

***Leptomorphus sevciki* sp. nov., a remarkable new
wasp-mimicking fungus gnat from Brunei
(Diptera: Mycetophilidae)**

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Abstract. A new species of Mycetophilidae (Diptera), *Leptomorphus sevciki* sp. nov., is described from primary lowland rainforest in Ulu Temburong National Park in Brunei. The type specimens were reared from pupae hanging from an unidentified wood encrusting fungus growing on a fallen tree. DNA sequences, including fragments of the nuclear 28S region and the mitochondrial 12S, 16S, CytB and COI (barcode region) genes, were extracted from two specimens, including the holotype.

Key words. Diptera, Sciaroidea, Mycetophilidae, Sciophilinae, *Leptomorphus*, COI barcode, DNA sequences, fungus gnats, mimicry, new species, taxonomy, Borneo, Brunei, Oriental Region

Introduction

The genus *Leptomorphus* Curtis, 1831 is a relatively species-rich genus of large fungus gnats (Diptera: Mycetophilidae) with some 45 described species worldwide (BORKENT & WHEELER 2012, PAPP & ŠEVČÍK 2011). It belongs to the subfamily Sciophilinae, where it forms a sister group to *Eudicrana* Loew, 1870 (BORKENT & WHEELER 2013, ŠEVČÍK et al. 2013). The Oriental species have recently been studied by PAPP & ŠEVČÍK (2011), who described 8 new species, and by BORKENT & WHEELER (2012) who described three new species from the region and provided a phylogenetic hypothesis of the relationships between all *Leptomorphus*

species. The two earliest described Oriental species, *L. ornatus* Brunetti, 1912 and *L. chaseni* Edwards, 1933, are only known from female specimens. As discussed in BORKENT & WHEELER (2012), their relationship to other species in the genus remains tentative, as the identification and phylogenetic placement of the Oriental species of this genus is based principally on the complex male terminalia.

The insect fauna of Brunei is becoming increasingly more studied and new species are discovered regularly (see e.g. GABRIŠ et al. 2017; GNEZDILOV 2015; JEŽEK et al. 2015; KUŘAVOVÁ et al. 2017a,b). However, the fungus gnat fauna (Diptera: Sciaroidea) still remains mostly unknown, with only several species of Diadocidiidae, Keroplatidae and Mycetophilidae described or recorded (see HIPPA & ŠEVČÍK 2010; PAPP & ŠEVČÍK 2005, 2011; ŠEVČÍK & HIPPA 2010; ŠEVČÍK 2012; ŠEVČÍK & PAPP 2009; ŠEVČÍK et al. 2014a; HIPPA et al. 2016). In the years 2013–2015, we were able to study the fungus gnat community in a primary lowland rainforest at the Kuala Belalong Field Studies Centre (KBFSC) in Ulu Temburong National Park, Brunei. During the second (2014) stay at the field station we discovered, observed, and collected a remarkable new species of *Leptomorphus*, which is described here.

Material and methods

The adults of the new species were collected in January 2014, by rearing pupae found hanging from a fallen tree (Fig. 15) in the surroundings of KBFSC (for the description of study area see ŠEVČÍK et al. 2014a). The specimens were either pinned or preserved in 80% ethanol. A total of 7 males and 4 females were examined, with the holotype and one male paratype specimen first being incubated overnight in isolation buffers and enzymes for DNA isolation.

The holotype and two paratypes (one male and one female) are deposited in the collection of the University of Brunei Darussalam (UBD), Bandar Seri Begawan, Brunei. One paratype male is deposited in the National Museum, Prague, Czech Republic (NMPC) and two paratypes (one male and one female) in the California State Collection of Arthropods (CSCA). The other paratypes (three males and one female) and immature material are deposited in the reference collection of the Ševčík Lab, University of Ostrava, Czech Republic (JSL-UOC).

The general morphological terminology of adults principally follows that of CUMMING & WOOD (2009) and the genitalic terminology follows that of SØLI (1997). The measurements were taken from the specimen stored in ethanol using an Olympus SZ stereomicroscope and QuickPHOTO Camera 3.0 software (PROMICRA 2015). The male genitalia were observed and drawn with an Olympus CX41 microscope equipped with a drawing tube. All photographs were taken using a Canon EOS 1100D camera.

The mitochondrial DNA markers 12S, 16S, cytochrome oxidase I (COI), and cytochrome B (cytB), along with nuclear DNA marker 28S, were extracted, amplified, and sequenced using the protocols in ŠEVČÍK et al. (2013, 2014b, 2016). The sequences are deposited in the GenBank (www.ncbi.nlm.nih.gov/Genbank) database (accession numbers below).

