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Published in:
Fragmenta Entomologica

DOI:
[10.4081/fe.2016.161](https://doi.org/10.4081/fe.2016.161)

Publication date:
2016

Document version
Publisher's PDF, also known as Version of record

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Citation for published version (APA):
Lo Giudice, G., Pape, T., & Cerretti, P. (2016). Revision of *Malayia* Malloch, with the first reports of Rhinophoridae from India and Indonesia (Diptera Oestroidea). *Fragmenta Entomologica*, 48(1), 61-67.
<https://doi.org/10.4081/fe.2016.161>

Research articleSubmitted: May 20th, 2016 - Accepted: June 23rd, 2016 - Published: June 30th, 2016**Revision of *Malayia* Malloch, with the first reports of Rhinophoridae from India and Indonesia (Diptera: Oestroidea)**Giuseppe LO GIUDICE^{1,*}, Thomas PAPE², Pierfilippo CERRETTI^{1,3}¹ Centro Nazionale Biodiversità Forestale (CNBFVR), Corpo Forestale dello Stato - Via Carlo Ederle 16/a, 37100 Verona, Italy; giuseppegliudice78@gmail.com² Natural History Museum of Denmark, University of Copenhagen - Copenhagen, Denmark; tpape@snm.ku.dk³ Dipartimento di Biologia e Biotecnologie "Charles Darwin", Sapienza Università di Roma - Piazzale A. Moro 5, 00185 Rome, Italy; pierfilippo.cerretti@uniroma1.it

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urn:lsid:zoobank.org:pub:C1B2585E-C3CC-43D4-B233-E5AA53EB05D7

Abstract

Malayia Malloch, 1926 is revised and a new species, *M. indica* sp. n., is described and illustrated from a female collected from Kodai-kanal, Tamil Nadu, India. The male of *M. fuscinervis* Malloch, 1926 is described for the first time from material from Malaysia and Philippines, and *M. nigripennis* Malloch, 1927 is reported from Sumatra, Indonesia. The records from India and Indonesia are new country records for the genus. A key to the three species of *Malayia* is provided.

Keywords: Oriental Region, Rhinophoridae, *Malayia*, new species, India, Indonesia, morphology, taxonomy.**Introduction**

The oestroid fly family Rhinophoridae currently contains approximately 150 species worldwide (see Cerretti & Pape, 2007; Cerretti et al., 2014). Of these, only five species have been reported as occurring in the Oriental Region: *Acompomintho lobata* Villeneuve, 1927 from South Korea, Japan (Ryukyu Is) and Taiwan; *Rhinomorinia longifacies* Herting, 1966 from Nepal; *Stevenia ceylanica* Townsend, 1919 from Sri Lanka; and two species of *Malayia* Malloch, *M. fuscinervis* Malloch, 1926 and *M. nigripennis* Malloch, 1927 both described from West Malaysia, with the former subsequently being cited from the Philippines by Dear & Crosskey (1982: 134).

In this work we revise the genus *Malayia* Malloch, 1926 and describe a new species based on a single female specimen from India, which represents the first record of a rhinophorid for the Indian subcontinent. Also, we provide the first country record of a rhinophorid for Indonesia (*M. nigripennis*). We give cladistic arguments for the generic placement of the new species and provide a key to the three species of the genus *Malayia*. We also provide the first description of the male of *M. fuscinervis* based on three specimens from Malaysia and the Philippines.

Material and methods

Material preparation. Pinned specimens were examined using a MZ 12.5 stereoscopic microscope (Leica, Wetzlar, Germany) and a TM1000 environmental scanning electron microscope (ESEM, Hitachi, Tokyo). Composite "all-in-focus" images of the type material of *M. indica* sp. n. and of the specimens deposited in ZMUC were produced from stacked images captured using a DS-L1 digital camera (Nikon, Tokyo) mounted on the MZ 12.5 for pinned specimens or on a DMLS compound microscope (Leica, Wetzlar, Germany) for terminalia and processed with Adobe Photoshop® CS6 (1990-2012 Adobe Systems Incorporated). Composite "all-in-focus" images of the type material of *M. fuscinervis* and *M. nigripennis* were produced from stacked images captured using an EOS 5D SR digital camera with a MP-E 65 mm macro lens (Canon, Tokyo) mounted on a Stackshot Micro Rail Package (Traverse City, Michigan). Helicon Remote ver. 3.3.6 W software was used for capturing images and Helicon Focus ver. 6.6.1 (Helicon Soft Ltd.) for the stacking process.

