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Three Sarcophagid species (Diptera: Sarcophagidae) newly recorded in Thailand

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Abstract. This study contributed new records of three flesh fly species (Diptera: Sarcophagidae) to the fauna of Thailand – *Miltogramma tibita* Chao & Zhang (subfamily Miltogrammatinae), *Myorhina situliformis* (Zhong, Wu & Fan, 1982), and *Iranihindia martellata* (Senior-White, 1924) (subfamily Sarcophaginae). Collections of these species were performed using a sweep net and one-day old beef offal as bait. *Miltogramma tibita* differs from other known *Miltogramma* by having a fine long seta on the dorsal surface of tarsomeres 2-4. With this new record, the number of species belonging to the genus *Miltogramma* known from Thailand has increased to three which includes *Miltogramma angustifrons* (Townsend, 1933) and *Miltogramma iberica* Villeneuve, 1912. The new record of *My. situliformis* makes a total of three species for *Myorhina* and these include *Myorhina otiophalla* (Fan & Chen, 1981) and *Myorhina caudagalli* (Böttcher, 1912). Regarding *Iranihindia*, the recording of *I. martellata* makes a total of two species, the other being *Iranihindia martellatoides* (Baranov, 1931). This study provides a revised key of each genus where these newly recorded species were recorded, with their re-descriptions, illustrations, photographs, and scanning electron micrographs focusing on the male genitalia. The findings of these newly recorded species means that a total of 86 species of flesh flies have been recorded from Thailand.

INTRODUCTION

Flesh flies (Diptera: Sarcophagidae) are one of the medically and forensically important insect groups worldwide. According to Pape (1996), the catalogue of the Sarcophagidae of the world listed 2510 known species. In Thailand, the most recent list of flesh fly species consisted of 29 genera and 83 species (Kurahashi & Chaiwong 2013). Of these, two species of the genus *Miltogramma* [*Mi. angustifrons* (Townsend) and *Mi. iberica* Villeneuve], two species of the genus *Myorhina* [*My. otiophalla* (Fan & Chen) and *My. caudagalli* (Böttcher)], and one species of the genus *Iranihindia* [*I. martellatoides* (Senior-White)] were reported. Surveys of medically important flies conducted in several regions in Thailand revealed three species of sarcophagids that had not been recorded previously. This study recorded these three sarcophagids as new to Thailand, re-described the adult males in general morphology, presented revised keys to their identification, and documented the male genitalia using scanning electron micrographs.

Abbreviations for institutions housing specimens are as follows: BPBM, Bishop Museum, Honolulu; DPCM, Department of Parasitology, Chiang Mai University, Chiang Mai; CMPH, College of Medicine and Public Health, Ubon Ratchathani University, Ubon Ratchathani; IDD, International Department of Dipterology; NSMT, National Museum of Nature and Science, Tokyo.

MATERIALS AND METHODS

Fly collections

Flies were collected from Lampang province (18º23'32.64°N, 99º12'29.03°E, 439 m a.s.l.), Nakhon Sawan province (15º34'56.5680°N, 100º08'48.1200°E, 81 m a.s.l.) and Ubon Ratchathani province (Muang Ubon Ratchathani, 15°16'29.668°N, 104°49'27.471°E, 127 m a.s.l. and Warinchamrap districts, 15°11'33.212°N, 104°50'6.756°E, 126 m a.s.l.), North-East Thailand using sweep nets with one-day beef offal as bait. The beef was left for 24 h at room temperature (≈25-30°C) before use. Identification using a key of Tumrasvin and Kano (1979) was performed and the male specimens of *Mi. tibita*, *My. situliformis* and *I. martellata* appeared as new records to Thailand.

Examination of external morphology and scanning electron microscopy

After pinning, the external morphology of flesh flies was examined under a dissecting microscope (Olympus, Japan). The length of the frons was measured using an ocular micrometer. Regarding the male genitalia, the last abdominal segment was dissected from pinned specimens under a dissecting microscope and soaked in 10% potassium hydroxide overnight. Specimens were then transferred to a compound microscope and photographed using a mounted digital camera. The specimens were cleaned of KOH by rinsing in normal saline solution and then kept in 70% ethanol. Illustrations were performed from the micrographs taken with the digital camera. For the scanning electron microscopy (SEM) process, specimens placed in 70% ethanol were left for 1 day at room temperature to let them dry completely. All specimens were then attached to double-sided sticky tape on an aluminum stub, coated with gold in sputter-coating apparatus, and viewed under a JEOL-JSM6610LV scanning electron microscope (JEOL, Japan, Faculty of Medicine, Chiang Mai University).

Terminology

The terminology related to fly taxonomy has been changed on several occasions. In this paper, the terminology of the general morphology follows McAlpine (1981) and Senior-White *et al.* (1940). Terminology of male genitalia mainly follows Zumpt & Heinz (1950) and Giroux *et al.* (2010).

