Journal of Natural History
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/tnah20

Taxonomy and cladistic analysis of the subgenus *Xenomorellia* Malloch (Diptera: Muscidae: *Morellia* Robineau-Desvoidy) with description of two new species

Silvio Shigueo Nihei [a] & Claudio J. B. De Carvalho [b]

[a] Departamento de Zoologia, Instituto de Biociências, Universidade São Paulo, Rua do Matão, Travessa 14, 101, 05508-900, São Paulo, SP, Brazil

[b] Departamento de Zoologia, Universidade Federal do Paraná, Caixa postal 19020, 81531-980, Curitiba, PR, Brazil

Available online: 28 Sep 2011

To cite this article: Silvio Shigueo Nihei & Claudio J. B. De Carvalho (2011): Taxonomy and cladistic analysis of the subgenus *Xenomorellia* Malloch (Diptera: Muscidae: *Morellia* Robineau-Desvoidy) with description of two new species, Journal of Natural History, 45:41-42, 2627-2644

To link to this article: http://dx.doi.org/10.1080/00222933.2011.597883

Journal of Natural History
Vol. 45, Nos. 41–42, November 2011, 2627–2644

Taylor & Francis
Taylor & Francis Group

Taxonomy and cladistic analysis of the subgenus *Xenomorellia* Malloch (Diptera: Muscidae: *Morellia* Robineau-Desvoidy) with description of two new species

Silvio Shigueo Nihei[a]* and Claudio J. B. De Carvalho[b]

[a]*Departamento de Zoologia, Instituto de Biociências, Universidade São Paulo, Rua do Matão, Travessa 14, 101, 05508-900, São Paulo, SP, Brazil;* [b]*Departamento de Zoologia, Universidade Federal do Paraná, Caixa postal 19020, 81531-980, Curitiba, PR, Brazil*

(*Received 24 August 2010; final version received 30 May 2011; printed 1 September 2011*)

Xenomorellia Malloch, a subgenus of *Morellia* Robineau-Desvoidy, is revised to include two new species, *Morellia* (*Xenomorellia*) *inca* Nihei and Carvalho sp. nov. from South America, and *M.* (*X.*) *maia* Carvalho and Nihei sp. nov. from Costa Rica and Mexico. Diagnoses for *M.* (*X.*) *holti* (Malloch) and *M.* (*X.*) *montanhesa* (Albuquerque) are provided, as well as an identification key to the four species of the subgenus. A cladistic analysis was performed to test the monophyly of *Xenomorellia* and to recover the phylogenetic relationships among its species. Tree searches resulted in one single most-parsimonious cladogram, wherein the monophyly of *Xenomorellia* is supported, as well as a sister-group relationship with the Neotropical subgenus *Trichomorellia* Stein. *Xenomorellia* was divided into two clades: one with Caribbean–Andean species (*maia* + *inca*), and another with species from southeastern South America (*holti* + *montanhesa*).

Keywords: identification key; Neotropical region; phylogeny; systematics

Introduction

Xenomorellia was erected by Malloch (1923) for a new species that shares several similarities with *Morellia* Robineau-Desvoidy, 1830. The author distinguished his new genus from *Morellia* based on the chaetotaxy of the stem-vein. *Xenomorellia* has a long dorsal setula on the apical portion of stem-vein, next to the humeral vein, and also ventral setulae at the basal portion of the stem-vein, before the humeral. *Xenomorellia* was originally described in Muscinae and included only the genotype, *Xenomorellia holti*, which was described based on Peruvian females. A second species was added almost three decades later by Albuquerque (1952), who described *Xenomorellia montanhesa*, based on males and females, and also the male of *Xenomorellia holti*, both based on material from southeastern Brazil. Additionally, Albuquerque (1952) transferred *Xenomorellia* to Phaoniinae based on the shape of the calypters. *Xenomorellia* was placed back into Muscinae-Muscini in the catalogue of Neotropical Muscidae (Pont 1972), a placement that was maintained in subsequent catalogues (Carvalho et al. 1993, 2005).