Video with the shots of larval behaviour and the pupae of *L. sevciki* on the underside of a log at the type locality is available on YouTube (<https://youtu.be/89HN2255ZO>), Vimeo (<https://vimeo.com/217065105>), or on request from the first author.

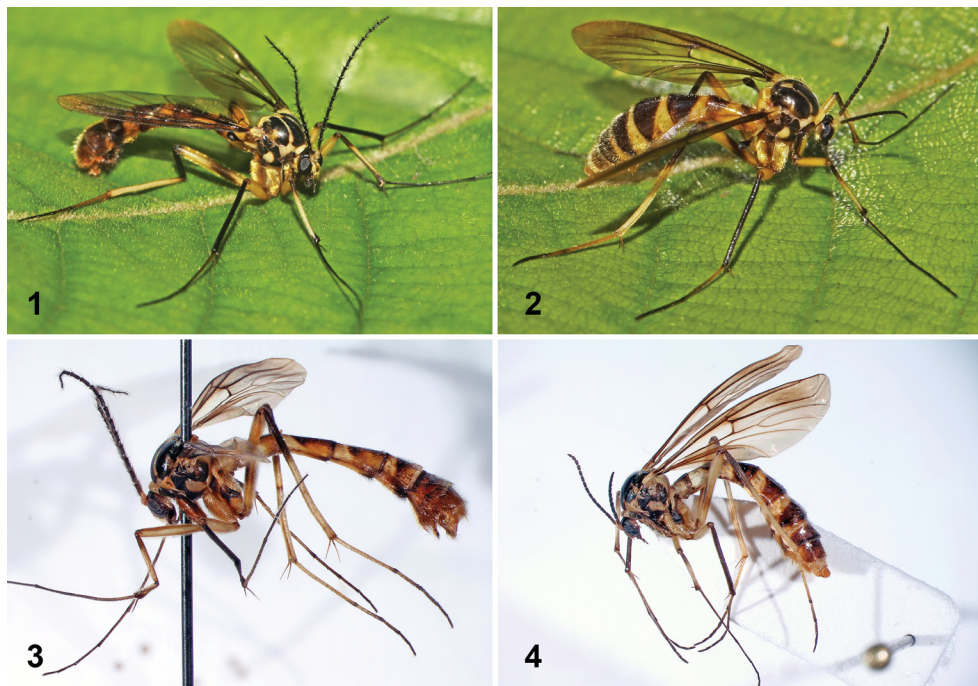
Species description

Leptomorphus sevciki Kaspřák & Borkent sp. nov.

Type material. HOLOTYPE: ♂, **BRUNEI:** Ulu Temburong National Park, Kuala Belalong Field Studies Centre, primary forest, 4°33'07.5"N 115°09'26.8"E, 14.i.2014, J. Ševčík and D. Kaspřák leg., ex pupa (coll. UBD, in ethanol). Specimen voucher number JSS25a-LS1. PARATYPES: **BRUNEI:** Ulu Temburong National Park, Kuala Belalong Field Studies Centre, primary forest, 4°33'07.5"N 115°09'26.8"E, 8–20.i.2014, ex pupa, ♂ (JSS25c-LS2) and ♀ (JSS25e-LS3) (coll. UBD, in ethanol); 3 ♂♂ (pinned, JSS25-LS4, JSS25-LS5, JSS25-LS6), 1 ♀ (pinned, JSS25-LS7) and 1 ♀ (in ethanol, JSS25f-LS8) (coll. JSL-UOC); 1 ♂ (JSS25-LS9) and 1 ♀ (JSS25-LS10) (coll. CSCA, pinned); and 1 ♂ (JSS25-LS11) (coll. NMPC, pinned).

Immature material not included in type series: **BRUNEI:** Ulu Temburong National Park, Kuala Belalong Field Studies Centre, primary forest, 4°33'07.5"N 115°09'26.8"E, 8–20.i.2014, 2 L and 2 P (coll. JSL-UOC, in ethanol).

Diagnosis. The only extant species of *Leptomorphus* with the following combination of characters: male antennae covered in long setae (unique in the genus); yellow V-shaped marking on the dorsal side of dark brown scutum; katapisternum yellow and brown; metakatepisternum partially dark brown; abdominal segments swelling towards the apex of terminalia. Sternite 9 with medioventral lobe and a pair of lateroventral lobes bearing four dark megasetae apically.