RESULTS

Miltogramma tibita Chao & Zhang, 1988 (Figs. 1a, 1b)

Male (2 specimens). Body length 10.0 mm, width 3.0 mm. *Head.* Frons index 0.24 ($n = 2$), frontal stripe yellow brown, parafrontal and parafacial entirely golden pollinose (Fig. 1c), parafrontal slightly yellowish tinged, with about 10 frontal bristles (*ori*) and 0+1 fronto-orbital bristles (*ors*), outer vertical bristles (*ov*) shorter than 2/3 the length of inner vertical bristles (*iv*). Antennae entirely blackish (Fig. 1c), only second segment with yellow-brown apical margin, third segment more than three times as long as second segment, arista blackish. Gena silver-grey pollinose, with numerous white hairs except for several black ones below lower eye margin, postgena with numerous whitish hairs. Occiput with group of black postocular setae, on upper parts but only one row regular. Palpus slender, yellow brown. *Thorax.* Black, silver-grey pollinose, with 3 broad black longitudinal stripes; propleuron bare; mesothoracic spiracle yellowish; metathoracic spiracle creamy white. Chaetotaxy acrostichial (*ac*) 0+1 (prescutellar), *dc* 2+2, intraalars (*ia*) 0+1, humeral (*h*) 3 (strongly developed), posthumeral (*ph*) 1, presutural (*prs*) 1, supraalar (*sa*) 2, notopleural (*n*) 2 (strongly developed), postalar (*pa*) 2, *sc* 3+1. Wing entirely fuscous hyaline, epaulet blackish, basicosta creamy white, R_1 bare above, R_{4+5} with row of 9-10 setae extending nearly halfway from basal node to r-m above, CS 5 with short spines along less than basal one-third of anterior margin. Alar and thoracic squamae creamy white. Halter brownish. Legs black, fore femur with row of strong *pd*, *p* and *pv*, with row of long hair on postero-ventral surface; fore tibia with 1 short *ad* apically without *p*, male tarsal segment 2-4 of foreleg with several long hairs on dorsal

surface (Fig. 1d); mid femur with row of strong hair, 2 *p-pd* apically, rows of *av*, and *pv* apically; mid tibia with 3 *ad* (1 strong), 1 *pd* medially, with *p*, *pv* apically; hind femur with rows of strong *ad*, with 3 *pd* apically; hind tibia with 3-4 strong *ad*, row of *pd*. *Abdomen.* Clothed with yellowish-grey pollinose, more or less yellowish on lateral side of tergite 1+2 to tergite 3; tergite 4 with row of short erect marginal bristles; tergite 5 with row of erect marginal bristles. Sternite 5 U-shaped with fine setulae scattered on sternal arms (Fig. 2a). GS 1 and GS 2 (epandrium) fuscous brown pollinose. Genitalia hypopygium: surstylus elongate when viewed from the rear (Fig. 2b). Cercus broad at base in lateral view, tapering to point at apex (Fig. 2c), with long hairs at basically 2/3, apical cercus pointed and sharp (Fig. 2d). Aedeagus small, juxta smooth tubular, median stylus membranous antero-lateral and serrated medially (Fig. 2e).

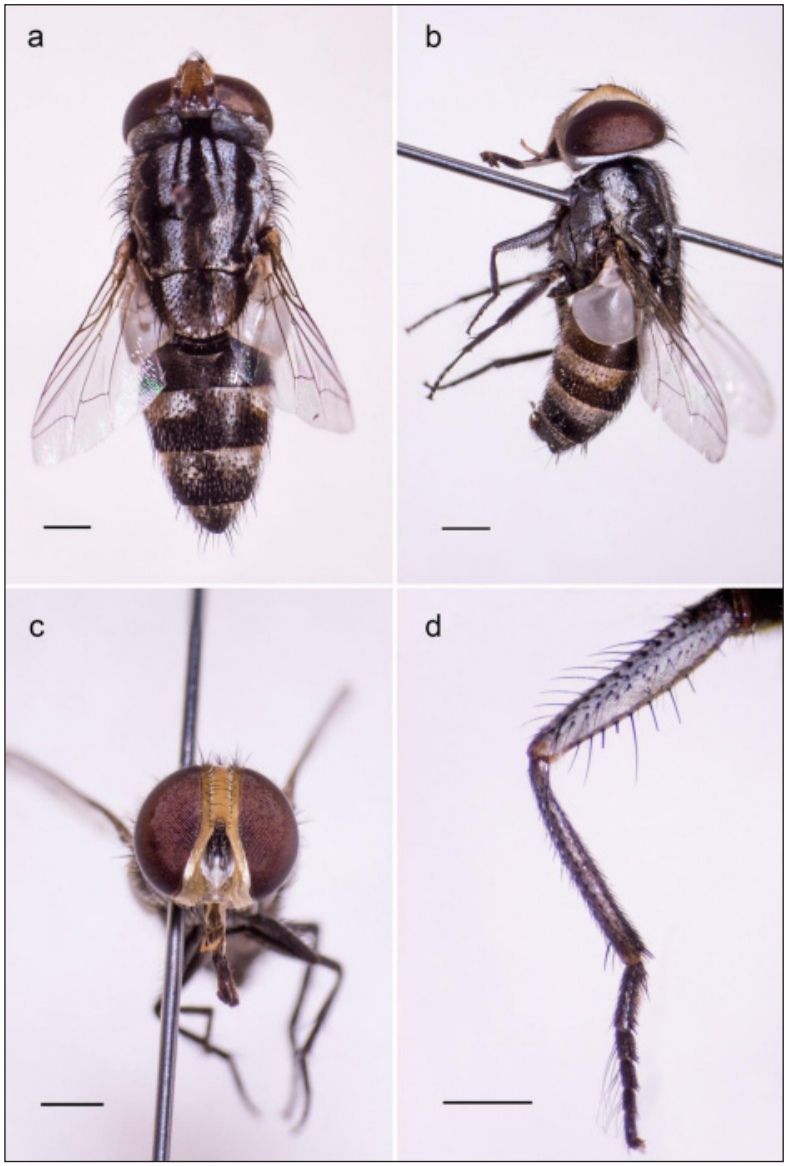

Figure 1. Male *Mi. tibita*. (a) Dorsal view. Bar = 1 mm. (b) Lateral view. Bar = 1 mm. (c) Anterior view of the head showing golden parafrontal and parafacial, blackish antennae. Bar = 1 mm. (d) Second to fourth tarsal segment of foreleg showing long hairs on dorsal surface. Bar = 0.5 mm.