*Corresponding author. Email: silvionihei@gmail.com

ISSN 0022-2933 print/ISSN 1464-5262 online

DOI: 10.1080/00222933.2011.597883
http://www.informaworld.com

The results of a cladistic analysis of Muscini, including all the 18 genera previously assigned to the tribe (Nihei and Carvalho 2007), indicated that the Neotropical genera *Xenomorellia*, *Parapyrellia* Townsend, 1915 and *Trichomorellia* Stein, 1918 form a grouping within the *Morellia* clade. Based on those results, the authors divided *Morellia* into four subgenera: *Morellia* s.s. (50 species), *Parapyrellia* (three species), *Trichomorellia* (eight species) and *Xenomorellia* (two species). *Morellia* s.s. is widespread throughout Afrotropical, Nearctic, Neotropical, Oriental and Palaearctic regions, whereas the remaining subgenera are endemic to the Neotropics (Nihei and Carvalho 2009). The monophyly of *Morellia* s.l. was supported by two characters: mid-tibia of male with backward-orientated setae on the anterodorsal surface, and male cercal plate with a ventral marginal spined process.

In the present paper, we describe two new species in the subgenus *Xenomorellia* of *Morellia*. One species, *M.* (*X.*) *inca* Nihei and Carvalho sp. nov., is based on material collected from Bolivia, Peru, Colombia and Venezuela; whereas *M.* (*X.*) *maia* Carvalho and Nihei sp. nov. is based on specimens from Costa Rica and Mexico. Additionally, we provide diagnoses for *M.* (*X.*) *holti* and *M.* (*X.*) *montanhesa* and an identification key to the species of the subgenus. Finally, we carried out a cladistic analysis of *Xenomorellia* to ascertain the phylogenetic relationships among the species.

Materials and methods

The examined material is deposited at the following institutions: The Natural History Museum, London, UK (BMNH); Coleção Entomológica "Padre Jesus Santiago Moure", Departamento de Zoologia, Universidade Federal do Paraná, Curitiba, Brazil (DZUP); Field Museum of Natural History, Chicago, IL, USA (FMNH); Colección Instituto Alexander von Humboldt, Bogotá, Colombia (IAVH); Instituto de Zoología Agrícola, Maracay, Venezuela (MIZA); Museu Nacional, Rio de Janeiro, Brazil (MNRJ); and Museo de Historia Natural "Noel Kempff Mercado", Santa Cruz de la Sierra, Bolivia (UASC).

The morphological terminology follows McAlpine (1981) and Huckett and Vockeroth (1987) with some exceptions noted in Carvalho (1989) and Nihei and Carvalho (2007).

In the cladistic analysis, all species of the subgenus *Xenomorellia* were included as terminal taxa in the ingroup. The outgroup included representatives of the other subgenera of *Morellia*: *M.* (*M.*) *paulistensis* Pamplona and Mendes, 1995, *M.* (*Parapyrellia*) *maculipennis* (Macquart, 1846) and *M.* (*Trichomorellia*) *trichops* (Malloch, 1923). The selection of outgroup taxa, as well as tree rooting, were based on the results of Nihei and Carvalho (2007), wherein the subgeneric relationships of *Morellia* were (*Morellia* s.s. (*Parapyrellia* (*Morellia* s.s. (*Trichomorellia*, *Xenomorellia*)))). The subgenus *Morellia* was not supported as monophyletic in Nihei and Carvalho (2007), and *M.* (*M.*) *paulistensis*, its representative in the present analysis, was placed closely related to the clade *Trichomorellia* + *Xenomorellia*. For this reason, instead of *M. paulistensis*, the resulting cladograms were rooted with *M.* (*P.*) *maculipennis*.

Nineteen characters were constructed (Table 1). All characters were treated as unordered and equally weighted. Polymorphisms were coded according to the "polymorphic" coding (Wiens 1998). We used the program NEXUS (Page 2001) to edit the data matrix (Table 2), and the program NONA version 2.0 (Goloboff 1993) to tree

Table 1. List of characters used in the analysis of *Morellia* species.

