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New records of *Megaselia* (Diptera: Phoridae) reared from fungus sporophores in Japan, including five new species

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Abstract

Megaselia donaldsonae Disney sp. nov., *M. flava* (Fallén), *M. gotoi* Disney, *M. kanekoi* Disney, *M. margaretae* Disney sp. nov., *M. nakayamai* Disney sp. nov., *M. salteri* Disney sp. nov. and *M. stepheni* Disney sp. nov. were reared from sporophores of fungi.

Key words: mycophagy, *Amanita, Gymnopilus, Russula*

Introduction

Most of the reports of scuttle flies (Diptera, Phoridae) reared from fungi are from sporophores in Europe, but include a few records from Japan (Disney, 1994). The majority of these records are for species of the giant genus *Megaselia* Rondani (Disney 1994). But these records represent a subset only of the

known larval habits for this genus, which includes parasitoids, predators, feeders on decaying organic materials, etc (Disney 1994). Species reared from fungi are a substantial subset that includes true fungus feeders but also some known to be parasitoids of the larvae of other fungus feeders (e.g. Sciaridae). *Megaselia*" is one of the largest, most biologically diverse and taxonomically difficult genera in the entire animal kingdom" (Marshall 2012). Our knowledge of Japanese species of *Megaselia* is rudimentary. Prior to this study the total was 23 described species (Disney 1989a). By contrast at least 250 species are recorded from the British Isles (Disney 1989b, and subsequent additions) and at least 1500 species for the world (according to Henry Disney's most recent estimate). Our knowledge of Japanese species associated with fungi is likewise in its infancy. This paper extends our knowledge.

During 2012, Masayuki Nitta and Mio Kobayashi, under the supervision of Nobuko Tuno, reared insects from fungi sporophores. The scuttle flies were kindly examined by Dr. Hiroto Nakayama (Biosystematics Laboratory, Graduate School of Social & Cultural Studies, Kyushu University). He reported that they all belonged to the huge genus *Megaselia*, with three being of previously reported species from Japan but the rest being undescribed species. The latter were sent to Henry Disney who describes five new species below.

Materials and methods

Sporophores of fungi were collected and put on moist vermiculite in containers of appropriate sizes at 27±1°C under 14 hour light and10 hour dark photoperiod

conditions. The containers lids had a hole plugged with cotton wool to ensure adequate air exchange. The sporophores were misted with water to maintain adequately high humidity. The containers were checked for emerging insects every 1 or 2 days for at least one month after sporophore collection.

The flies that emerged were preserved in 70% ethanol. Some were mounted whole on slides in Berlese Fluid and the rest sent to Henry Disney. He made slide mounts of specimens dissected into components placed under separate coverslips (e.g. Disney 1983) mounted in the same medium, whose advantages have been discussed elsewhere (Disney 2001).

The holotypes and some paratypes of the new species are deposited in the Museum of Zoology of the University of Cambridge (MZUC). Some paratypes are deposited in the Laboratory of Ecology of Kanazawa University (LEKU). The sample numbers refer to the rearing records. The reference numbers (e.g. 34–166) are also written on the slide labels and refer to Henry Disney's notebook 34 and page 166. In this study, we applied updated fungal supra-genetic classifications (Hosaka *et al*. 2011), however, we employed sporophore names as reported in the previous studies (Disney 1994).

Results

The following species of scuttle flies were reared from the fungi indicated.***Megaselia donaldsonae*** **Disney sp. nov.** (Fig. 1A–F)

Etymology. Named for Margaret Donaldson (see Acknowledgements).

Type series. Holotype, male, Ishikawa Prefecture, Kanazawa City, 9_20 vii 2012, ex *Amanita vaginata* (Amanitaceae), N. Tuno (sample 21, MZUC, 34–166). Paratypes: 4 males, 5 females same data as holotype except females (sample 22, MZUC, 34-167); and 1 male, 2 females (samples 15–17, LEKU).

Diagnosis. The fifth segment of the mid tarsus being clearly longer than the fourth segment means that in the key to males recorded from the British Isles (Disney 1989a) this species runs to couplet 12, lead 2, to *M. lutea* (Meigen); from which it is at once distinguished by its hairs on the mesopleuron (e.g. as fig. 8.3(a) in Disney 1994). In the keys to Australasian and Oriental species (Borgmeier 1967) it will run to couplet 11 on page 206. As its costal index is intermediate between the two options offered it needs to be keyed both ways. However, the male is immediately distinguished from all the species of the following couplets by the same mid tarsal feature indicated above. Likewise several subsequently described species are excluded with the exception of two species from China, from which it is distinguished in the key below.

Description. Male. Frons mainly yellow but brown around the sockets of the supra-antennal bristles (SAs) and ocelli, clearly broader than long, with 42_54 hairs and dense but very fine microtrichia. Supra-antennal bristles unequal (Fig. 1A), the lower pair being at most two thirds as long as upper pair. The antials lower on frons than anterolaterals (ALs), and about midway between upper SAs and an AL bristle. Pre-ocellars a little nearer together than either from a mediolateral bristle, all four being at about the same level on frons. Cheek with 4_5 bristles and jowl with 2 long and 1 shorter bristles. The subglobose

postpedicels yellow, without subcutaneous pit sensilla (SPS) vesicles (Fig. 1A). Palps (Fig. 1A) yellow, about 1.5 times as long as breadth of postpedicel, with 5 bristles, the longest (apical) being about as long as lower SAs, and 5_8 hairs. Labrum (Fig. 1A) slightly darker than palps and about 0.8_0.9 times as wide as a palp. Labella (Fig. 1A) coloured as palps and with only a few short spinules below. Thorax, apart from brown patch on pteropleuron, yellow. Three notopleural bristles, the middle one being shorter than the other two, and no cleft in front of these. Mesopleuron with 4_7 (most commonly 5_6) hairs. Scutellum with an anterior pair of hairs (about as long as those in middle of scutum) and a posterior pair of bristles. Abdominal tergites 1–4 brown contrasting with yellow tergites 5–6 and with hairs, those towards the sides of tergite 2 and at rear of tergite 6 being longer than the rest (Fig. 1B). Venter yellow with hairs on segments 3–6. Hypopygium with brown epandrium with a pale yellow anal tube (Fig. 1B), the epandrium with moderately long hairs only and thus lacking differentiated bristles. Hypandrium largely dusky yellow, with a pair of asymmetric lobes; left lobe large, with small microtrichia and with few beyond the basal half; right lobe much shorter and smaller, with stronger microtrichia extending its full length. The pair of hypandrial hairs short but somewhat robust. Apart from brown patch on mid coxa, legs yellow. Fore tarsus with posterodorsal hair palisade on segments 1-5; segment 5 longer than 4. The ratios of the lengths of tarsal segments about 3.6: 1.1: 1.0: 0.8: 1. Dorsal hair palisade of mid tibia extending about three quarters and its spur about 0.8 times as long as basitarsus. The ratios of the lengths of mid tarsal segments (Fig. 1C) about 2.1: 1.1: 0.9: 0.4: 1. Hairs below basal half of hind

femur clearly longer than those of anteroventral row of outer half. Hind tibia with 12_16 differentiated posterodorsal hairs and simple spinules of apical combs. Wings (Fig. 1D) 1.8_1.9 mm long. Costal index 0.45_0.52. Costal ratios 4.3_5.0: 1.6_1.9: 1. Costal cilia (of section3) 0.07_0.08 mm long. No hair at base of vein 3. Sc not reaching vein 1. With 2 axillary bristles, both being longer than costal cilia (the outer one being 0.12_0.15 mm long). Sc almost reaching R1. Thick veins yellowish gray; thin veins gray but pale. Membrane tinged gray (evident to naked eye when viewed against a white background). Haltere grayish brown.