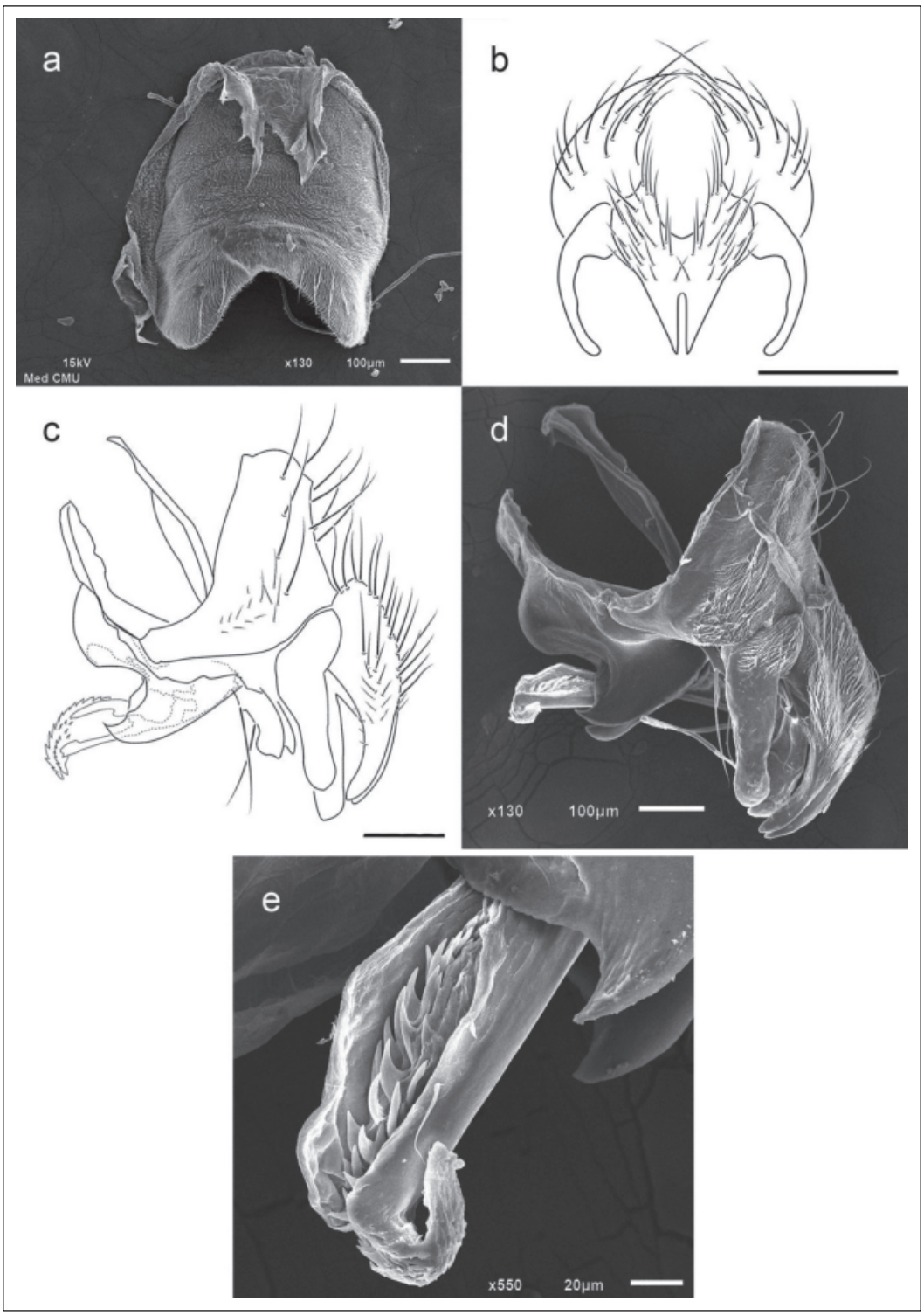

Figure 2. Male *Mi. tibita*. (a) SEM micrograph of fifth sternite. (b) Posterior view of cerci and surstyli. Bar = 0.1 mm. (c) Lateral view of male genitalia. Bar = 0.1 mm. (d) SEM micrograph of male genitalia. (e) SEM micrograph of aedeagus showing tubular juxta and membranous anterolateral and serrated medially median stylus.

Material examined. 1 male, Chiang Mai Prov., NW, Chiangdao, 450m, 5-11.iv.1958, T.C. Maa (BPBM); 1 male 1 female, Lamphang Prov., Hang Chat Dist., Doi Khun Tan, 493m, rest area, 8.iii.2013, H. Kurahashi (IDD); 13 males 1 female >NSMT(gift); 2 males >DPCM (gift); 2 males > CMPH (gift).

Female. Unknown

Biology. Flies of the genus *Miltogramma* are commonly parasites brood of bee, as have been documented in the large Australian native bee by *Miltogramma rectangularis* (Alcock 2000). In the current collection, males *Mi. tibita* were collected around the rest of a wasp in the dense forested area of Lampang province, Northern Thailand.