Material examined is deposited in the following collections (acronyms used in the text):

BMNH Natural History Museum, London, United Kingdom;

ZMUC Natural History Museum of Denmark, Zoologi-

cal Museum, University of Copenhagen, Denmark.

Label data. Label data of name-bearing types are given verbatim using the following symbols:

/ end of a line and beginning of the next;
 // end of one side of the label and beginning of the other;
 /// end of a label and beginning of the next (from top to bottom on the same pin).

Terminology. Terminology of the morphology follows Merz & Haenni (2000) and Sinclair (2000), except for the antenna (Stuckenberg 1999). Additionally, we use the term microtomentum instead of microtrichosity. Measurements and ratios of the head follow Cerretti (2010).

Systematics

Material examined

Type material. *M. indica* sp. n. Holotype ♀, **India:** Kodaikanal 7000 ft. / S. India. 23 – III – 36 [date hand-written] // B. M. – C. M. / Expedⁿ to / S. India. 1936. /// HOLOTYPE ♀ / *Malayia / indica* sp. nov. / Lo Giudice, Pape & Cerretti 2016 (BMNH).

***M. fuscineris* Malloch.** Holotype ♀, **Malaysia:** HOLOTYPE /// PAHANG, F. M. S. / “Cameron’s High- / lands.” At light [hand-written] / No 4 Camp 4800 ft. [hand-written except for “ft.”] / Oct 18th, 1923 [month and day hand-written] // EX COLL. F. M. S. / MUSEUM. /// ‘999 /// Pres. by / F. M. S. Museum / B. M. 1934 – 650 [label hand-written] /// *Malayia / fuscineris* / Type [hand-written] / Det. / J. R. Malloch /// NHMUK010241033 [with QR code] (BMNH).

***M. nigripennis* Malloch.** Holotype ♀, **Malaysia:** HOLOTYPE /// MALAY PENIN: / Selangor, / Bukit Kutu / 500-1000 [hand-written] ft. / April 12th 1926 [hand-written except for “19”] / H. M. Pendlebury. // EX COLL.: / F. M. S. / MUSEUMS /// 924 /// Pres. by / F. M. S. Museum / B. M. 1934 – 650. [label hand-written] /// *Malayia / nigripennis* / Type [hand-written] / Det. / J. R. Malloch /// NHMUK010241032 [with QR code] (BMNH).

Other material examined

***M. fuscineris*.** 1 ♂, **Philippines:** Palawan, Mantalingajan, Pinigisan, 600 meter, 24 Sep 1961, Noona Dan Exp. 61-62, caught in Malaise trap inside forest, *Malayia fuscineris* Mall., det. R.W. Crosskey, 1979, Rhinophoridae, det. Stig Andersen (ZMUC) (see Dear & Crosskey 1982: 134); 1 ♂, 1 ♀, **Malaysia:** Pahang, Cameron Highlands, Gunung Jasar, 15-27.xi.1995, T. Pape (ZMUC); 1 ♂, Malaysia, Pahang, Cameron Highlands, Gunung Brinchang, light-trap, 28 Mar 1992, B. Gustavsson [error for “Gustafsson”], H. Hippa, G. Sellerholm (ZMUC).

***M. nigripennis*.** 1 ♀, **Indonesia:** Sumatra, Aceh, Gunung Leuser, Malaise-trap in jungle, Nat. Park, 20 Mar 1992, H. Hippa (ZMUC).

Malayia Malloch

Malayia Malloch, 1926: 510. Type species: *Malayia fuscineris* Malloch, 1926, by original designation.

Diagnosis. Head higher than long. Facial profile receding; i.e., vibrissal angle about in line with or behind anterior margin of eye. Facial ridge with robust setae on lower 1/2 or more. Vibrissal triangle projected (especially in male). Inner vertical seta well-developed, outer vertical seta not distinguishable from postocular setae. Postpedicel at least twice as long as pedicel. Lunula bare. Prementum and palpus short. Presutural intra-alar seta absent. Anterior and posterior lappets of metathoracic spiracle of about equal size. Cell r_{4+5} open. Bend of vein M shallow. Vein CuA+CuP reaching wing margin. Posterior margin of hind coxa with one or more setae. Female: postpedicel with a row of setae dorsally. Male: median process of ventral sclerotisations of distiphallus absent.

Distribution. India (Tamil Nadu), Indonesia (Sumatra), Malaysia (West Malaysia), Philippines.