Female. Head similar to male except labrum 1.3_1.4 times as wide as diameter of postpedicel and palps with 5_7 bristles and at least as many hairs. Thorax, apart from brown patch on pteropleuron, yellow as male. Abdominal tergites yellow. Tergites 5–6 with hairs (Fig. 1E). Venter yellow, with hairs below segments 3–6. Sternite 7 pale (Fig. 1F). Posterolateral lobes at rear of sternum 8 not long and with hairs at base. Cerci very pale and about 2.5 times as long as broad. Furca not evident. Dufour's crop mechanism about 2.3 times as long as greatest width and rounded behind. Legs ratios of the lengths of mid tarsal segments about 3.7: 1.8: 1.6: 0.8: 1. Wing length 2.0_2.1 mm. Costal index 0.48_0.54. Costal ratios 5.0_5.9: 1.7_2.4: 1. Haltere grayish brown.

***Megaselia flava* (Fallén)**

Trineura flava Fallén,1823: 7.

Aphiochaeta matsutakei Sasaki, 1935: 112.

Material examined. A hundred fifty specimens emerged from the sporocarps of the following species belonging to 3 orders (Agaricales, Boletales, and Russulales) in Ishikawa Prefecture: *Agaricus abruptibulbus*, *Calvatia craniiformis*, *Chlorophyllum neomastoideum* (Agaricaceae), *Amanita ibotengutake*, *A. longistriata*, *A. pantherina*, *A. pseudoporphyria*, *A. punctate*, *A. spissacea*, *A. sychnopyramis*, *A. vaginata*, *A. virgineoides*, *Amanita* sp. (Amanitaceae), *Hygrocybe cuspidate* (Hygrophoraceae), *Gymnopus peronatus* (Omphalotaceae), *Armillaria tabescens* (Physalacriaceae), *Psilocybe argentipes* (Strophariaceae), *Boletellus floriformis, B. bicolor*, *B. griseus, Heimioporus japonicus*, *Leccinum eximium*, *Tylopilus neofelleus*, *T. rigens*, *T. vinosobrunneus*, *Xanthoconium affine*, *Xerocomus subtomentosus* (Boletaceae), *Suillus bovinus* (Suillaceae), *Russula alboareolata*, *R. cyanoxantha* (Russulaceae).

This species has previously been reared from the sporophores of the following fungi, *Amanita ibotengutake* (Yamashita *et al*. 2005) and *A. muscaria* (Yakovlev 1986, 1994) (Amanitaceae), *Boletus rubellus* (Khalidov 1984; Yakovlev 1994), *Leccinum scabrum* aggregate (Yakovlev 1986) (Boletaceae), *Gymnopilus hybridus* (Disney & Evans 1988) (Cortinariaceae), *Armillaria matsudake* (Sasaki 1935; Kiyoku1958) and *A. mellea* (Yakovlev 1994) (Marasmiaceae), *Peziza* (= *Aleuria*) sp. (Yakovlev 1980, 1986), *P. micropus* (Disney & Evans 1982; Disney & Ševčík 2009), *P. repanda* (Colyer 1954; Buxton 1961; Disney 1994), *P. varia* (Disney & Evans 1982, 1999), and *P. vesiculosa* (Disney & Evans 1996) (Pezizaceae), *Pluteus cervinus* (=

atricapillus) (Disney & Evans 1982) (Pluteaceae), *Russula aeruginea* (Eisfelder 1956), *R. heterophylla* (Schmitz 1948), *R. risigallina* form *roseipes* (Yakovlev 1994), *R. rubra* (Schmitz 1948) and *R. violeipes* (Ševčík 2001) (Russulaceae), *Suillus granulatus* (Yakovlev 1994) (Suillaceae), and *Tricholoma matsutake* (=*T. edodes*) (Sasaki1935; Kiyoku 1958) (Tricholomataceae). The larvae invade the stems of the sporophores.

***Megaselia gotoi* Disney**

Megaselia gotoi Disney, 370.

Material examined. Twenty-one specimens were reared from sporophores of the following species belonging to two orders, Agaricales and Russulales; *Amanita castanopsidis*, *A. hemibapha, A. neoovoidea, A. punctate, A. sychnopyramis, A. virosa, Amanita* sp. (Amanitaceae), *Hymenopellis* sp. (Physalacriaceae), *Russula cyanoxantha, Russula* sp. (Russulaceae).

The species has previously been reared from sporophores of *Amanita farinosa* and *A. spissacea* (Disney 1989b) and *A. ibotengutake* (Yamashita *et al.* 2005).

***Megaselia kanekoi* Disney**

Megaselia kanekoi Disney 1989b, 372.

Material examined. Eight specimens were reared from sporophores of the following species belonging to Agaricales and Russulales. *Amanita pseudoporphyria* (Amanitaceae), *Hymenopellis* sp. (Physalacriaceae), *Russula alboareolata, R. cyanoxantha, Russula sp.* (Russulaceae).

The species has previously been reared from sporophores of *Amanita spissacea* (Disney 1989b) and *A. ibotengutake* (Yamashita *et al.* 2005).

***Megaselia margaretae* Disney sp. nov.** (Fig. 2A–H)

Etymology. Named for Margaret Donaldson (see Acknowledgements).

Type series. Holotype, male, Ishikawa Prefecture, Kanazawa City, 9–20 vii 2012, ex *Amanita vaginata* (Amanitaceae) (sample 23, MZUC, 34–167). Paratypes: 1 male, 3 females same data as holotype except females (sample 24); 4 males Ishikawa Prefecture, Nomi City, 4–18.ix.2012, ex *A. pseudoporphyria* (sample 20, MZUC, 34–166, samples 8 & 9, LEKU); 3 males, 2 females, Ishikawa Prefecture, Nanao City, 22.vii–4.viii.2012, ex *Amanita* sp., N. Tuno (samples 10–14, LEKU); 2 females, Kanazawa City, 2–15.vii.2012, ex *Russula violeipes*, N. Tuno (samples 6 & 7, LEKU).

Diagnosis. The fifth segment of the mid tarsus clearly longer than the fourth segment means that in the key to males recorded from the British Isles (Disney 1989a) this species runs to couplet 12, lead 2, to *M. lutea* (Meigen); but more closely resembles the Japanese *M. gotoi* and an Australasian and an Oriental species. It is distinguished from these 3 species in the key below.

Description. Male. Frons mainly yellow but brown around sockets of the Supra–antennal bristles (SAs) and ocellar triangle, with 28_44 hairs and dense but very fine microtrichia. Supra-antennal bristles unequal, the lower pair being about half as long as the upper pair. The antials a little lower on frons than anterolaterals (which slightly higher on frons than upper SAs), and 3_6 times as far from upper SAs as either from an AL bristle. Pre-ocellars slightly further apart than either from a mediolateral bristle, which very slightly higher on frons. Cheek with 2_3 bristles and jowl with 2. Postpedicels subglobose, yellow, without subcutaneous pit sensilla (SPS) vesicles (Fig. 2A). Palps (Fig. 2A) yellow, 1.3_1.5 times as long as postpedicel, with 6 bristles, the most apical being about half as long as palp, and up to twice as many hairs. Labrum (Fig. 2A) yellow and about 0.8_0.9 times as wide as a postpedicel. Labella (Fig. 2A) yellow, at most with only 1_2 hairs reduced to short spinules below. Thorax mainly yellow, with 3 notopleural bristles and no cleft in front of these. Mesopleuron bare. Scutellum with an anterior pair of hairs (as long as those in middle of scutum) and a posterior pair of bristles. Abdominal tergites 1–3 extensively brown (especially tergite 3) and tergites 4–6 mainly yellow, slightly longer hairs towards the sides of tergite 2 and at rear of tergite 6 (Fig. 2B). Venter yellow, and with hairs on segments 3–6 (Fig. 2B). Hypopygium with brown epandrium, the hypandrium largely pale dusky yellow, with a pale yellow anal tube (Fig. 2B). Apart from brown patch on mid coxa, legs yellow. Fore tarsus with posterodorsal hair palisade on segments 1–5; 5 slightly longer than 4. The ratios of the lengths of the segments about 3.2: 1.5: 1.1: 0.6: 1; segment 5 slightly wider than 3 and 4. Dorsal hair palisade of mid tibia extends about