1. Male upper frontal setae proclinate:
   0. present
   1. absent (medioclinate)
2. Female proclinate fronto-orbital seta:
   0. absent
   1. present
3. Setulosity on upper half of female fronto-orbital plate:
   0. scarcely setulose
   1. densely setulose
4. Number of humeral setae:
   0. three
   1. four
5. Parahumeral seta:
   0. absent
   1. present
6. Number of postsutural acrostichal setae:
   0. one
   1. two
7. Number of postsutural intra-alar setae:
   0. absent
   1. one
   2. two
8. Intra-postalar setae:
   0. undeveloped
   1. present
9. Setulosity on proepisternum:
   0. present
   1. absent
10. Setulosity on anterior suprasquamal ridge:
   0. absent
   1. Present
11. Preapical scutellar setae:
   0. absent
   1. present
12. Shape of lower calypter:
   0. enlarged and subtruncate posteriorly
   1. glossiform
13. Ventral setulosity on subcostal sclerite:
   0. absent
   1. present
14. Dorsal setulosity on R4+5 vein (except on node):
   0. present
   1. absent
15. Long setae on median third of posteroventral surface of male hind tibia:
   0. present
   1. absent
16. Length of the anteroventral setae on male hind tibia:
   0. about twice the tibial width
   1. conspicuosly over twice the tibial width
   2. conspicuously shorter than twice the tibial width
17. Setulosity on posterodorsal surface of hind tibia:
   0. one seta on apical third (calcar)
   1. two setae on basal and apical thirds
18. Setulosity on abdominal sternite 1:
   0. widely setulose
   1. setulose laterally
19. Lower lobe of male cercal plate:
   0. rounded
   1. truncate

search, with the commands hold1000, mult*100, generating a heuristic search with "tree bisection-reconnection branch-swapping" and "random addition sequence", with 100 replicates. The program WINCLADA (Nixon 2002) was used for viewing and editing the cladograms and for character optimization. Characters were optimized as unambiguous and under ACCTRAN optimization.

Taxonomy

A morphological diagnosis for *Morellia* is presented in Nihei and Carvalho (2009, and references therein), a discussion on its composition, phylogenetic relationships

Table 2. Character matrix for cladistic analysis of *Morellia* species.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
M. maculipennis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M. paulistensis	1	0	0	1	1	0	1	1	1	0	0	0	0	0	1	0	0	0	0
M. trichops	1	1	0	1	1	1	2	1	1	0	1	1	0	0	0	2	1	1	?
M. holti	0	1	0	1	1	1	2	1	1	1	1	1	1	1	1	2	1	1	1
M. inca	0	1	1	1	1	0	2	0	1	1	1	1	1	1	0	1	0	1	0
M. maia	0	1	0	1	1	0/1	2	0	1	1	1	1	1	1	0	1	0	1	0
M. montanhesa	0	1	0	1	1	1	2	1	1	1	1	1	1	1	0	2	1	1	1

and monophyly are given in Nihei and Carvalho (2007, 2009). This section contains a diagnosis of the subgenus *Xenomorellia*, an identification key to species, the description of two new species, and diagnoses for the two previously known species. A complete list of literature citations for each species is given in the recently published catalogue by Carvalho et al. (2005) and will not be repeated here.

Subgenus ***Xenomorellia***

Diagnosis

Colouration metallic blackish-blue with silver pruinosity; wing without maculae, but some infuscation on humeral vein and apex of Sc and R_1. Female with proclinate fronto-orbital seta; fronto-orbital plate setulose; interfrontal seta absent. Dorsocentrals 2+4; posthumeral present; postsutural intra-alars 2; intrapostalar seta absent or present. Prosternum bare; katepisternals 1+2; meron bare. Anterior suprasquamal ridge setulose. Wing with the basal portion of stem-vein setulose ventrally; apical portion of stem-vein dorsally with a strong reclinate setula; R_{4+5} bare dorsally and ventrally; M bent forward to R_{4+5}. Lower calypter glossiform. Subcostal sclerite setulose ventrally. Mid-femur of male with a dorsal preapical protuberance bearing three short and stout hook-like setae. Male mid-tibia with a row of short, fine anterodorsal setae, the whole row is directed backwards and with the first four to six basalmost setae stout and hook-like. Hind tibia with a strong posterodorsal seta on apical fourth (calcar). Abdominal sternite 1 setulose laterally.

