameres.

Etymology. The specific name refers to the occurrence of the new species in the Oriental Region.

Description

Head. Dark brown. Length of antenna 2.3 mm (0.6 times as long as wing). Scape and pedicel

Fig. 6. Right wing of *Speolepta orientalis* **sp. nov.** dorsal view (holotype). Scale bar = 0.1 mm.

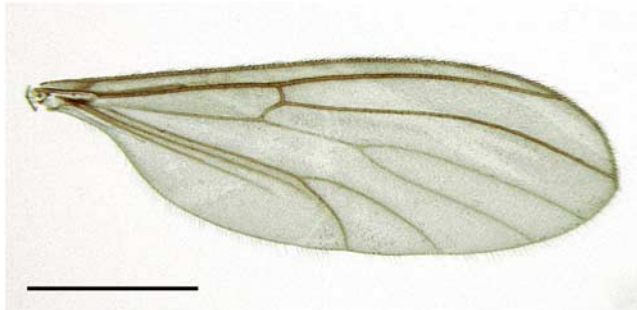
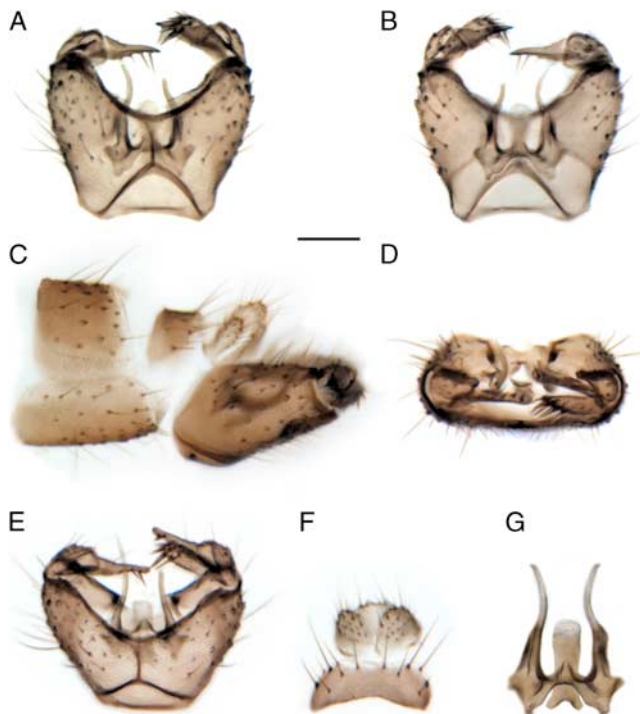


Fig. 7. Male terminalia of *Speolepta orientalis* **sp. nov.** (holotype) (preterminal segments, tergite 9, and cerci removed except in C and F). Ventral branch of right gonostylus is missing. (A) ventral view, (B) dorsal view, (C) lateral view, including segment 8, tergite 9, and cerci, (D) caudal view, (E) ventrocaudal view, (F) tergite 9 and cerci, dorsal view, (G) aedeagal apparatus including gonocoxal apodemes, parameres, and aedeagus, dorsal view. Scale bar = 0.01 mm.

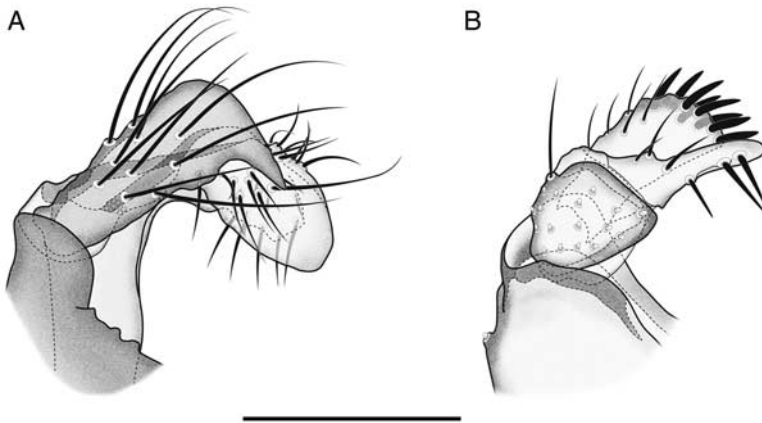


dark brown, slightly wider than long. Flagellum dark brown, cylindrical, narrow (0.04 mm), with 14 flagellomeres covered with short setae. First flagellomere longest (0.23 mm), basally yellow. Relative lengths of flagellomeres 1 to 14: 1, 0.9, 0.9, 0.8, 0.8, 0.7, 0.7, 0.7, 0.7, 0.6, 0.6, 0.6, 0.6,

0.7. Mouthparts brown, including palpus. Palpus with five palpomeres sparsely covered with setae.

Thorax. Brown. Scutum with a few acrostichals, dorsocentrals, and lateral bristles, mainly on anterior half. Scutellum with several apical bristles. Mediotergite, laterotergite, anepisternum,

Fig. 8. Dorsal view of right gonostylus. (A) *Speolepta vockerothi* sp. nov. (holotype), (B) *Speolepta orientalis* sp. nov. (holotype). Scale bar = 0.01 mm.



and preepisternum 2 bare. Proepisternum and antepronotum with several fine setae.