0.8 times its length and its apical spur about 0.8_0.9 times as long as mid basitarsus (Fig. 2C) and rest of mid tarsus as Fig. 2C. Hairs below basal half of hind femur longer than those of anteroventral row of outer half (Fig. 2D). Hind tibia with 16_18 differentiated posterodorsal hairs and spinules of apical combs simple. Wings (Fig. 2E) 1.2_1.9 mm long. Costal index 0.48_0.52. Costal ratios 6.7_8.0: 2.9_4.4: 1. Costal cilia (of section 3) 0.05_0.07 mm long. No hair at base of vein 3. With 2 axillary bristles, both being longer than costal cilia (the outer being 0.09_0.12 mm long). Sc not reaching R1. Thick veins brown but costa paler than rest, thin veins brown but pale. Membrane tinged grey (just evident to naked eye when viewed against a white background). Haltere brown.

Female. Head (Fig. 2F) similar to male but labrum about 1.1 times wider than diameter of postpedicel. Thorax mainly yellow as male. Abdominal tergites 2–6 typically with anterior two thirds yellow and posterior third brown, but the brown reduced on tergites 5–6. Tergites 5–6 as Fig. 2G, tergite 6 being slightly wider at its anterior end than its greatest length; and the sub rectangular tergite 7 (Fig. 2G) almost 3 times as long as its greatest breadth and the hairs restricted to the posterior two fifths. Venter yellow but a little greyer on the flanks below the sides of the tergites, with hairs below segments 3–6, but those on 3 reduced to only 1 or 2. Sternite 7 (Fig. 2H) at least twice as long as greatest breadth and tapered forwards in its anterior half and with its hairs restricted to its posterior half. Posterolateral lobes at rear of sternum 8 pale (Fig. 2H), at least as long as width at base and with 3 longer bristles behind and 2 smaller ones in front. Cerci pale and at most 1.5 times as long as broad. Furca and Dufour's crop

mechanism not discerned. Legs similar to male except segment 5 of the mid tarsus is about as long as segment 4. Wing as in males except length 1.8_1.9 mm, Costal index 0.52_0.57. Costal ratios 5.4_6.3: 3.0_3.4: 1. Outer axillary bristle 0.11_0.12 mm long. Costal cilia 0.07_0.08 mm long.

***Megaselia nakayamai* Disney sp. nov.** (Fig. 3A–C)

Etymology. Named for Dr. Hiroto Nakayama who identified speciemens belongings to described species.

Type series. Holotype, male, Ishikawa Prefecture, Nanao City, 22.vii–1 viii.2012, ex *Russula cyanoxantha* f. *peltereaui* (Russulaceae), N. Tuno (sample 19, MZUC, 34–166).

Diagnosis. In the keys to the males of *Megaselia* species from the British Isles it runs to couplet 267, lead 1, to *M. surdifrons* (Wood). The subsequently described *M. okazakii* Disney also runs to this point. Both differ from *M. nakayamai* in having thorax and postpedicels brown, a grayish venter with hairs on segments 3–6, a pair of long bristles on the hypandrium, and with a small hair at the base. In addition *M. okazakii* has a shortened dorsal face of the epandrium and much paler wings.

Description. Male. Frons yellow but ocellar triangle largely brown, clearly broader than long, with 90_96 hairs and dense but very fine microtrichia. Supra-antennal bristles (SAs) unequal the lower pair being half as long as the upper pair. The antials lower on frons than anterolaterals, and about 1.5 times as far from upper SAs as either from an AL bristle. Pre-ocellars about as far apart as either from a mediolateral bristle, which at about the same level on frons.

Cheek with seemingly no bristles and jowl with two. The subglobose postpedicels yellow, without subcutaneous pit sensilla (SPS) vesicles (Fig. 3A). Palps (Fig. 3A) yellow, about two fifths as broad as postpedicel but almost twice as long as breadth of latter, with 6 bristles, the longest (apical) being only about half as long as an upper SA bristle, and with as many hairs. Labrum obscured in available specimen. Labella almost as pale as palps, together at least twice as broad as postpedicel, and with numerous, densely crowded, short spinules below. Thorax yellow. Two notopleural bristles and no cleft in front of these. Mesopleuron bare. Scutellum with an anterior pair of hairs (about as long as those in middle of scutum) and a posterior pair of bristles. Abdominal tergites brown with hairs a little longer towards sides of tergite 2 and clearly longest at rear of tergite 6 (Fig. 3B). Venter very pale yellow, and with hairs only on segments 5 and 6. Hypopygium with light brown epandrium, a pale hypandrium with a pale yellow anal tube (Fig. 3B). Apart from brown patch on mid coxa, legs yellow. Fore tarsus with posterodorsal hair palisade on segments 1–4 and 5 clearly longer than 4. Dorsal hair palisade of mid tibia extends almost three quarters of its length. Hairs below basal half of hind femur longer than those of anteroventral row of outer half. Hind tibia with 14_16 differentiated posterodorsal hairs and spinules of apical combs simple. Wings (Fig. 3C) 1.1_1.2 mm long. Costal index 0.54_0.55. Costal ratios 3.0_3.1: 1.9: 1. Costal cilia (of section 3) 0.04_0.05 mm long. No hair at base of vein 3. With 2 axillary bristles, both being longer than costal cilia (the outermost 0.09 mm long). Sc not reaching R1. Costa pale, rest of thick veins light brown, 4_6 grey and 7 very pale. Membrane only lightly tinged grey. Haltere with light gray knob.

***Megaselia salteri* Disney sp. nov.** (Fig. 4A–G)

Etymology. Named for Stephen Salter (see Acknowledgements).

Type series. Holotype, male, Ishikawa Prefecture, Nomi City, 12–27.vii.2012, ex *Gymnopilus* sp. (family undetermined), N. Tuno (sample 28, MZUC, 34–168). Paratypes: 3 females as holotype; 1 male, 6 females as holotype except 12–26.vii.2012 (samples 1 & 27, MZUC, samples 2–3, LEKU); 1 male, 6 females, Kanazawa City, 6–18.ix.2012, ex *G. picreus*, N. Tuno (sample 29, MZUZ, 34–168).

Diagnosis. In the key to the males of *Megaselia* species from the British Isles it runs to couplet 285, where the lack of a notopleural cleft and the AL bristles being clearly higher on the frons than the antials excludes the two species of this couplet. The hypopygium of the mainland European species *M. praeacuta* (Schmitz) has a much shorter anal tube and hypandrial lobes, apart from its postpedicels having SPS vesicles. The subsequently described *M. tamilnaduensis* Disney will also run to this couplet but it has a distinctly different hypopygium, with its shortened dorsal face of the epandrium and shorter anal tube and shorter hairs below the basal half of the hind femur, and it lacks the densely crowded spinules on the ventral faces of the labella. In the keys of Borgmeier (1967) *M. salteri* runs to couplet 14, lead 2, on page 93, to *M. patellipyga* Borgmeier. However, the latter has strikingly enlarged posterolateral lobes of the epandrium. Apart from *M. tamilnaduensis* (see above) also running to this point *M. abdita* (Brues) and *M. media* (Collin) will also both key out here. Their shorter anal tubes and lack of densely crowded

spinules on the ventral faces of their labella distinguish them from *M. salteri.* The subsequently described *M. alisamorum* Disney will also key out here. It has densely spinose labella, but its hypopygium has a longer yellow anal tube and a distinctive elongated and downward curving left lobe of the hypandrium.