Distribution. China (Tibet) and Thailand (Chiang Mai, Lampang)

Myorhina situliformis (Zhong, Wu & Fan, 1982) (Figs. 3a, 3b)

Male (1 specimen). Body length 10.0 mm, width 3.0 mm. *Head.* Frons index 0.24 (n = 1), frontal stripe black, parafrontal and parafacial entirely silver-grey pollinose (Fig. 3c), parafrontal slightly blackish, with about 11 frontal bristles (*ori*) and 0+1 fronto-orbital bristles (*ors*), outer vertical bristles (*ov*) shorter than 2/3 the length of inner vertical bristles (*iv*). Antennae entirely blackish (Fig. 3c), third segment more than three times as long as second segment, arista blackish. Gena silver-grey pollinose, with numerous black hairs, postgena with numerous whitish hairs. Occiput with group of black postocular setae, on upper parts but only one row regular. Palpus slender, entirely black. *Thorax.* Black, silver-grey pollinose, with 3 broad black longitudinal stripes; propleuron bare; mesothoracic spiracle brown; metathoracic spiracle brown. Chaetotaxy acrostichial (*ac*) 0+1 (prescutellar), *dc* 2+2, intraalars (*ia*) 0+1, humeral (*h*) 3 (strongly developed), posthumeral (*ph*) 1, presutural (*prs*) 1, supraalar (*sa*) 2, notopleural (*n*) 2 (strongly developed), postalar (*pa*) 2, *sc* 3+1. Wing entirely fuscous hyaline, epaulet blackish, basicosta creamy white, R_1 bare above, R_{4+5} with row of 9-10 setae extending nearly halfway from basal node to r-m above, Costal section 5 (CS5) with short spines along less than basal one-third of anterior margin. Alar and thoracic squamae creamy white. Halter brownish. Legs black, fore femur with row of strong *pd*, *p* and *pv*, with row of long hair on postero-ventral surface; fore tibia with 1 short *ad* apically without *p* (Fig. 3a); mid femur with row of strong hair, 2 *ad*, 1 *p-pd* apically, rows of *av*, and *pv* apically; mid tibia with 3 *ad* (1 strong), 1 *pd* medially, with *p*, *pv* apically; hind femur with rows of strong *ad*,

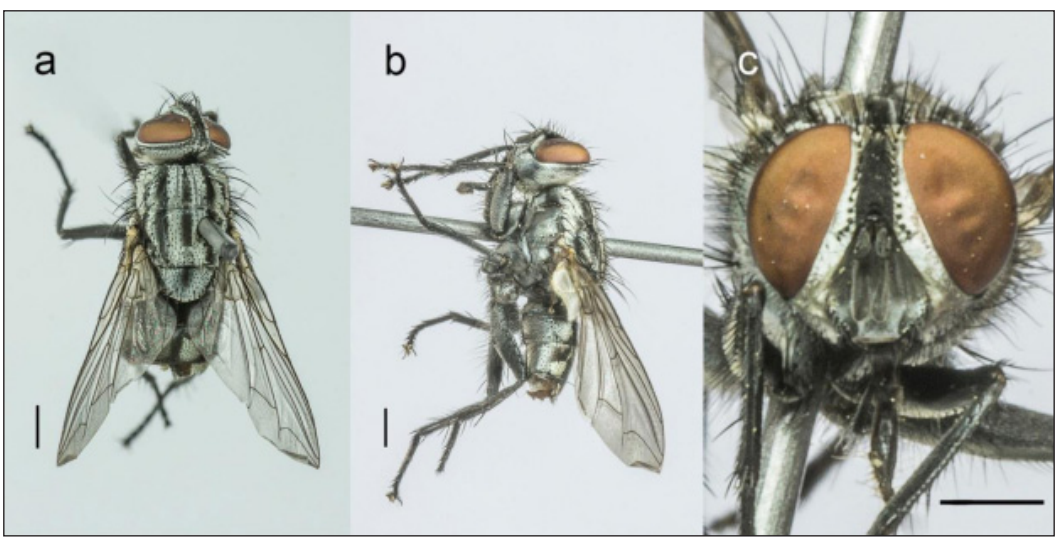

Figure 3. Male *My. situliformis*. (a) Dorsal view. Bar = 1 mm. (b) Lateral view. Bar = 1 mm. (c) Anterior view of the head showing golden parafrontal and parafacial, blackish antennae. Bar = 1 mm.

with 3 *pd* apically; hind tibia with 3-4 strong *ad*, row of *pd*. *Abdomen*. Clothed with yellowish-grey pollinose, more or less yellowish on lateral. Sternite 5 V-shaped with fine setulae scattered on sternal arms (Fig. 4a). GS 1 and GS 2 (epandrium) fuscous brown pollinose. Hypopygium: surstylus elongate when viewed from the rear (Fig. 4b, 4c, 4d). Anterior part of cercus normal, tapering to point at apex (Fig. 4c, 4d), with long hairs at basically 2/3, apical cercus pointed and sharp (Fig. 4c, 4d). Phallus small, apical plate of juxta long, median stylus bifid anteriorly, ventralia curve-shaped (Fig. 4e, 4f). Pregonite and Postgonite slender, pointed at end (Fig. 4e, 4g).

Material examined. THAILAND: 1 male, Nakhon Sawan, Pnayuhakiri, T. Khao Tong, 345 m, 28.xii.2012, K. Moophayak.

Distribution. China (Tibet), Nepal and Thailand (Nakhon Sawan)

Iranihindia martellata (Senior-White, 1924) (Figs. 5a, 5b)

Male (n = 5). Body length 11-14 mm, width 3-4 mm. *Head.* Frons index 0.22 (n= 5), frontal stripe blackish, parafrontal and parafacial black, parafrontal slightly yellowish tinged, with about 10 frontal bristles (*ori*) and 0+1 fronto-orbital bristles (*ors*), outer vertical bristles (*ov*) shorter than ½ length of inner vertical bristles (*iv*). Antennae yellowish-red to orange (Fig. 5c), first segment brown, second segment yellowish red, third segment yellowish orange and about more than three times as long as second segment, arista plumose, brown, yellowish medially. Gena silver-grey pollinose, with numerous white hairs except for several black ones below lower eye margin, postgena with numerous whitish hairs. Occiput with group of black postocular setae, on upper parts but only one row regular. Palpus slender, entirely yellowish orange. *Thorax.* Black, silver-grey pollinose, with 3 broad black longitudinal stripes; propleuron bare; mesothoracic spiracle yellowish orange; metathoracic