Wing (Fig. 6). Hyaline, unmarked, membrane densely covered with microtrichia, no macrotrichia. Wing length 3.65 mm. Costa slightly produced beyond R_5 (about one-fifth of distance between tips of R_5 and M_1). Sc relatively short, entirely bare, ending free, distinctly before Rs, apical part after Sc_2 weak. R_4 absent. Cross-vein ta slightly curved, without setae. Vein tb slightly longer than stem of M. Stem of M bare, rather faint, 0.45 times length of M_1 . Both M_1 and M_2 without setae. Stem of Cu fork bare, about 1.4 times as long as CuA_1 , both fork veins without setae. CuA_2 slightly curved at tip. CuP distinct but apically faint, slightly longer than A_1 . A_1 bare, reaching to the level of Rs. Halter brownish yellow.

Legs (only left foreleg of holotype present). Yellowish brown, elongated, covered with dark trichia and setae. Apex of foretibia with well developed anteroapical depressed area. First tarsomere of foreleg about 1.2 times as long as foretibia. One spur on foretibia.

Abdomen. Dark brown, all tergites and sternites covered with long dark setae. Segments 7 and 8 relatively long.

Terminalia (Figs. 7, 8B). Tergite 9 small and short, almost four times as broad as long (Fig. 7F, 7G). Gonocoxite (Fig. 7A, 7B) roundly concave posteriorly, without medioventral process; basally with deep triangular excavation and distinct midventral suture. Gonostylus (Figs. 7A, 7B, 7D, 7E, 8B) with two branches; dorsal one

pointed and bearing four setae along inner margin; ventral one setose, broadly rounded apically. Aedeagal complex (Fig. 3G) compact, with pair of relatively short blunt parameres; aedeagus subrectangular, apically rounded.

Female. Unknown.

Holotype male (pinned, with cleared terminalia in a glycerine microvial left wing, all legs except the left fore one missing, also most of the left antenna missing): **VIETNAM:** Sin Chai, Fan Si Pan, 2100 m, 11.–13.11.2003, Földvári, Peregovits & Körösi leg. (HNHM).

Discussion

Although the European *S. leptogaster* normally breeds and completes its life cycle entirely underground (Matile 1962; Laurence 1982), adults of both sexes are frequently found far away from caves (material studied, see also Kjærandsen and Jørgensen 1992; Kjærandsen and Jordal 2007). This does not rule out an obligatory cavernicolous biology (*i.e.*, a troglolite, see Jefferson 1976) because, to our knowledge, the species is not known to breed away from underground environments. This suggests good dispersal abilities where some gene flow may be retained between otherwise very isolated cave populations. Moreover, the many records from areas with very few natural caves in western Norway and isolated localities such as the Faeroe Island strongly suggest that this species frequently breeds away from

natural caves. Its larvae can be found in many artificial underground environments, such as cellars and bunkers, and it probably also breeds frequently inside larger boulder scree slopes and rock fissures inaccessible to collectors.

A similar troglotic biology for *S. vockerothi* seems plausible even though our observations of one population in an Ontario cave revealed this species only in the darkest part of the cave, where larvae were found only in the damp, marl-encrusted ceiling and walls of the cave. Adults were seen resting on vertical and horizontal rock surfaces; pupae were found suspended by silk threads from the cave roof or from upper surfaces of pits and crevasses in the cave wall. Almost all pupae observed had droplets of water on the distal (anterior) part of the body; similar droplets could usually be seen hanging from silken threads around the suspended pupae (Fig. 5C). Prepupal larvae were also found hanging from silken threads, each partly enveloped in a drop of fluid (Fig. 5D). Larvae occurred in tubes connected to a network of fine silk strands that held the tube close to the cave ceiling and wall surfaces, which was covered by wet mineral precipitates. Larvae graze on these precipitates, which are presumably rich in microorganisms, and a larval midgut filled with precipitate can be seen in Figure 5E.