Description. Male. Head as Fig. 4A, frons brown, clearly broader than long, with 110_120 hairs and dense but very fine microtrichia. Supra-antennal bristles (SAs) unequal, the lower pair being about 0.8 times as long the upper pair. The antials clearly lower on frons than anterolaterals and almost as close to eye margins, but almost midway between upper SAs and AL bristles or a little closer to USAs. Pre-ocellars closer together than either is from a mediolateral bristle, which is at about the same level on frons. Cheek with 1_3 bristles and jowl with two longer. The subglobose postpedicels brown, without subcutaneous pit sensilla (SPS) vesicles (Fig. 4A, B). Palps (Fig. 4A, B) yellow, about a quarter as broad as postpedicel but a little longer than breadth of latter, with 4_6 bristles (the longest, apical, being about two thirds as long as a lower SA bristle) and 5_6 hairs. Labrum (Fig. 4A) dusky yellow and about three quarters the width of a postpedicel. Labella coloured as labrum but with darker bands towards sides, their combined widths about 1.5 times the width of a postpedicel, and with numerous, densely crowded, short spinules below (Fig. 4B). Thorax brown with two notopleural bristles and no cleft in front of these. Mesopleuron bare. Scutellum with an anterior pair of hairs (subequal to those in middle of scutum) and a posterior pair of bristles. Abdominal tergites brown with hairs longest towards sides of tergite 2 and at rear of tergite 6 (Fig. 4C). Venter brown, with hairs on segments 3–6. Epandrium brown, hypandrium only lightly tinged

brown and anal tube pale brown (Fig. 4C). Left lobe of hypandrium longer than right lobe. Apart from brown patch on mid coxa, legs yellowish lightly tinged brown, except the hind femora browner and getting darker towards tip. Fore tarsus with posterodorsal hair palisade on segments 1–4 and 5 slightly longer than 4. Dorsal hair palisade of mid tibia extends about 0.8 times its length. Hairs below basal half of hind femur clearly longer than those of anteroventral row of outer half (Fig. 4D). Hind tibia with 8_10 clearly differentiated posterodorsal hairs and spinules of apical combs simple or occasionally with a single bifurcated spinule above the posteroventral apical spur. Wings (Fig. 4E) 1.3_1.6 mm long. Costal index 0.34_0.44. Costal ratios 4.2_6.5: 1.8_2.9: 1. Costal cilia (of section 3) 0.07_0.09 mm long. A small hair at base of vein 3. With 2 axillary bristles, both being longer than costal cilia (the outer being 0.09_0.11 mm long). Membrane pale, only slightly tinged gray. Thick veins brown, except costa pale, thin veins 4_6 more gray and 7 only discernible with critical lighting. Membrane only very lightly tinged gray (not evident to naked eye when viewed against a white background). Haltere brown.

Female. Head similar to male but except palp with 6_7 hairs that are longer than those of male, labrum brown and a little wider than diameter of postpedicel and labella not enlarged and with at most only 1 or 2 small spinules below. Abdominal tergites brown. Tergites 3–7, front margin of tergite 6 being as broad as length. Venter brown, with hairs below segments 3–6. Sternite 7 as Fig. 4G. Posterolateral lobes at rear of sternum 8 as Fig. 4G. Cerci pale and about 2.6 times as long as broad. Furca and Dufour's crop mechanism not discerned. Legs similar to male but hind tibia with fewer posterodorsal hairs. Wing as male

except 1.4_1.7 mm long. Costal index 0.38_0.43. Costal ratios 3.3_6.0: 1.9_3.3: 1. Costal cilia 0.06_0.08mm long. Outer axillary bristle 0.08_0.10mm long. Otherwise it and haltere as male.

***Megaselia stepheni* Disney sp. nov.** (Fig. 5A–G)

Etymology. Named for Stephen Salter (see Acknowledgements).

Type series. Holotype, male, Ishikawa Prefecture, Kanazawa City, 2–15.vii.2012, ex *Russula violeipes*, N. Tuno (sample 25, MZUC, 34–167). Paratypes, 3 males, 4 females as holotype except samples 18 & 26, MZUC, and samples 4 & 5, LEKU.

Diagnosis. The fifth segment of the mid tarsus being clearly longer than the fourth segment means that in the key to males recorded from the British Isles (Disney 1989a) this species runs to couplet 12, lead 2, to *M. lutea* (Meigen); but more closely resembles the Japanese *M. gotoi* and an Australasian and an Oriental species. It is distinguished from these 3 species in the key below.

Description. Male. Frons mainly yellow but brown around the sockets of the Supra-antennal bristles (SAs) and ocellar triangle brown, clearly broader than long, with 40_50 hairs and crowded but very fine microtrichia. Supra-antennal bristles (SAs) unequal the lower pair being about two thirds the length of the upper pair. The antials slightly lower on frons than anterolaterals, and about twice as far from upper SAs as either from an AL bristle. Pre-ocellars about as far apart than either from a mediolateral bristle, all four being at about the same level on frons. Cheek with 3_4 bristles and jowl with 2 longer. The subglobose postpedicels yellow, without subcutaneous pit sensilla (SPS) vesicles (Fig. 5A).

Palps (Fig. 5A) yellow, about 6 times as long as broad and 1.2 times as long as width of postpedicel, with 5–6 bristles (the longest, apical, one about 1.2 times as long as lower SA bristle) and as many hairs. Labrum (Fig. 5A) yellow about two thirds as wide as a postpedicel. Labella (Fig. 5A) coloured as palps almost devoid of short spinules below. Thorax mainly yellow. Three notopleural bristles and no cleft in front of these. Mesopleuron bare. Scutellum with an anterior pair of hairs (about as long as those in middle of scutum) and a posterior pair of bristles. Abdominal tergites 1–3 brown and tergites 4–5 yellow, with hairs longest at rear of tergite 6 (Fig. 5B). Venter yellow, with hairs on segments 3–6. Epandrium brown, hypandrium paler and its long left lobe and very short right lobe pale yellowish; with a pale brown anal tube. Apart from brown patch on mid coxa, legs yellow. Fore tarsus with posterodorsal hair palisade on segments 1–5 and 5 just longer than 4. Dorsal hair palisade of mid tibia extends about two thirds its length and its spur about as long as basitarsus of mid tarsus. The ratios of the lengths of the mid tarsal segments about 1.4: 0.5: 0.4: 0.2: 1. Hairs below basal half of hind femur longer than those of anteroventral row of outer half (Fig. 5D). Hind tibia with 16–18 differentiated posterodorsal hairs and spinules of apical combs simple. Wings (Fig. 5E) 1.5–1.6 mm long. Costal index 0.42–0.45. Costal ratios 3.7–3.8: 1.2–1.7: 1. Costal cilia (of section 3) 0.05–0.06 mm long. No hair at base of vein 3 and the latter a little thickened in basal half. With 2 axillary bristles, both being longer than costal cilia (the outer being 0.10 mm long). Sc not quite reaching R1. All veins brown, except costa pale. Membrane tinged gray (just evident to naked eye when viewed against a white background). Haltere with brownish gray knob.

Female. Head similar to male but labrum light brown and a little wider than a postpedicel. Thorax as male. Abdominal tergites yellow apart from tergite 7. Tergites 5–7 as Fig. 5F. Venter pale dusky yellow, and with hairs below segments 3–6. Sternite 7 brown (Fig. 5G). Posterolateral lobes at rear of sternum 8 largely represented by a pair of apical bristles (Fig. 5G). Cerci pale relatively short (Fig. 5G). Furca and Dufour's crop mechanism not discerned. Legs similar to male but last segment of mid tarsus not longer than 3+4, but a little longer than 4. Wing as male except length 1.7_1.8mm. Costal index 0.49_0.54. Costal ratios 3.5_4.7: 1.5_2.3: 1. Costal cilia 0.06_0.08mm long. Outer axillary bristle 0.11_0.12 mm long. Vein 3 not thickened in basal half. Haltere as male.