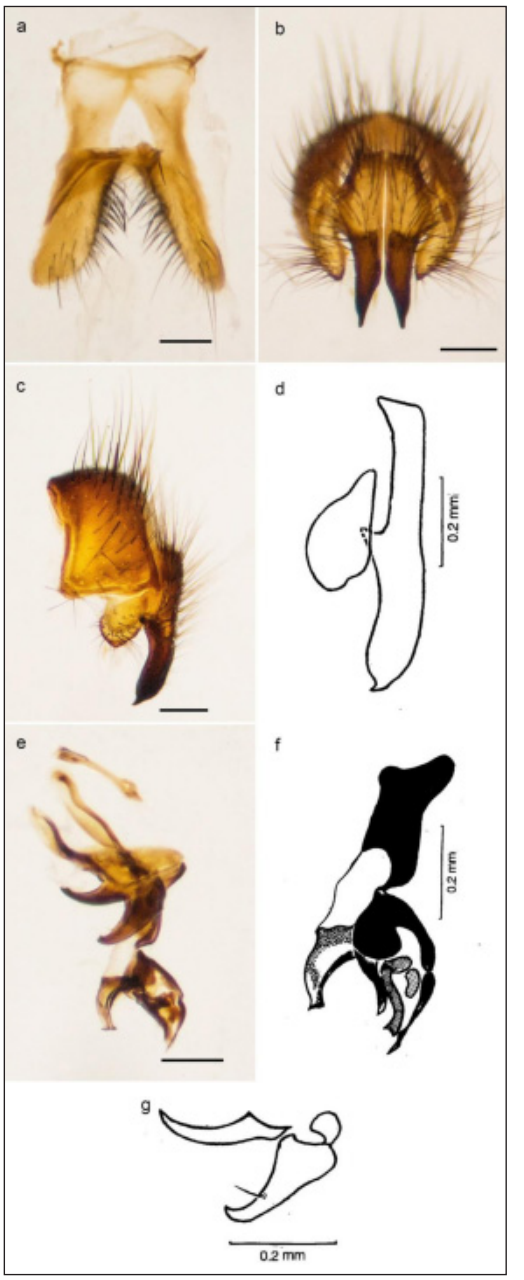

Figure 4. Male *My. situliformis*. (a) Light micrograph of fifth sternite. (b) Light micrograph of cercus and surstylus, posterior view. (c) Lateral view of cercus and surstylus. (d) Illustrations of cercus and surstylus, lateral view. (e) Light micrograph of aedeagus, pregonite and postgonite, lateral view. (f) Illustrations of aedeagus, lateral view. (g) Illustrations of pregonite and postgonite, lateral view.

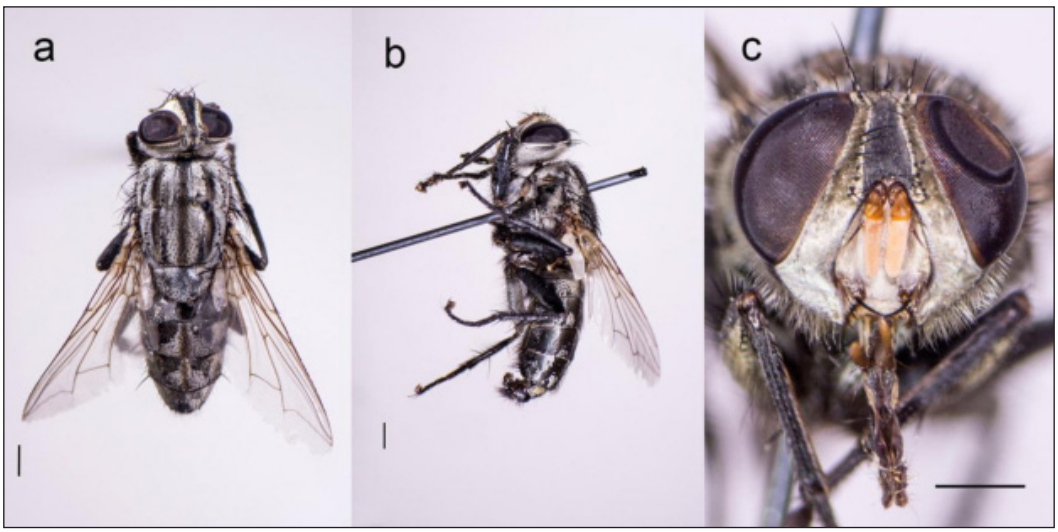

Figure 5. Male *I. martellata*. (a) Dorsal view. Bar = 1 mm. (b) Lateral view. Bar = 1 mm. (c) Anterior view of the head showing yellowish-red to orange antennae. Bar = 1 mm.