The dense fields of silk threads ending in suspended glistening droplets are remarkably similar to those produced by the bioluminescent cave “glowworms”, *Arachnocampa* Edwards (Diptera: Keroplatidae), of New Zealand and eastern Australia. However, there is no evidence that larvae of *Speolepta* are predaceous, nor would there be sufficient prey for such large predator populations in the cave studied. Although they seem to graze directly on mineral precipitates (Fig. 5F), it is possible that the larvae feed in part by reeling in their suspended droplets containing the precipitates and associated microorganisms, much the way *Arachnocampa* prey on small flies captured on their suspended silk lines covered with sticky fluid globules.

The Ontario distribution of *S. vockerothi*, includes the type locality and two other caves. It is remarkable that this species has not shown up in surveys of cave insects in the United States, many of which have involved thorough fly collections (*e.g.*, Lewis *et al.* 2003; Barnes

et al. 2009) including large numbers of carefully identified mycetophilids. The only North American cave surveys to mention *Speolepta* are Peck (1988), which listed this species (as *Speolepta* sp.) from the CNCI specimens, and Shaw and Davis (2000), which listed “*Speolepta* spp.” from a British Columbia cave. Peck (1988) mentioned that the genus occurs elsewhere in Ontario and in New Hampshire, but failed to list it among the many other mycetophilids records from dozens of other Canadian caves. Although Canadian caves have been less thoroughly surveyed than American caves, specimens of *Speolepta* have not been found in cave surveys in Canadian provinces other than Ontario and British Columbia (*e.g.*, Moseley 2007).

Nothing is known about the biology of *Speolepta orientalis* except that the holotype was not collected in a cave. The only Oriental genus of fungus gnats (Sciarioidea) known to develop in caves thus remains *Chetoneura* Colless (Diptera: Keroplatidae), with two species recorded from China, Malaysia, and Brunei (Colless 1962; Amorim *et al.* 2008; Ševčík and Papp 2009).

Phylogenetic relationships among the three currently known species of *Speolepta* are difficult to determine. Based on male terminalia, *S. leptogaster* and *S. vockerothi* could form a sister group. The rectangular and dorsally separated gonocoxites may be considered as a synapomorphy of these species. The male terminalia of *S. orientalis* are relatively short and its fused gonocoxites with distinct medioventral suture may be considered plesiomorphic.