Key to palaearctic species resembling *Megaselia lutea* as their fifth segment of the mid tarsus being clearly longer than the fourth segment

Note: females can only be assigned to this complex by their association with males.

1 Males……..…….... 2

- Females…….…… 9

2 Mesopleuron with hairs…….....… 3

- Mesopleuron bare……..…… 5

3 Epandrium with hairs only. Section 1 of costa not thicker in basal two thirds and section 2 is longer than section 3. Spur of mid tibia clearly shorter than mid basitarsus……..…….. 4

\- Epandrium with hairs plus 3_4 bristles towards lower margins each side. Costa thicker in basal two thirds of section 1 and section 2 shorter than section 3. Spur of mid tibia about as long as mid basitarsus……..…… *setifurcana* Liu

4 Abdominal tergites brown…….…….. *tibisetalis* Fang

\- Abdominal tergites 1_4 brown contrasting with yellow tergites 5–6 (Fig. 1B)……..……. *donaldsonae* Disney sp. nov.

5 Thorax and postpedicels of antennae yellow……. 6

\- Thorax and postpedicels of antennae brown. (Hypopygium as fig. 414 in Disney 1989a. More than 3 bristles on axillary ridge of wing. Tip of hind femur brown)……..…… s*cutellaris* (Wood)

Note: the Australasian *M. tetrachaeta* Beyer has a light brown thorax and a brown tip to the postpedicel. It differs from *M. scutellaris* in having the first costal section clearly shorter than sections 2+3 combined and its costal cilia being less than 0.1 mm in length.

6 With only 2 axillary bristles. Hind femur entirely yellow……. 7

\- With more than 3 axillary bristles. Tip of hind femur brown. (Hypopygium as fig. 415 in Disney 1989a).…… *lutea* (Meigen)

7 Epandrium with hairs above and 1 or more bristles near lateral margins. Abdominal tergites with longer hairs towards lateral margins only on segments 2 and 6. Abdominal venter with smaller hairs on segments 3-6. The last segment of the mid tarsus thicker than segment 4, at least basally…….…….. 8

- Epandrium with several bristles but lacking hairs dorsally (fig. 2 in Disney 1989b). Abdominal tergites 2–6 with long hairs laterally that are clearly differentiated from those above. Abdominal venter with long bristle-like hairs on segments 5 and 6 (fig. 32 in Disney 1989b) but minute hairs only on segments 3 and 4. The last segment of the mid tarsus not thicker than segment 4…….*gotoi* Disney

Note: the Oriental *M. termimycana* Disney closely resembles *M. gotoi* but only has short fine hairs on segments 5 and 6 of the venter.

8 Epandrium with a single bristle each side (Fig. 2B). Segment 5 of mid tarsus shorter than segments 3 and 4 combined (Fig. 2C) …….*margaretae* Disney sp. nov.

- Epandrium with 2 bristles each side (Fig. 5B). Segment 5 of mid tarsus longer than segments 3 and 4 combined (Fig. 5C)……..... *stepheni* Disney sp. nov.

9 Mesopleuron with hairs……...…. 10

- Mesopleuron bare……..……...……. 12

10 Abdominal tergite 6 at least as long as width on anterior margin (e. g. Fig.1E). Costal section 2 longer than section 3.…….…… 11

- Tergite 6 clearly wider than its length. Costal section 2 shorter than section 3…..... *setifurcana* Liu

11 Abdominal tergites brown and tergite 6 tapered towards hind margin……...*tibisetalis* Fang

- Abdominal tergites yellow and tergite 6 more-or-less rectangular……. ……*donaldsonae* Disney sp. nov.

12 Thorax and postpedicels of antennae yellow……. 13

- Thorax and postpedicels of antennae brown. (More than 3 bristles on axillary ridge of wing. Tip of hind femur brown. Rear of abdomen as Fig. 7)……..…….. s*cutellaris* (Wood)

Note: the unknown female of the Australasian *M. tetrachaeta* Beyer will have a light brown thorax and a brown tip to the postpedicel, It will differ from *M. scutellaris* in having the first costal section clearly shorter than sections 2+3 combined and its costal cilia being less than 0.1mm in length.

13 Wing with only 2 axillary bristles. Hind femur entirely yellow…….. 14

- With more than 3 axillary bristles. Tip of hind femur brown. (Abdominal tergites entirely brown and as Fig. 6)…..... *lutea* (Meigen)

14 Abdominal tergites yellow……. 15

- Abdominal tergites 2–5 yellow in anterior halves or more and brown behind and tergite 6 almost as long as width of anterior margin (Fig. 2G)……..*margaretae* Disney sp. nov.

Note: the Oriental *M. termimycana* Disney closely resembles *M. margaretae* but has uniformly brown abdominal tergites and tergite 7 narrows in its anterior half (fig. 4 in Disney & Chou 1996).

15 Tergite 6 clearly broader than long (Fig. 5F). Anterolateral bristles at about the same level on frons as upper supra-antennal bristles……...*stepheni* Disney sp. nov.

- Length of tergite 6 almost equal to width of front margin. AL bristles higher on frons than upper SAs…….. *gotoi* Disney

Discussion

The Phoridae is among the commonest families of flies reported emerging from fungus sporophores. Phorids have been recorded from younger sporophores than the family Drosophilidae, which are more characteristic of mature to decaying stages (Tuno N pers. obs.). In our rearings from various species of sporophores sampled in Ishikawa Prefecture we obtained eight *Megaselia* species including five species new to science. Among the new species, *M. salteri* sp. nov. and *M. stepheni* sp. nov. showed narrow host preference. The latter emerged from species of *Russula* (Russulaceae) and the former from species of *Gymnopilus* (a genus formerly assigned to Cortinareaceae but

currently unplaced in the present fungal classification). Compared with dominating species like *M. flava*, these minor species in number showed proportionally narrower host preferences. Some ecologists have explored the general pattern in the relationships between fungal host and fungivorous flies using mycophagous drosophillid flies, a taxonomically well studied group (Lacy 1984; Takahashi *et al*. 2005; Toda *et al*. 1999; Tuno 2001). In the Drosophildae, most of the dominating species utilize a wide range of host mushrooms. It is apparent that we are far from a comprehensive understanding of the species diversity in mycophagous flies in Japan. It has been proposed that mycophagous flies are generalists in terms of host selection but this has been observed in only for dominating fly species and most of unnamed flies have been omitted from ecological studies. We may need to review ecological hypothesis and theories that have been proposed on the basis of such biased datasets on fungal host ranges for most of the unnamed mycophagous flies. The proportion of new species of scuttle flies underlines the perception that Phoridae associated with fungi in Japan is still a largely unexplored field. Future studies can be expected to add many more new phorid species and new fungus host records for known species. Those for Phoridae associated with fungi in Japan are likely to contribute to a more comprehensive understanding of the relationships between fungal host and their consumers and the diversity of the group in terms of ecological functions.

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Captions for figures for paper on **New records of scuttle flies (Diptera: Phoridae) reared from fungus sporophores in Japan, including five new species**

Figure 1. *Megaselia donaldsonae* sp. nov., male (A-D) and female (E, F). (A) dorsal (frontal) view of anterior (lower) part of head; (B) left face of hypopygium; (C) mid tarsus; (D) right wing; (E) abdominal tergites 5 and 6 (anterior end to right); (F) abdominal sternite 7 (anterior end to right).

Figure 2. *Megaselia margaretae* sp. nov., male (A-E) and female (F-H). (A) antennae, palps and proboscis from above; (B) left face of hypopygium; (C) mid tarsus; (D) hind femur; (E) right wing; (F) dorsal (frontal) view of anterior (lower) part of head; (G) dorsal face of abdomen from tergite 5 onwards; (H) abdominal sternite 7 and tips of lobes at rear of sternum 8 (anterior end to left).