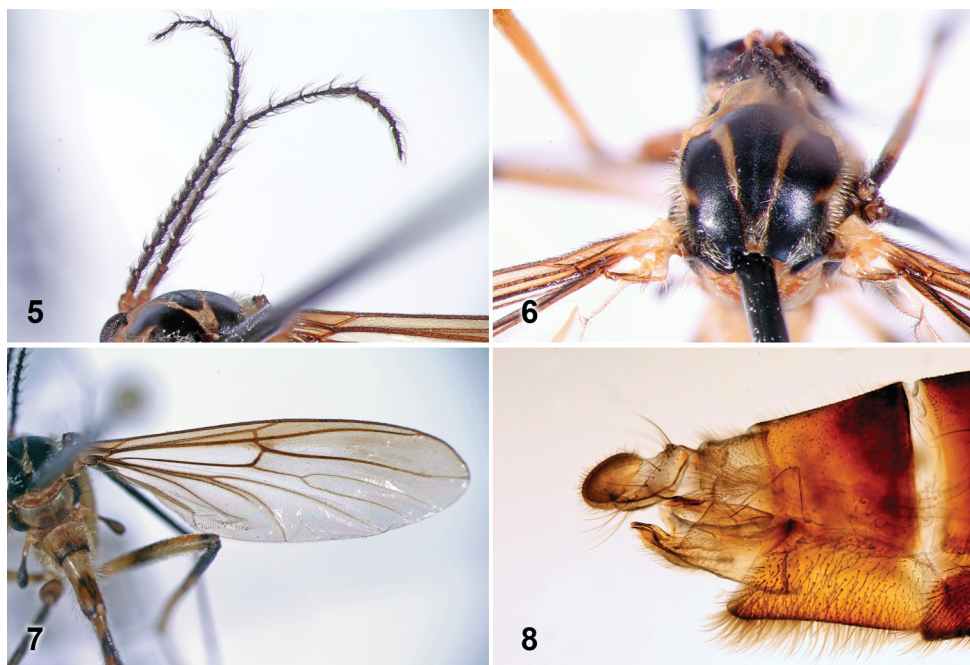
Figs 1–4. *Leptomorphus sevciki* sp. nov.: 1 – male (Photo: J. Ševčík); 2 – female (Photo: J. Ševčík); 3 – male, habitus; 4 – female, habitus.

Description. Male. Body length 14.3 mm. General colouration dark brown and dark yellow, yellow-orange and brown striped abdomen (Fig. 1, 3).

Head. Dark brown, light brown laterally with many long setae. Ocelli yellow, in a straight line. Face yellow. Flagellomeres dark brown, densely covered with long, fine, dark brown setae (Fig. 5). Basal part of first flagellomere yellow. Scape and pedicel yellow, setae on at least the anterior surface. Face and clypeus covered with many long setae. Clypeus and palpus light brown.

Thorax. Mostly dark brown. Scutum dark brown with dorsal yellow V-shape marking, covered with fine hairs, several long light setae along margin (Fig. 6). Scutellum light brown, with many short setae. Anteprepronotum, proepisternum, anepisternum, anepimeron and laterotergite dark brown. Proepisternum covered with light setae. Paratergite light to dark brown. Laterotergite with several long setae. Anepisternum and anepimeron bare. Katepisternum anterior dark brown and posterior yellow, bare. Metakatepisternum partially dark brown, bare. Mediotergite yellow, bare. Margin of anterior and posterior spiracles yellow with yellow trichia. Haltere: stem yellow, knob dark brown.