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References

- Amorim, D.S., Niu, C.H., Li, X., Lei, C.H., and Clarke, A.K. 2008. *Chetoneura shennonggongensis*, a new species of cave-dwelling Keroplatini from China (Diptera: Keroplatidae), with a discussion of the position of *Chetoneura*. *Zootaxa*, **1716**: 59–68.
- Baker, C.H. 2010. A new subgenus and five new species of Australian glow-worms (Diptera: Keroplatidae: *Arachnocampa*). *Memoirs of the Queensland Museum – Nature*, **55**: 11–43.
- Barnes, J.K., Slay, M.E., and Taylor, S.J. 2009. Adult Diptera from Ozark caves. *Proceedings of the Entomological Society of Washington*, **111**: 335–353.
- Chandler, P.J. 1980. The European and eastern Nearctic fungus gnats in the genus *Ectrepesthoneura* (Mycetophilidae). *Systematic Entomology*, **5**: 27–41.
- Colless, D.H. 1962. *Chetoneura cavernae* n. gen., n. sp. from Batu Caves, Malaya (Diptera: Mycetophilidae). *Pacific Insects*, **4**: 437–439.
- De Man, J.G. 1884. Eene variatie in het aderbehoop der vleugels eener mycetophilide. *Tijdschrift voor Entomologie*, **27**: 137–139.
- Edwards, F.W. 1925. British fungus-gnats (Diptera, Mycetophilidae). With a revised generic classification of the family. *Transactions of the Royal Entomological Society of London*, **1924**: 505–670.
- Jefferson, G.T. 1976. Cave faunas. *In* The science of speleology. *Edited by* T.D. Ford and C.H.D. Cullingford. Academic Press, London, New York, San Francisco, pp. 359–421.
- Kjærandsen, J. 1993. Diptera in mines and cave systems in southern Norway. *Entomologica Fennica*, **4**: 151–160.
- Kjærandsen, J., and Jordal, J.B. 2007. Fungus gnats (Diptera: Bolitophilidae, Diadocidiidae, Ditomyiidae, Keroplatidae and Mycetophilidae) from Møre og Romsdal. *Norwegian Journal of Entomology*, **54**: 147–171.
- Kjærandsen, J., and Jørgensen, L.L. 1992. Fungus-gnats from the Faroes (Diptera, Mycetophilidae). *Entomologiske Meddelelser*, **60**: 85–87.
- Laurence, B.R. 1982. A cave dwelling mycetophilid in central London. *Entomologist's Monthly Magazine*, **117**: 198.
- Lewis, J., Moss, P., Tecic, D., and Nelson, M.E. 2003. A conservation-focused inventory of the subterranean invertebrates of the southwestern Illinois karst. *Journal of Cave and Karst Studies*, **65**: 9–21.
- Madwar, S. 1937. Biology and morphology of the immature stages of Mycetophilidae (Diptera, Nematocera). *Philosophical Transactions of the Royal Society of London, Series B*, **227**: 1–110.
- Marshall, S.A. 2006. *Insects: their natural history and diversity: with a photographic guide to insects of eastern North America*. Richmond Hill, Firefly Books.
- Matile, L. 1962. Morphologie et biologie d'un insecte diptère cavernicole, *Speolepta leptogaster* Winnertz (Mycetophilidae). *Memoires du Museum National d'Histoire Naturelle (N.S.), (A) Zoologie*, **20**: 219–242.
- Matile, L. 1970. Les diptères cavernicoles. *Annales de Spéléologie*, **25**: 179–222.
- Matile, L. 1983. Notes taxinomiques et chorologiques sur les Gnoristini Paléarctiques (Diptera, Mycetophilidae). *Annales de la Societe entomologique de France*, **19**: 427–432.
- Miller, G. 2005. Linnaeus's legacy carries on. *Science*, **307**: 1038–1039.
- Moseley, M. 2007. Acadian biospeleology: composition and ecology of cave fauna of Nova Scotia and southern New Brunswick, Canada. *International Journal of Speleology*, **36**: 1–21.
- Peck, S.B. 1988. A review of the cave fauna of Canada, and the composition and ecology of the invertebrate fauna of caves and mines in Ontario. *Canadian Journal of Zoology*, **66**: 1197–1213.
- Plachter, H. 1981. Chorionic structures of the eggshells of 15 fungus- and root-gnat species (Diptera: Mycetophiloidea). *International Journal of Insect Morphology and Embryology*, **10**: 43–63.
- Plassmann, E. 1977. Drei weitere neue Mycetophilidenarten aus dem Allgäu (Diptera: Mycetophilidae). *Nachrichtenblatt der Bayerischen Entomologen*, **26**: 30–31.
- Rindal, E., Søli, G.E.E., and Bachmann, L. 2009. Molecular phylogeny of the fungus gnat family Mycetophilidae (Diptera, Mycetophiliformia). *Systematic Entomology*, **34**: 524–532.
- Schmitz, H. 1912. Biologisch-anatomische Untersuchungen an einer höhlenbewohnenden Mycetophilidenlarve, *Polylepta leptogaster* Winn. *Jaarboek van het Natuurhistorisch Genootschap in Limburg*, **1912**: 65–96.
- Shaw, P., and Davis, M. 2000. Invertebrates from caves on Vancouver Island. *In* Proceedings of a conference on the biology and management of

- species and habitats at risk, Kamloops, BC, 15–19 February, 1999, vol. 1. *Edited by* L.M. Darling. BC Ministry of Environment, Lands and Parks, Victoria, BC and University College of the Cariboo, Kamloops, British Columbia.
- Søli, G.E.E. 1997. The adult morphology of Mycetophilidae (s.str.), with a tentative phylogeny of the family (Diptera, Sciaroidea). *Entomologica scandinavica Supplement*, **50**: 5–55.
- Ševčík, J., and Papp, L. 2009. *Microkeroplatus*, a new genus of Keroplatidae (Diptera) from the Oriental region. *Acta Zoologica Academiae Scientiarum Hungaricae*, **55**: 339–347.
- Väisänen, R. 1986. The delimitation of the Gnoristinae: criteria for the classification of recent European genera (Diptera, Mycetophilidae). *Annales Zoologici Fennici*, **23**: 197–206.
- Vockeroth, J.R. 1981. Mycetophilidae. *In* Manual of Nearctic Diptera, vol. 1. *Co-ordinated by* J.F. McAlpine, B.V. Peterson, G.E. Shewell, H.J. Teskey, J.R. Vockeroth, and D.M. Wood. Agriculture Canada Monograph No. 27. pp. 223–246.
- Winnertz, J. 1864. Beitrag zu einer Monografie der Pilzmücken (Mycetophilidae). *Verhandlungen der Zoologisch-Botanische Gesellschaft in Wien*, **13**: 637–964.