Figure 3. *Megaselia nakayamai* sp. nov., male (A-C). (A) left antenna and palp from above; (B) left face of hypopygium; (C) right wing.

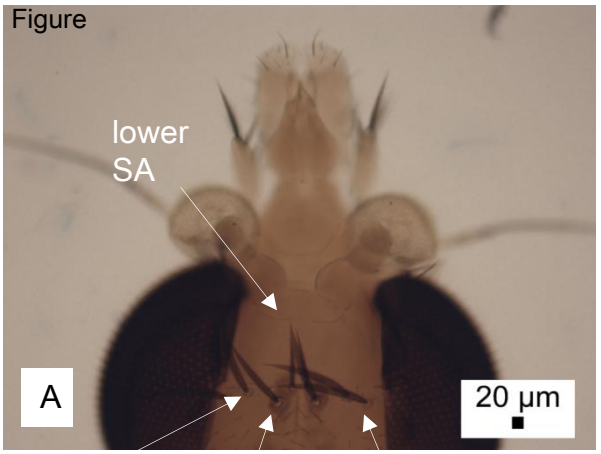
Figure 4. *Megaselia salteri* sp. nov., male (A-E) and female (F, G). (A) frontal view of head; (B) proboscis, palps and antennae, but focused down to ventral view of labella; (C) left face of hypopygium; (D) hind femur; (E) right wing; (F) abdominal tergites 3-7; (G) abdominal sternite 7 and tips of lobes at rear of sternum 8.

Figure 5. *Megaselia stepheni* sp. nov., male (A-E) and female (F, G). (A) proboscis and right palp and antenna; (B) left face of hypopygium; (C) mid tarsus; (D) hind femur; (E) right wing; (F) abdominal tergites 5-7; (G) sternite 7 to tip of abdomen.

Figure 6. *Megaselia lutea* female, abdominal tergite 5 to tip of abdomen.

Figure 7. *Megaselia scutellaris* female, abdominal tergite 5 to tip of abdomen.

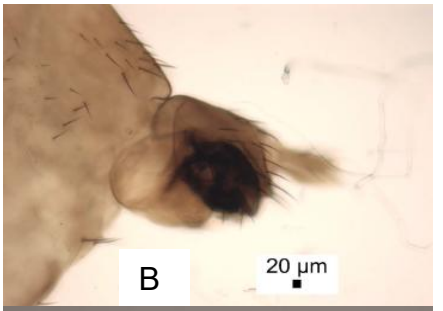
Figure

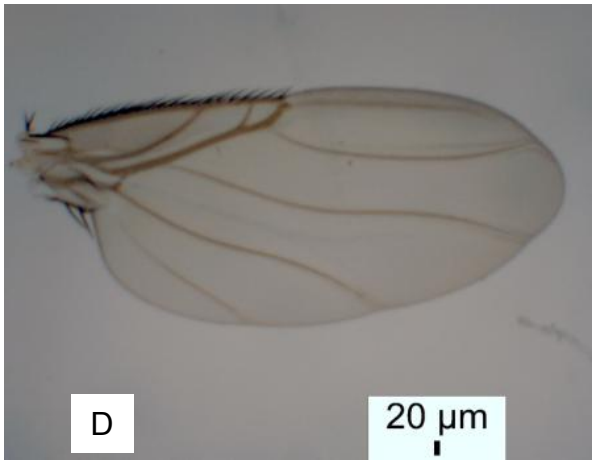


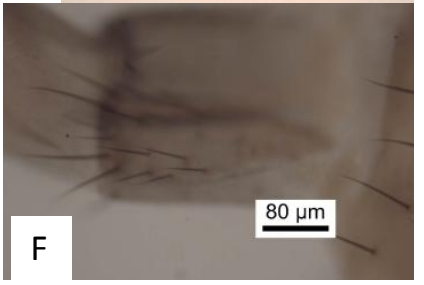
antial (A)

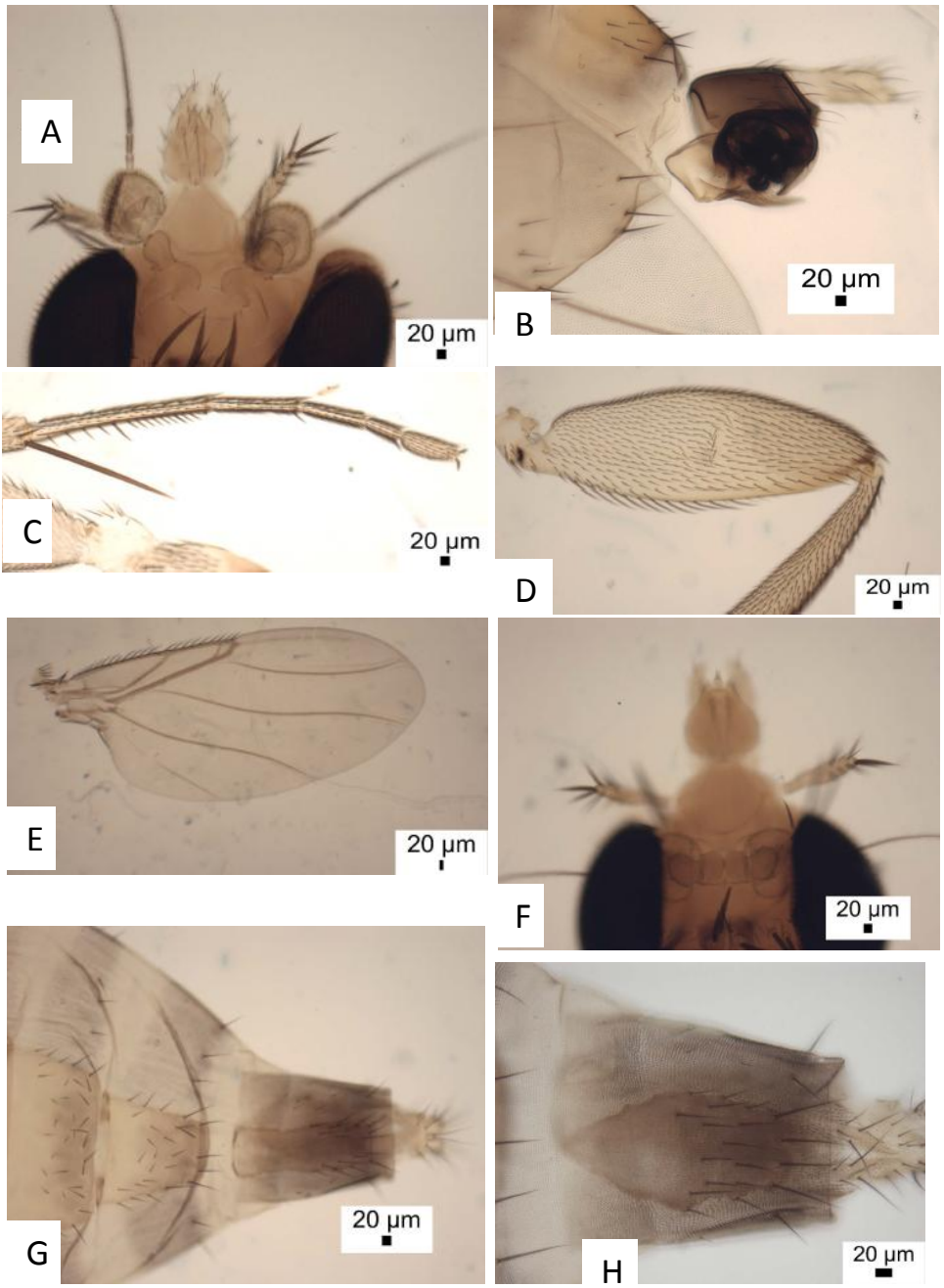
upper supra-antennal (SA)

antero-lateral (AL)