spiracle brown. Chaetotaxy acrostichal (*ac*) 0+1, *dc* 5+5, intraalars (*ia*) 1+2, humeral (*h*) 3, posthumeral (*ph*) 2, presutural (*prs*) 1, *sa* 3 (median 1 strongly developed), *n* 4 (2 strongly developed), postalar (*pa*) 2, *sc* 3. Wing entirely fuscous hyaline, epaulet blackish, basicosta creamy white, R_1 bare above, R_{4+5} with row of 8-9 short setae extending up to about three-fifths from basal node to r-m, Costal section 5 (CS5) with short spines along ½ anterior margin. Alar and thoracic squamae creamy white. Halter yellowish orange. Legs black, fore femur with row of strong *pd*, *p* and *pv*; fore tibia with 2-3 short *ad* basally, 1 *p* at apical 1/3; mid femur with 3-4 short *a* medially, 2 *p-pd* apically, rows of strong *av*, and *pv* apically, without long hairs exceeding width of femur on postero-ventral surface; mid tibia with 1 *ad*, *pd* medially, with *p*, *pv* apically; hind femur with rows of strong *ad*, *a* and *av* of apical ½ , with 3 *pd* apically, 3 *av* medially, with low of long hair on postero-ventral surface; hind tibia with 3 strong *ad*, 2 *pd* medially. *Abdomen.* Black, silver-grey pollinose, tessellate; tergite 2-3 without median marginal bristle; tergite 3 with strong *marginal bristles (mb)*; tergite 4-5 with median and 2 strong lateral erect marginal bristles. Sternite 1-4with tuft of long hairs. Sternite 5 V-shaped with brush of spines laterally, fine setulae scattered on middle of arms, sternal arms with slightly curving inward apically (Figs. 6a,6b). GS1 dark brown pollinose; GS2 (epandrium) blackish with long hairs. Genitalia hypopygium: cercus broad at base, tapering to point at apex (Figs. 6c,6d), with long hairs and a row of sort comb-like spines on the middle (Figs. 6e,6f); Pregonite bifurcated at distal end; Postgonite slender, pointed at end with hair anteriorly (Fig. 6f); Aedeagus large, corpus large, smooth, rounded (Figs. 7a,7b,7c), juxta with plough-shaped of antero-lateral membranous anteriorly (Figs. 7a,7c), stylus curved inwards and serrated (Figs. 7c,7d).

Material examined. THAILAND: 1 male, Ubon Ratchathani, Muang, school cafeteria, 15°16'29.668°N 104°49'27.471°E, 127 m, 12.iii.2011, T. Chaiwong (CMPH); 1 male, Ubon Ratchathani, Muang, school cafeteria, 15°16'29.668°N 104°49'27.471°E, 127 m a.s.l., 22.v.2011, T. Chaiwong (CMPH); 1 male, Ubon Ratchathani, Muang, restaurant, 15°16'29.668°N 104°49'27.471°E, 132 m a.s.l., 22.v.2011, T. Chaiwong (CMPH); 1 male, Ubon Ratchathani, Muang, restaurant, 15°16'29.668°N 104°49'27.471°E, 132 m a.s.l., 12.vi.2011, T. Chaiwong (CMPH); 1 male, Ubon Ratchathani, Warinchamrap, school cafeteria, 15°11'33.212°N 104°50'6.756°E, 126 m a.s.l., 12.vi.2011, T. Chaiwong (CMPH).