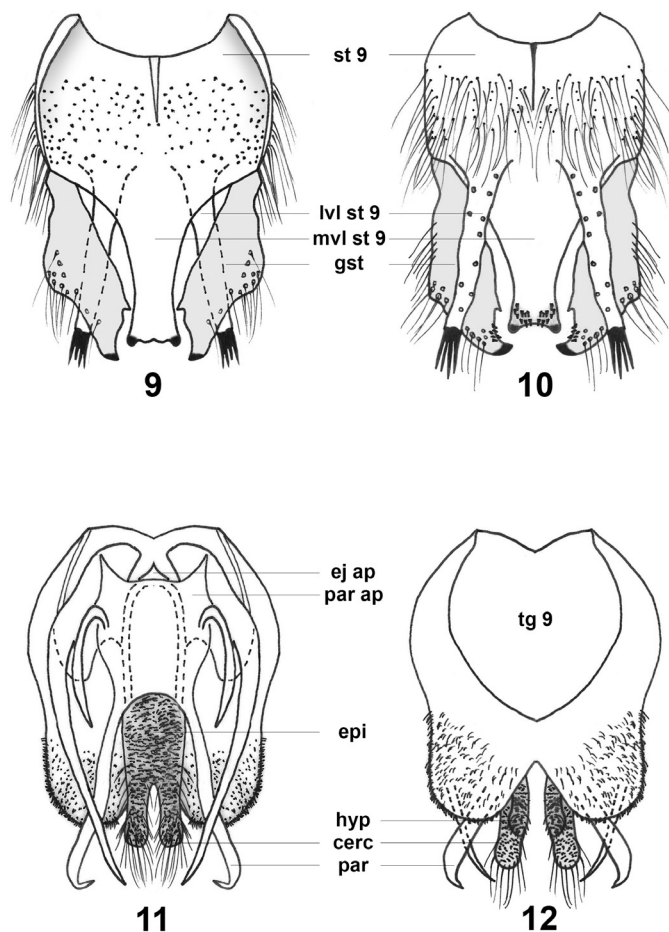
Wing (Fig. 7). Hyaline, membrane densely covered with irregularly arranged macrotrichia. Cell among base of R_1 , crossvein r-m and M bare, sector between veins M and CuA bare except apically. Apical shading dark brown but fading towards apex and posterior margin (pale brown apical wing shading not reaching to wing tip), running from anterior to posterior wing



Figs 5–8. 5–7 – *Leptomorphus sevciki* sp. nov., male: 5 – antennae; 6 – thorax, V-shape mark; 7 – wing; 8 – female, genitalia, lateral view.

margin, beginning halfway along R_5 . Medial macula small, only around Rs. Costa ending at tip of R_5 . Sc short, ending in costa beyond base of r-m. Vein sc-r ending beyond Rs. Vein R_4 absent. Vein R_5 slightly concave for entire length. Crossvein r-m relatively long (twice as long as radial sector). Apex of crossvein r-m lighter than base. Apices of M and CuA veins clearly reaching wing margin. Point of furcation of CuA and M_4 well before crossvein r-m. CuP thick, slightly shorter than A_1 . A_1 distinct.

Legs. Coxae principally yellow, forecoxa dark brown and hind coxa with anterior dark brown mark. All trochanters brown. Femora yellow, dark long setae laterally, hind femur brownish, dense setulae and dark brown mark beginning one third of length of hind femur and reaching beyond midpoint. Fore tibia yellow with basal brown mark, dense row of anteroventral bristles



Figs 9–12 – *Leptomorphus sevciki* sp. nov., male, terminalia: 9 – ventral part, internal view; 10 – ventral part, external view; 11 – dorsal part, internal view; 12 – dorsal part, external view. Abbreviations: cerc = cercus; ej ap = ejaculatory apodeme; epi = epiproct; gst = gonostylus; hyp = hypoproct; mvl st 9 = medioventral lobe of sternite 9; lvi st 9 = lateroventral lobe of sternite 9; par = paramere; par ap = parameral apodeme; st 9 = sternite 9; tg 9 = tergite 9.

absent. Mid tibia entirely dark brown with irregular rows of short dark bristles. Hind tibia yellow with basal dark brown mark longer than fore tibia basal mark. Tarsi dark brown. First and second hind tarsomeres yellowish to light brown with dark brown apex.

Abdomen. Tergites principally dark brown, tergites 1–6 with anterior third light brown. Tergites 7–8 dark brown. Sternites brown. Posterior 4 segments of abdomen noticeably swollen relative to other segments (Fig. 3).

Terminalia (Figs 9–12). Light brown, apex of gonostyli and medioventral lobe of sternite 9 darker. Sternite 9 sclerotized, medially covered with long setae, with medioventral lobe and a pair of lateroventral lobes, dark brown suture mediobasally. Medioventral lobe bare, as long as sternite 9, covering cerci, with two rounded processes bent ventrally and apical dark blunt bristles. Lateroventral lobe with bumpy margin, with several long setae and four dark apical megasetae. Tergite 9 sclerotized, densely covered with short setae and V-shaped indentation on the apex, bare transparent tapering part of base. Gonostyli bare, except lateral margin with long setae, dark blunt bristles on medial margin of apex, lateral rounded process and medial hooked process. Apex of gonostylus dark, tapering towards apex. Cerci and hypoproct covered with short trichia and long apical setae. Parameres strongly hooked at apex.