Malayia indica sp. n. (Figs 1–5)

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Description

Female.

Body length: 5.9 mm.

Colouration. Ground colour of head blackish-brown, covered with silver microtomentum, more evident on parafacial and genal dilation. Scape and pedicel dark brown, postpedicel yellowish. Mouthparts brownish-orange. Thorax blackish and covered with silver microtomentum. Scutum with two narrow presutural black vittae between dorsocentral and acrostichal rows and two wider presutural black vittae lateral to dorsocentral row. Legs black. Tegula and basicosta blackish-brown; wing membrane brownish, infuscate in distal portion (Fig. 4). Calypters concolorous with wing membrane. Abdominal tergites shining black with narrow basal bands of weak, whitish microtomentum interrupted mediodorsally (Fig. 5).

Head (Figs 2–3). Frons about 0.9 times as wide as eye in dorsal view. Frontal vitta 1.22 times as wide as fronto-orbital plate. Inner vertical seta well-developed, outer vertical seta not distinguishable from postocular setae. One proclinate and 1 upper laterocline orbital setae. Fronto-orbital plate with scattered setulae of varying sizes between frontal setae and inner margin of eye. Ocellar seta well-developed, postocellar seta short and fine. Few short and fine setulae present between ocellar and postocellar setae. Six crossed frontal setae, descending to level of middle of pedicel. Lunula bare. Facial ridge straight with strong setae on lower 2/3–3/4. Vibrissa inserted slightly below lower facial margin. Subvibrissal setae about 0.5



Figs 1–5 – *Malayia indica* n. sp. **1**, Habitus, lateral view, and labels; **2**, Head, lateral view; **3**, Head, frontal view; **4**, Left wing, dorsal view; **5**, Abdomen, dorsal view (Holotype ♀).

times as long as vibrissa. Face and lower facial margin not visible in lateral view. Parafacial bare, about as wide as postpedicel (both measured at midlength). Genal dilation well-developed. Gena 0.44 times as high as eye. Postpedicel 2.3 times as long as pedicel. Postpedicel with a row of short black setulae on dorsal ridge (Figs. 2–3). Arista appearing bare and thickened on proximal 1/3–1/2. Second aristomere about as long as wide. Prementum short. Palpus short and slightly clavate.

Thorax. Three postpronotal setae (inner one shorter); one posthumeral seta; 1 + 3 supra-alar setae (first postsutural supra-alar seta shorter and thinner than notopleural setae, and shorter than first postsutural dorsocentral seta); 0 + 2 intra-alar setae; 2 + 3 dorsocentral setae; 1–3 + 0 acrostichal setae. Anterior and posterior lappets of metathoracic spiracle of same size. Three pairs of marginal scutellar setae: lateral setae about as long as crossed, horizontal apical setae; basal setae about half the length of apical setae. One pair of discal scutellar setae about as long as basal setae.

Disc of scutellum covered with short setae. Katepisternum with 8–10 sparse setulae in addition to the two katepisternal setae. Six to seven anepisternal setae. Anepimeron with a tuft of short setulae. Katepimeron with 2 fine setulae.

Legs. Preapical posterodorsal seta of fore tibia clearly longer than preapical dorsal seta. Mid tibia with one anterodorsal seta. Preapical anteroventral seta on hind tibia about as long and robust as preapical posteroventral seta. Hind tibia with two anterodorsal and two anteroventral setae. Hind coxa with one or more setae on posterodorsal margin.

Wing (Fig. 4). Bend of vein M at a right angle, with a short M_2 appendix. Cell r_{4+5} narrowly open. Base of vein R_{4+5} with one small seta.

Abdomen (Fig. 5). Mid-dorsal depression on syntergite 1 + 2 extending to proximal half of syntergite; syntergite 1 + 2 and tergites 3 and 4 each with one pair of median marginal setae and with lateral marginal setae. Discal setae absent. Tergite 5 about 0.7 times as long as tergite 4.



Figs 6–9 – *Malaya nigripennis* Malloch. **6**, Habitus, lateral view, and labels (Holotype ♀); **7**, Head, lateral view (♀, Indonesia, Sumatra); **8**, Head, frontal view (♀, Indonesia, Sumatra); **9**, Right wing, ventral view (Holotype ♀).

Distribution. India (Tamil Nadu).

Etymology. The species epithet derives from the classical Greek and Latin adjective *indica*, meaning ‘of India’.