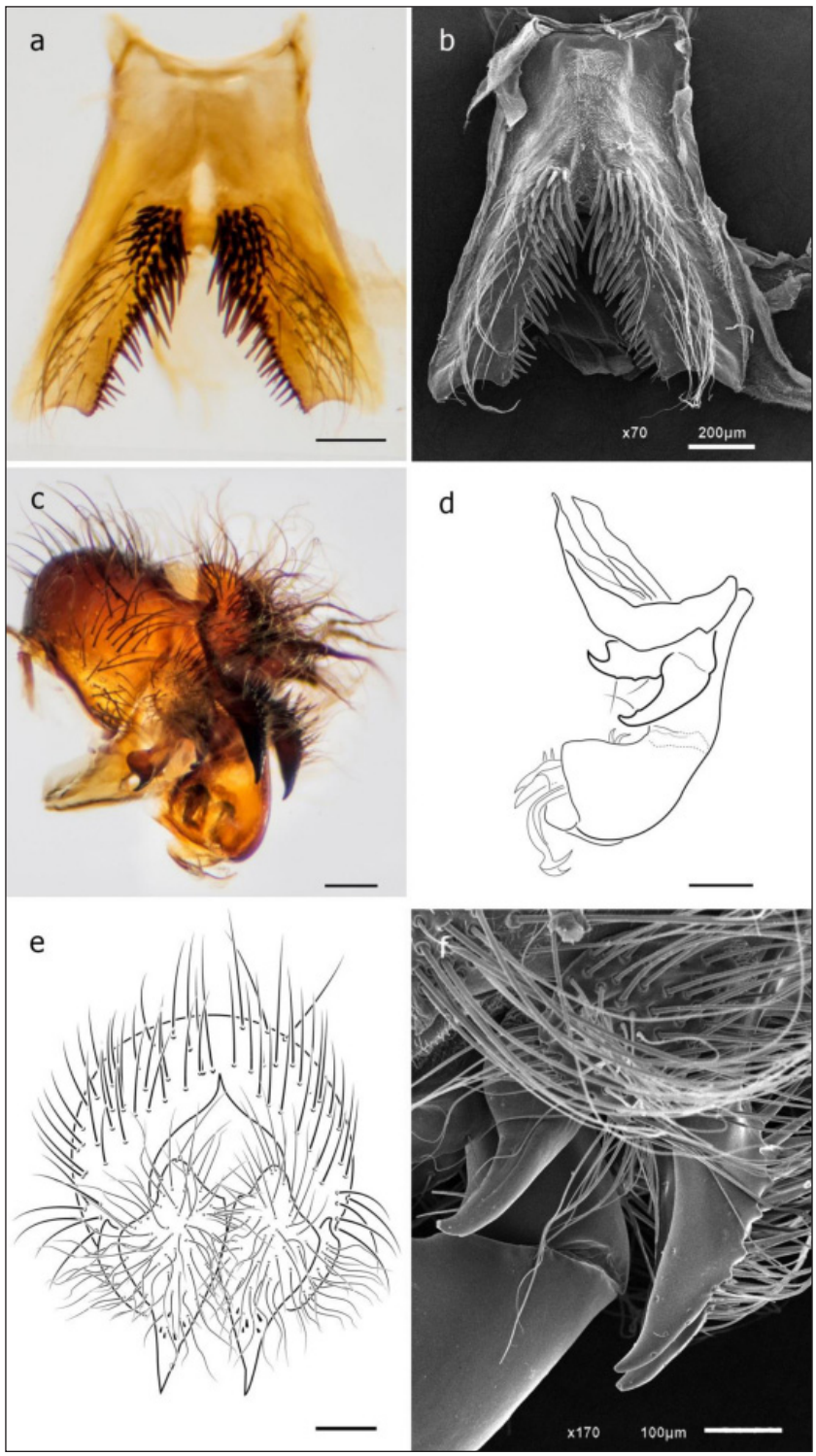

Figure 6. Male *I. martellata*. (a) Light micrograph of fifth sternite. Bar = 0.2 mm. (b) SEM micrograph of fifth sternite. (c) Light micrograph of male genitalia, lateral view. Bar = 0.2 mm. (d) Illustrations of male genitalia, posterior view. Bar = 0.2 mm. (e) Illustrations of cerci and surstyli. Bar = 0.1 mm. (f) SEM micrograph of cercus (C) and surstylus, lateral view.

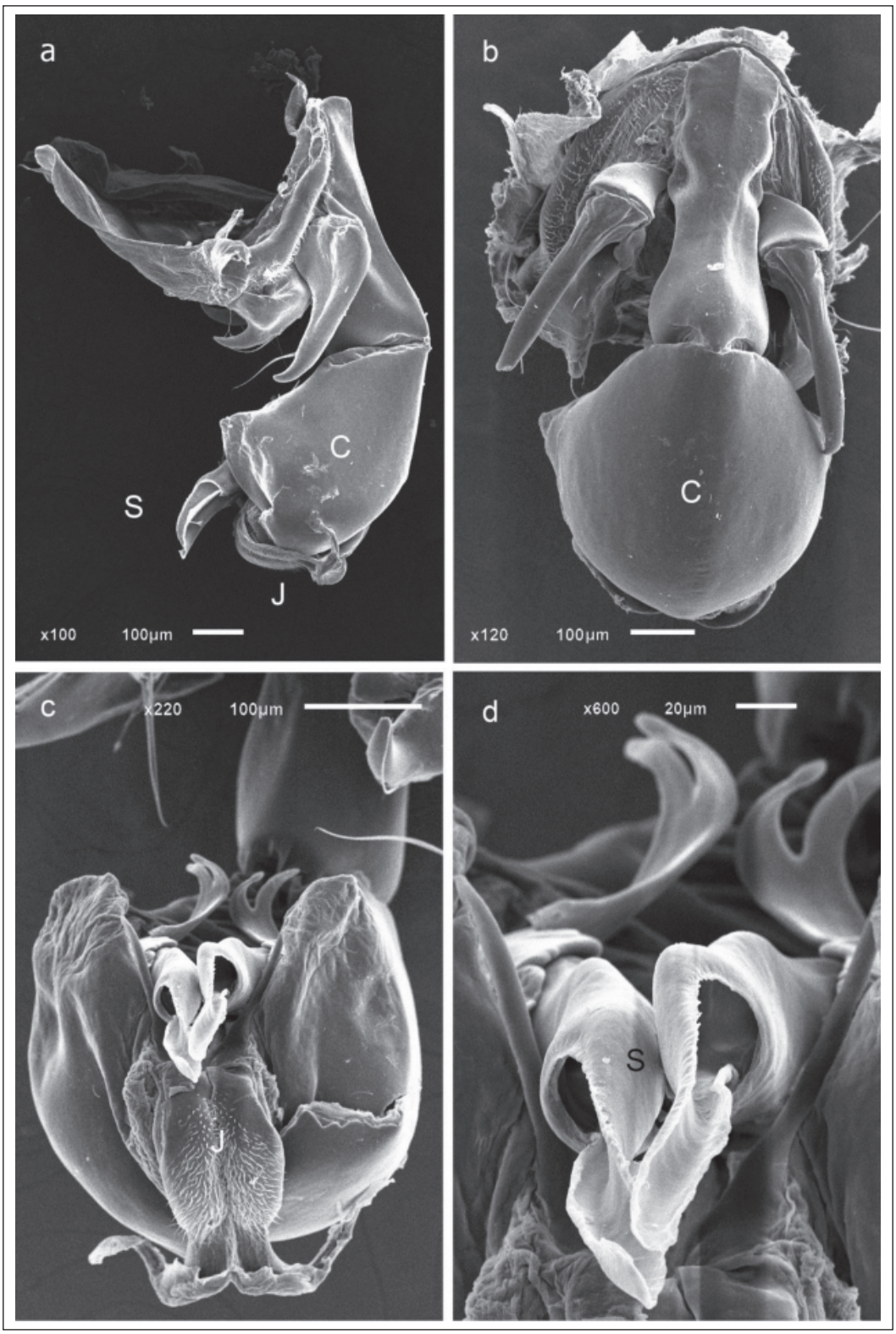

Figure 7. SEM micrographs of aedeagus *I. martellata*. (a) Lateral view showing large corpus (C). (b) Posterior view showing large rounded corpus (C). (c) Top view showing plough-shaped antero-lateral membranous juxta (J). (d) Higher magnification showing curved inwards and serrated stylus (S).

Female. Unknown

Biology. Unknown except that males were collected from one-day beef offal (in this study) or two-day-old spoiled beef (Tan *et al.*, 2010).

Distribution. India, Nepal, Sri Lanka (Pape, 1996), peninsular Malaysia (Tan *et al.*, 2010) and Thailand (Ubon Ratchathani).