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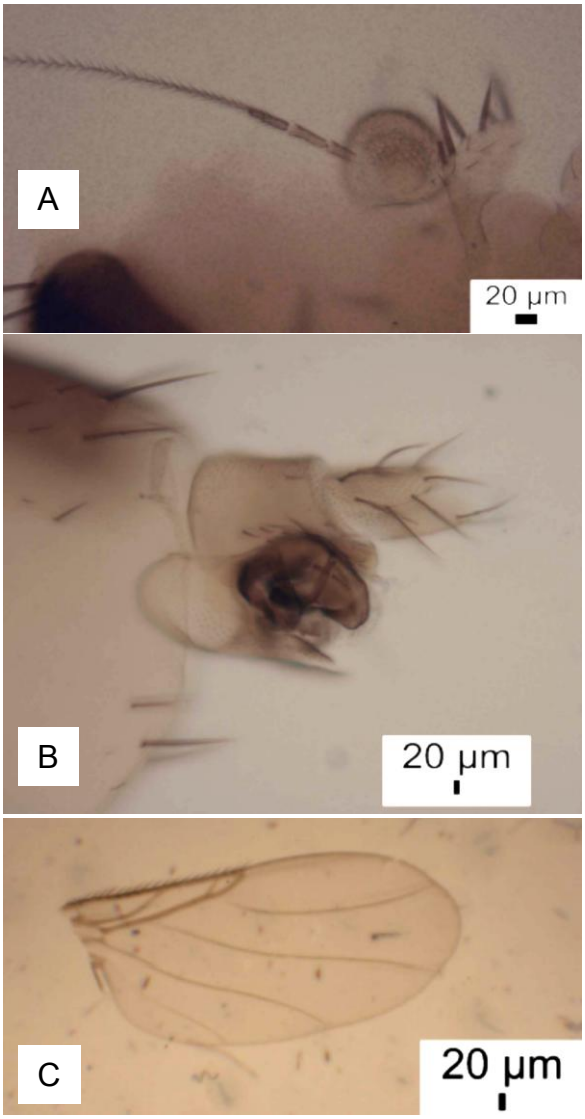
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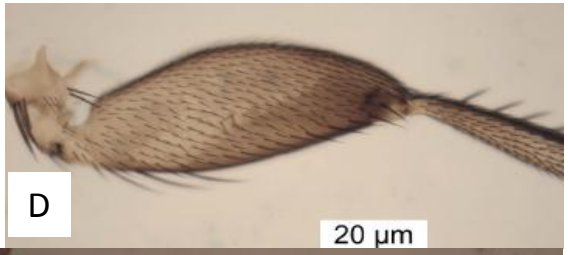
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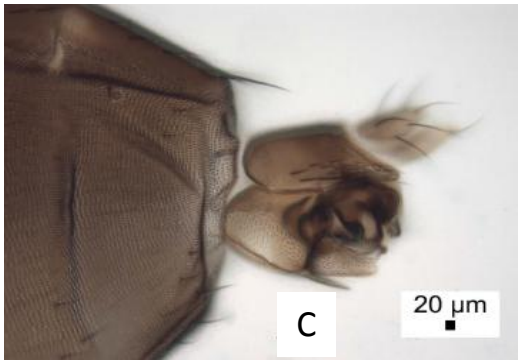
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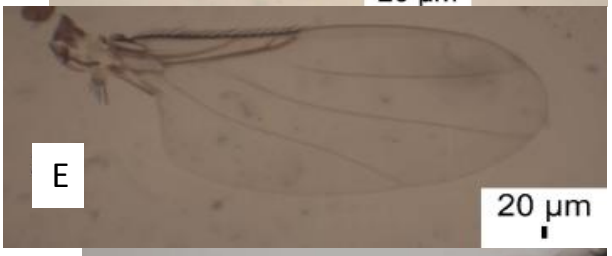
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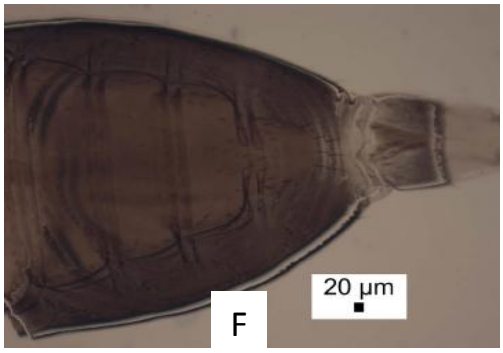
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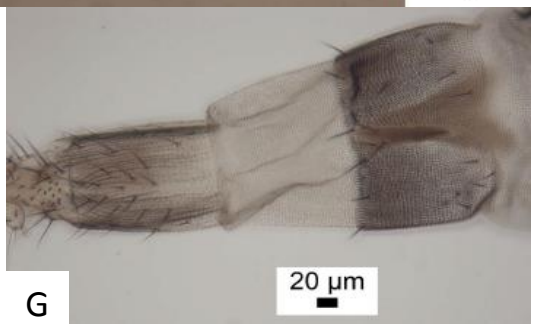
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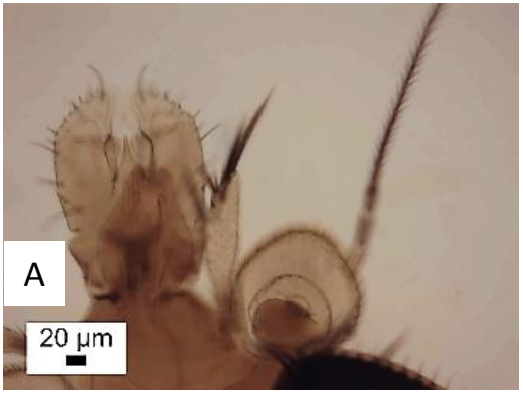