***Malaya fuscinervis* Malloch, 1926** (Figs 10–18)

Description

Male.

Body length: 3.4–4.3 mm

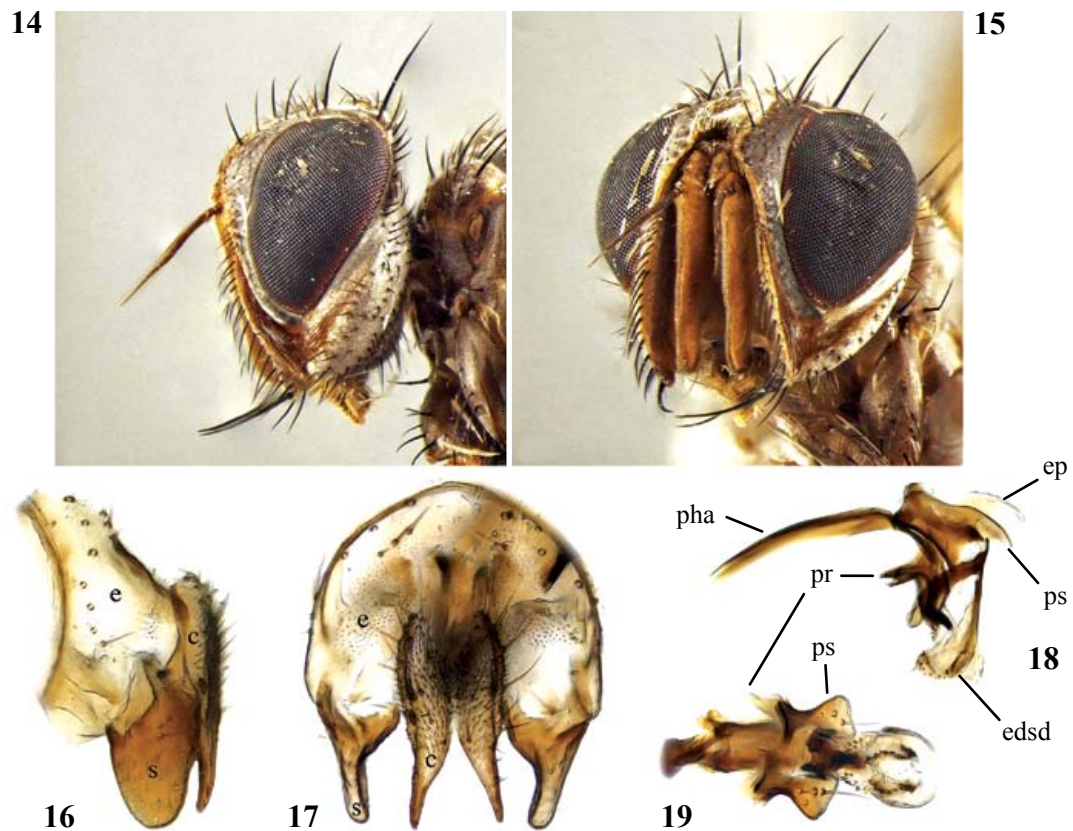
Colouration. Ground colour of head dark brown, covered with a silver microtomentum. Scape and pedicel brown, postpedicel brownish-orange. Mouthparts orange, palpus brownish. Thorax brown and covered with a barely visible

silver microtomentum. Scutum with two narrow presutural black vittae between dorsocentral and acrostichal rows and two lateral to dorsocentral setae. Legs dark brown. Tegula and basicosta brownish; wing membrane yellowish-brown, with darkened veins. Calypters white. Abdomen shining brown, covered with silver microtomentum on the proximal part of tergite 3.

Head (Figs 14–15). Frons 1.0–1.2 times as wide as eye in dorsal view. Frontal vitta 1.2–2.0 times as wide as fronto-orbital plate. Inner vertical seta well-developed, outer vertical seta not distinguishable from postocular setae. One proclinate (sometimes not differentiated) and 1 upper latero-clinate orbital setae. Fronto-orbital plate with scattered short setulae between frontal setae and inner eye margin. Ocellar seta well-developed, postocellar seta short and



Figs 10–13 – *Malaya fuscinervis* Malloch. **10**, Habitus, lateral view, and labels (Holotype ♀); **11**, Head, lateral view (♀, Philippines); **12**, Head, frontal view (♀, Philippines); **13**, Right wing, dorsal view (Holotype ♀).