Key to the Thai species *Miltogramma* (Kurahashi and Chaiwong, 2013, revised to include newly recorded species)

1. AS3 largely orange yellow, especially on inner surface .... *Mi. angustifrons* (Townsend)
   – AS3 largely or entirely fuscous to black 2

2. Basicosta black or fuscous black, sometimes reddish-brown; male tarsomeres 2-4 of fore leg without long hairs at dorsal surface .... *Mi. iberica* Villeneuve
   – Basicosta yellow; male tarsomeres 2-4 of foreleg with long hairs at dorsal surface ..... *Mi. tibita* Chao & Zhang

Key to the Thai species *Myorhina* (Kurahashi and Chaiwong, 2013, revised to include newly recorded species)

1. Cell R5 closed at wing margin; fore tibia with 2 bristles on posterior surface (1 *p* and 1 *pv*) .... *My. otiophalla* (Fan & Chen)
   – Cell R5 open; fore tibia with 1 *p* 2

2. Costal section 5 (CS5) setulose along anterior margin on less than basal 1/2; hind tibia with 1 *av*, with fringe of several fine long hairs medially on antero- and postero-ventral surfaces .... *My. situliformis* (Zhong, Wu & Fan)
   – CS5 setulose along anterior margin along more than basal 1/2, at most almost entirely; hind tibia with 2 *av*, without fringe on postero-ventral surface ..... *My. caudagalli* (Böttcher)

Key to the species *Iranihindia*

1. Tergite 3 with strong marginal bristles (*mb*); stylus long and blunt .... *I. martellatoides* (Baranov)
   – Tergite 3 without median *mb*; stylus short and pointed .... *I. martellata* (Senior-White)

DISCUSSION

Thailand is located in the tropics and contains various ecological niches and habitats, providing an ideal environment for variety of insects, including flesh flies. Based on the catalogue of Sarcophagidae of the World (Pape 1996), *Mi. tibita* is distributed in the Palaearctic region – China (Tibet). This study is the first record of this species in Thailand. *Mi. tibita* share a similar characteristic with another related species, *Miltogramma bimaculatum* Chao & Zhang. There is a noteworthy difference in the appearance between them, based on the illustrations of Fan (1992) (Figs. 1205e, 1207e) in that *Mi. tibita* possesses fine long hairs on the dorsal surface of second to fourth tarsomere of the foreleg, whereas those of *Mi. bimaculatum* occur on the fourth tarsomere and are longer in length.

Regarding *I. martellata*, this species seems to be widely distributed in and around the Indian subcontinent of the Oriental region – India, Nepal, and Sri Lanka (Pape 1996), but it has been newly recorded in Malaysia recently (Tan *et al.*, 2010). Habitats seem to be variable, such as a school cafeteria and restaurants (in this study) that are located in urban areas, gardens or bushes in residential areas and a sandy beach in Malaysia (Tan *et al.*, 2010), bushes and flowering plants (Nandi, 2002), or forests in India (Nandi, 1989).

In conclusion, *Mi. tibita*, *My. situliformis*, and *I. martellata* were newly recorded in Thailand, making a total of 86 species of sarcophagid flies in the country.

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REFERENCES

Alcock, J. (2000). The natural history of a miltogrammine fly, *Miltogramma rectangularis* (Diptera: Sarcophagidae). *The Journal of the Kansas Entomological Society*. **73**: 208-209.

Giroux, M., Pape, T. & Wheeler, T.A. (2010). Towards a phylogeny of the flesh flies (Diptera: Sarcophagidae): morphology and phylogenetic implications of the acrophallus in the subfamily Sarcophaginae. *Zoological Journal of the Linnean Society*. **158**: 740-778.

Fan, Z. (1992). *Key to the common flies of China*. 2nd ed.; XI viii. Science Press, Beijing, 992 pp.

Kurahashi, H. & Chaiwong, T. (2013). Keys to the flesh flies of Thailand, with description of a new species of *Robineauella* Enderlein (Diptera: Sarcophagidae). *Medical Entomology and Zoology* **64**: 83-101.

McAlpine, J.F. (1981). *Manual of Nearctic Diptera*. Biosystematic Research Institute Research Monograph No. 27.

Nandi, B.C. (1989). Sarcophagid flies (Diptera: Sarcophagidae) from Tripura, India. *Memorias do Instituto Oswaldo Cruz* **84** (Suppl IV) : 395-401.

Nandi, B.C. (2002). *Fauna of India and the adjacent countries - Diptera (Volume X) Sarcophagidae*. Director, Zoological Survey of India, Kolkata.

Pape, T. (1996). *Catalogue of the sarcophagidae of the world (Insecta: Diptera)*. Associated Publishers, Gainesville, FL.

Tan, S.H., Mohd Aris, E., Kurahashi, H. & Mohamed, Z. (2010). A new record of *Iranihindia martellata* (Senior-White, 1924) (Diptera: Sarcophagidae) from peninsular Malaysia and female identification using both morphology and DNA-based approaches. *Tropical Biomedicine* **27**: 287-293.

Tumrasvin, W. & Kano, R. (1979). Studies on medically important flies in Thailand. VI. Report on 48 species of Sarcophagid flies, including the taxonomic keys (Diptera: Sarcophagidae). *The Bulletin of Tokyo Medical and Dental University* **26**: 149-179.

Senior-White, R., Aubertin, D. & Smart, J. (1940). *The Fauna of British India, including Remainder of the Oriental region. Diptera VI. Family Calliphoridae*. Taylor & Francis Ltd., Londpn, *xii*+288 pp.

Zumpt, F. & Heinz, H.J. (1950). Studies on the sexal armature of Diptera. II. A contribution to the study of the morphology and homology of the male terminalia of *Calliphora* and *Sarcophaga* (Dipt., Calliphoridae). *Entomologist's Monthly Magazine* **86**: 207-216.