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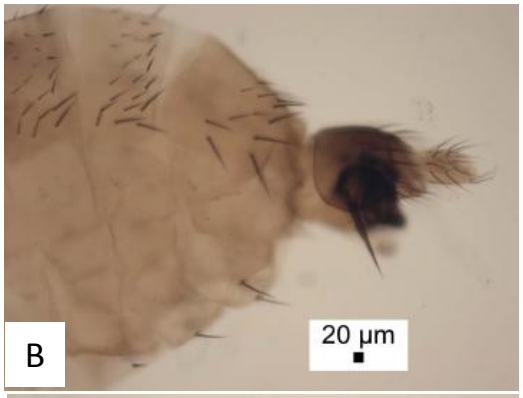
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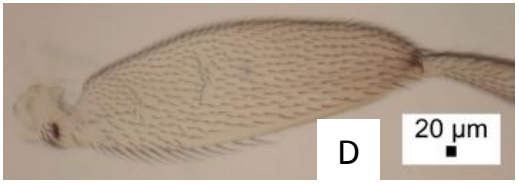
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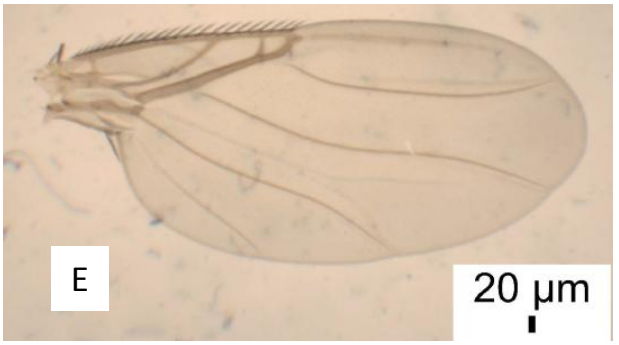
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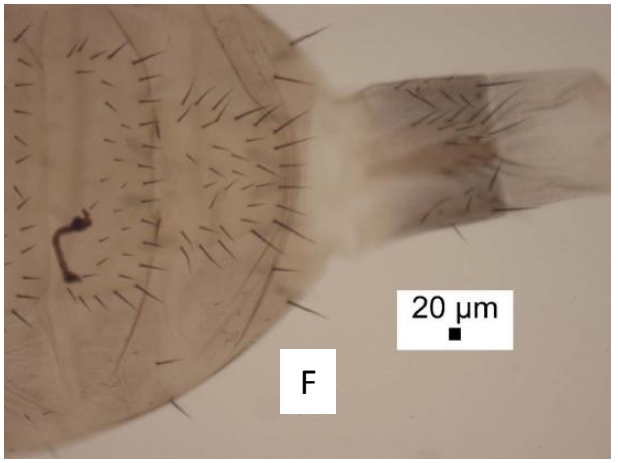
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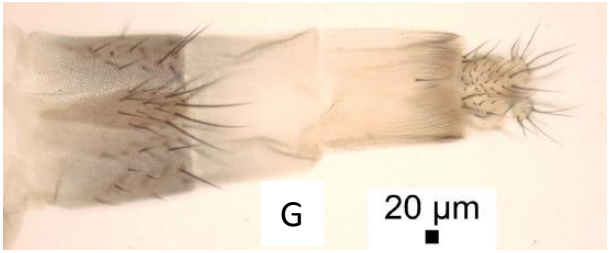
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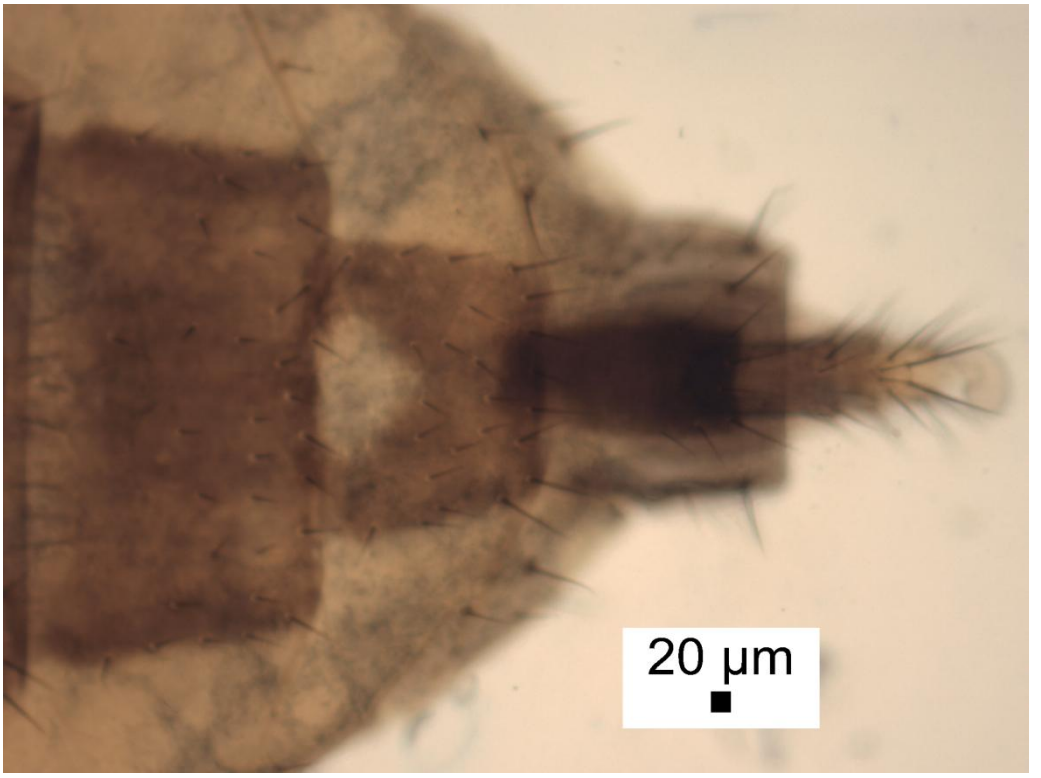
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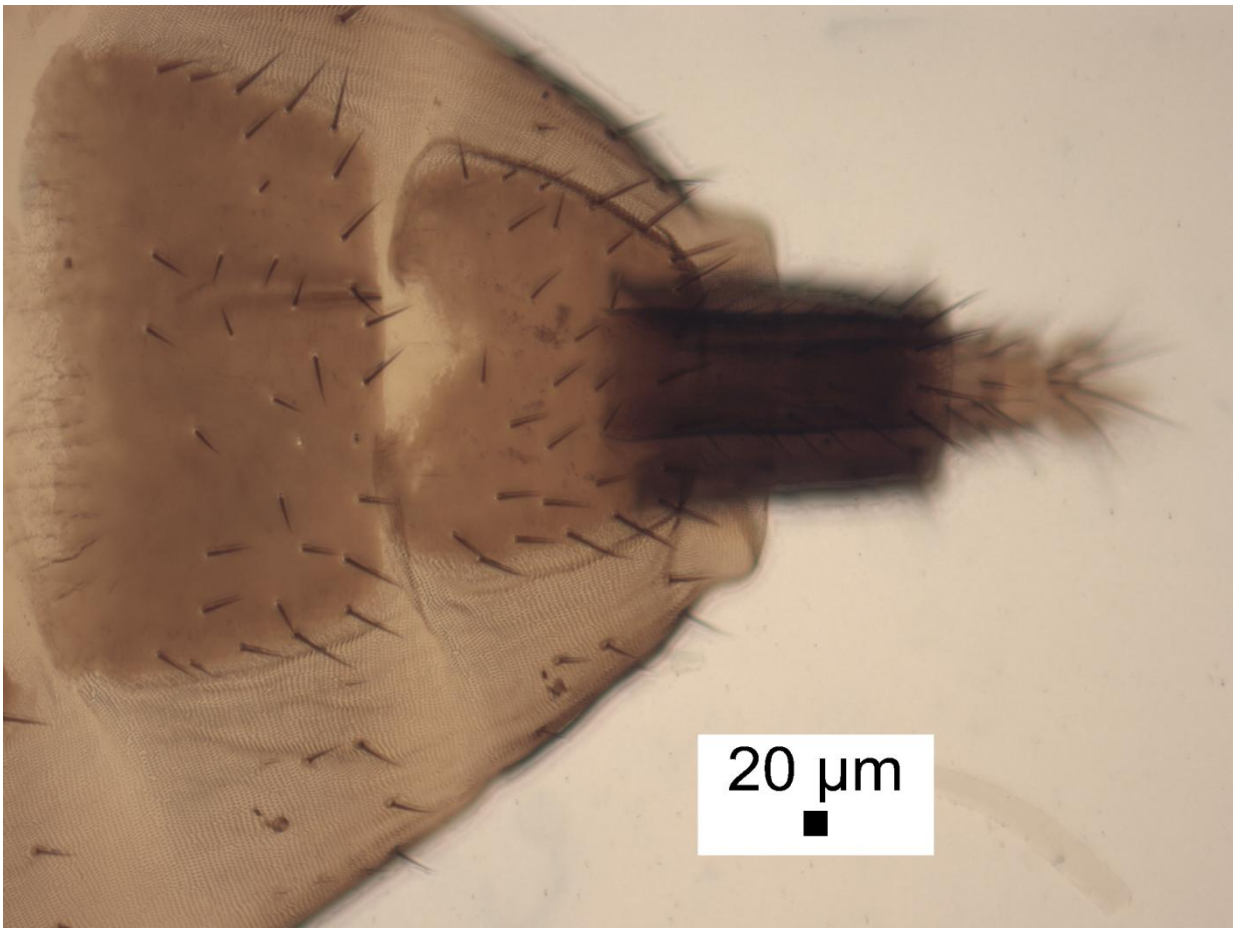
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