Female (Figs 2, 4). Similar to male with following differences: antennal setae short, hind femur lighter with brown mark only anteriorly, genitalia lighter. Tergite 9 yellow, with long setae. Tergite 10 yellow, row of several long and shorter setae on posterior margin. Cerci brown, setose. Gonopore 9 brown. Gonocoxite 8 posteriorly brown and setose (Fig. 8).

DNA sequences. DNA sequences taken from the holotype and one male paratype are deposited in the GenBank database, with following GB accession numbers: JSS25a-LS1 (holotype): 12S: MF045798, 16S: MF045800, COI: MF045803, cytB: MF045805, 28S: n/a; JSS25c-LS2 (paratype): 12S: MF045799, 16S: MF045801, COI: MF045804, cytB: MF045806, 28S: MF045802.

Etymology. This species is named after Jan Ševčík, a specialist on Diptera associated with fungi and supervisor of David Kasprák's Ph.D. study, who was the first to spot the specimens of the new species in Ulu Temburong National Park.

Biology. The larvae and pupae of the new species were found on the underside of a log over a small brook. The larvae spun a silk sheet over the surface of an unidentified wood encrusting fungus (Fig. 13, Video: <https://youtu.be/89HN2255ZO>). The pupae were hanging from a singly anchored 3–5 cm long yellowish thread, bearing a drop of brownish liquid (Fig. 14, Video: <https://youtu.be/89HN2255ZO>). The behaviour of the flying adults and their colouration were reminiscent of wasps or ichneumonids (Hymenoptera).

Discussion

The new species can be easily distinguished from its congeners by its robust size, male antennae with distinct setae, the colouration of the thorax, and specific male and female terminalia. According to the key by BORKENT & WHEELER (2012), the new species runs to couplet 23 and does not continue, because of two-coloured preepisternum 2 (katapisternum), metepisternum partially dark brown, wing with apical spot and last three abdominal segments swollen. Brown katapisternum, metepisternum partially brown or light brown, wing



Figs 13–15. 13 – The larvae of *Leptomorphus sevciki* sp. nov. on the surface of an unidentified wood encrusting fungus growing on a log in a rainforest in Brunei. 14 – The pupae of *L. sevciki* sp. nov., on the underside of a log in a rainforest in Brunei. 15 – The fallen tree over a pathway with hanging pupae in Ulu Temburong National Park in Brunei. (Photos: J. Ševčík).

without apical spot and swollen 3–5 abdominal segments are character states present in *L. tabatius* Borkent, 2012, *L. chaseni*, and *L. tagbanua* Borkent, 2012. Yellow katapisternum and metapisternum, wing with pale brown apical spot and abdominal segment relatively with the same thickness are characters common with *L. babai* Sasakawa, 1960, *L. titiwangsensis* Borkent, 2012 and *L. ornatus*.

Due to this combination of characters, *L. sevciki* is apparently not closely related to the Oriental species described by PAPP & ŠEVČÍK (2011). The species from their “*ascutellatus*” group were quite common in the samples taken at Kuala Belalong Field Studies Centre. *Leptomorphus sevciki* appears to be more closely related to members of the *L. walkeri* or *L. furcatus* groups of BORKENT & WHEELER (2012). We also captured one female in 2015 at the same locality which appears to represent a different species related to *L. sevciki*, indicating that there exists at least one more species from this group in Borneo.

The striking yellow and dark colouration, together with swollen abdomen in both the male and female (Figs 1, 2), suggest wasp-mimicking. A possible model could be either a true wasp, ichneumonid or other hymenopteran. This colour pattern is also present in several

other *Leptomorphus* species (BORKENT & WHEELER 2012). Within Sciaroidea, this phenomenon has also been reported for two Australasian Keroplatidae, *Nicholsonomyia* Tonnoir, 1929 and *Tamborinea* Matile, 1981 (see TONNOIR 1927 and MATILE 1981).

As discussed in BORKENT & WHEELER (2012) all members of this genus where the immature biology is known pupate while hanging from a silk line, either as a pendulum or hammock. As shown in Fig. 14, *L. sevciki* also pupates hanging from a silk line in a pendulum fashion. EBERHARD (1970) reported that males are attracted to female pupae, hanging on them and fighting off challengers as they await the emergence of the female. This might explain the male of *L. sevciki* hanging on the pupa in Fig. 14.

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