Figs 14–19 – *Malaya fuscinervis* Malloch. ♂; **14–15**: head, lateral view (**14**); head, laterofrontal view (**15**); **16–17**: epandrial complex, lateral view (**16**); epandrial complex, posterior view (**17**); **18–19**: phallic complex, lateral view (**18**); phallic complex, ventral view (**19**). Abbreviations: **c** = cerci; **e** = epandrium; **edsd** = extension of dorsal sclerite of distiphallus; **ep** = epiphallus; **pha** = phallapodeme; **pr** = pregonite; **ps** = postgonite; **s** = surstylus.

fine. Five to six crossed frontal setae, descending to level of middle of pedicel. Lunula bare. Facial ridge straight with strong setae on lower 3/4–4/5. Vibrissa well-developed, inserted distinctly below lower facial margin. One or two subvibrissal setae about 0.3 times as long as vibrissa. Face and lower facial margin deeply sunken (Fig. 15). Parafacial with few short setulae on upper half, about 0.3 times as wide as postpedicel (both measured at midlength). Genal dilation well-developed. Gena 0.35–0.40 times as high as eye. Postpedicel about 5.5 times as long as pedicel. Postpedicel with a row of short black setulae on dorsal ridge. Arista appearing bare and thickened on proximal half. Second aristomere about as long as wide. Prementum short. Palpus short and slightly clavate.

Thorax. Two postpronotal setae; 1 posthumeral seta; 1 + 1 supra-alar setae (first and third postsutural supra-alar setae not developed); 0 + 2 intra-alar setae; 2 + 3 dorsocentral setae; acrostichal setae not differentiated. Anterior and posterior lappets of metathoracic spiracle of same size. Three pairs of marginal scutellar setae: lateral setae about as long as crossed, horizontal apical setae; basal setae about half as long as apical setae or less. Disc of scutellum covered with irregular short setae. Katepisternum with 4–8 sparse setulae in addition to the two katepisternal setae. Four anepisternal setae. One or 2 anepimeral setae. Katepimeron bare.

Legs. Preapical posterodorsal seta of fore tibia shorter than preapical dorsal seta. Mid tibia with 0–1 anterodorsal setae. Preapical anteroventral seta on hind tibia about as long and robust as preapical posteroventral seta. Hind tibia with 2 anterodorsal, 2 anteroventral and 2 posterodorsal setae. Hind coxa with 1 or more setae on posterodorsal margin.

Wing. Bend of vein M gently curved and postangular section of M straight or slightly convex with respect to posterodistal wing margin. Cell r_{4+5} open. Base of vein R_{4+5} with 1–2 small setae.

Abdomen. Mid-dorsal depression on syntergite 1 + 2 extending on proximal half of syntergite; syntergite 1 + 2 and tergite 3 with one pair of median marginal setae and with lateral marginal setae. Tergites 4 and 5 with a row of marginal setae. Discal setae absent. Tergite 5 about 0.6 times as long as tergite 4.

Terminalia (Figs 16–19). Sternite 5 with a deep median cleft, lateral lobes rounded posteriorly, basal “window” absent. Tergite 6 with setae, more or less plate-like and divided from segment 7+8 by a short membrane. Sternite 6 very asymmetrical, articulated with segment 7+8 on left side, and attached to it by a wide membrane on its right side. Cerci not fused medially, well divided into two pointed branches distally. Epandrium short and convex. Surstylus relatively wide in lateral view, not fused to epandrium. Hypandrium short, medial plate not concave; hypandrial arms very long, convergent but not touching each other. Processi longi slightly enlarged and convergent medially (not touching each other) more or less boomerang-shaped. Processi longi articulated with, not fused to, sur-

stylus. Epiphallus well developed and hook-like. Dorsal processes of distiphallus fused medially in basal third, well separated in remaining part, bent anteriorly and strongly widened distally. Median process of ventral sclerite of distiphallus not differentiated. Lateroventral lobe with strong scale-like spinulae along its margin; lateroventral lobe in parbasal position. Acrophallus (not tripartite) with a pair of L-shaped sclerotisations. Postgonite bare, pregonite stout, not fused to hypandrium.

Malaysia – Key to species

1. Bend of vein M abrupt, right angled, with a very short extension, and postangular section of M concave with respect to posterodistal wing margin (Fig. 4); wing membrane irregularly darkened: membrane along veins distinctly infuscated distally to crossvein r-m [only females known] *M. indica* sp. n.
- Bend of vein M gradual, forming an obtuse angle, with no extension, and postangular section of M straight or slightly convex with respect to posterodistal wing margin (Fig. 9) .. 2
2. Thorax with 2+3 dorsocentral setae; wing membrane hyaline or infuscated along veins distal to crossvein r-m, leaving large hyaline areas between veins (Fig. 13) *M. fuscinervis* Malloch
- Thorax with 2+4 dorsocentral setae; wing membrane along veins uniformly and broadly darkened, leaving only very small patches of hyaline membrane between veins (Fig. 9) *M. nigripennis* Malloch

Discussion

The genus *Malaysia*, like very few other oestroid flies, has been in a ‘systematic limbo’ due to its unique combination of characters. It was, in fact, treated as an unplaced tachinid genus of the family Tachinidae by Crosskey (1976) and Dear & Crosskey (1982), until Pape (1992) questioned this classification stressing that the morphology of the male terminalia actually suggests a rhinophorid affiliation. Pape & Shima (1993) reinforced the arguments brought by Pape (1992), providing more details about external and male terminalia morphology of *Malaysia* species. Pape (1998) eventually assigned *Malaysia* to the Rhinophoridae in a key to the Asian genera. Since then both sexes of *M. fuscinervis* have been carefully examined and the species has been included in a morphological data set used for preliminary cladistic analyses aimed at elucidating the phylogenetic relationships among rhinophorid species (Cerretti & Pape 2012; Cerretti et al. 2014). Both analyses agreed in reconstructing *Malaysia fuscinervis* as being closely related to a clade composed by *Comoromyia* Crosskey, *Paykullia* Robineau-Desvoidy and *Melanophora* Meigen: either as its sister taxon (Cerretti & Pape 2012), or as part of its sister clade (i.e., *Malaysia fuscinervis* + *Rhinopeza gracilis* Cerretti, Lo Giudice & Pape) (Cerretti et al., 2014). However, in both these analyses the phylogenetic position of

Malayia is supported by low Bremer support values and low bootstrap resampling percentiles.

The character optimization performed by Cerretti et al. (2014) had *M. fuscineris* emerging with three homoplasious autapomorphic character states: vibrissal triangle projected (especially in male), posterior margin of hind coxa with one or more setae, and median process of ventral sclerotisations of distiphallus absent. Nevertheless, these three character states are also shared with some species of the New World genus *Bezzimyia*, which is not closely related to *Malayia* based on the mentioned preliminary phylogenies. The monophyly of *Malayia* may be strengthened by considering some other, probably derived, character states, which were not included in the analyses of Cerretti & Pape (2012) and Cerretti et al. (2014), and are shared by all species now assigned to *Malayia*:

- 1) facial ridge with robust setae on at least lower 1/2 – this condition, although shared by some Tachinidae, especially in the subfamily Exoristinae, is quite rare in other oestroids and unique among known rhinophorids;
- 2) vein CuA+CuP reaching wing margin – to our knowledge this condition is shared only with *Bixinia winkleri* Cerretti, Lo Giudice & Pape and *Parazamimus congolesensis* Verbeke among described rhinophorids, but occurs among various unrelated oestroid groups (e.g. Tachinidae of the tribe Siphonini; *Gyrostigma* Brauer and *Gasterophilus* Leach of the Oestridae);
- 3) female with a row of setae on dorsal ridge of the postpedicel – a similar condition is shared only by males (females unknown) of two Afrotropical species formerly ascribed to the genus *Bequaertiana* Curran though recently moved to *Melanophora* by Cerretti & Pape (2009): *M. argyriiventris* (Curran) and *M. basilewskyi* (Peris). If confirmed, the absence of postpedicellar setae in males of all *Malayia* species could be a strong autapomorphic support to the monophyly of this genus.

No biological data have so far been obtained for *Malayia*, but it would seem very likely that all species are parasitoids of woodlice because all rhinophorids for which hosts are known parasitize these isopods. It is noteworthy that all specimens of *Malayia* have been collected at elevations above 600 m. This is a good match to the situation in the Neotropics, where only very few specimens of Rhinophoridae have been collected at true lowland localities (Pape & Arnaud, 2001; Cerretti et al., 2014).

Acknowledgements – We would like to thank Daniel Whitmore (BMNH) for the images of the holotypes of *M. fuscineris* and *M. nigripennis*. We thank James E. O'Hara (Canadian Nation-

al Collection of Insects, Ottawa, Canada) and an anonymous reviewer for their constructive comments on earlier drafts of this manuscript.

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