Key to the species of *Morellia* (*Xenomorellia*)

1. Palpus blackish; two postsutural acrostichal setae; male hind tibia with fine short setae on apical third of posteroventral surface . . . . . *M. montanhesa* (Albuquerque, 1952)

   Palpus mostly yellow; other characters variable 2

2. Hind tibia with two posterodorsal setae, one on basal third and another on apical third (calcar); hind tibia with three to five setae on anteroventral surface; male without setae on the posteroventral surface of hind tibia . . . . . *M. holti* (Malloch, 1923).

Hind tibia with only one posterodorsal seta on apical third (calcar); hind tibia with seven or more setae on anteroventral surface; male with fine setae on posteroventral surface of hind tibia 3

3. Antenna black; acrostichals 0+1; male with the anterointernal ommatidia slightly enlarged (ommatidia smaller than posterior ocelli) . . . . . .*M. inca* Nihei and Carvalho, sp. nov.

Antenna light-brown, but the first flagellomere brownish with reddish-brown margins and base; acrostichals 1+1 or 1+2; male with the anterointernal ommatidia strongly enlarged (ommatidia nearly as large as the anterior ocellus). . . . . *M. maia* Carvalho and Nihei, sp. nov.

Morellia* (*Xenomorellia*) *inca Nihei and Carvalho, sp. nov.
(Figures 1, 2)

Description of male

Measurements: 6.5–7.5 mm (body length), 7.3–7.8 mm (wing length).

Colouration. Head black in ground-colour and greyish pruinose. Antenna blackish, except for the light-brown base of arista and the reddish-brown base of first flagellomere. Proboscis dark-brown, palpus yellowish, darker at base. Thorax black in ground-colour, with dark-blue metallic shining and greyish pruinosity; dorsally with two narrow dark vittae between acrostichal and dorsocentral setae, vittae more conspicuous on presutural area. Calypters and halter darkened. Wing mostly hyaline, with a blackish cloud from base to just beyond humeral vein, and slightly infuscated at apex of subcostal vein. Legs black. Abdomen black in ground-colour, dark-blue metallic shining and greyish pruinosity.

Head. Holoptic; eye with the anterointernal ommatidia moderately enlarged. About 20 frontal setae, uppermost setae weaker, shorter and proclinate, as long as ocellar setae. Vibrissa longer than first flagellomere; subvibrissal setae half the length of vibrissa. Arista plumose, except for the apical third bare, the longest cilia as long as the width of first flagellomere; with conspicuous secondary cilia on the inner-dorsal surface. Palpus spatulate on the apical half.

Thorax. Scutum with ground setulae dense and long. Acrostichal setae 0+1 (some specimens with two pairs of weakly developed presutural setae). Dorsocentral setae 2+4. Four humeral setae, inner setae shorter; one posthumeral seta inserted near the level of first dorsocentral and one weaker (parahumeral) seta inserted anteriorly to the posthumeral seta; presutural seta longer than notopleural setae, inserted near the level of second dorsocentral seta. Two notopleural setae, anterior seta slightly longer than posterior one. Two postsutural intra-alar setae, of equal size (in some specimens, posterior seta longer than anterior one); intrapostalar seta undeveloped. Pre-alar seta shorter than notopleurals. Two postsutural supra-alar setae, the anterior stronger and twice as long as the posterior, which is similar to the pre-alar. Two postsupra-alar setae, the posterior similar to the posteriormost dorsocentral and about 2.5 times longer than anterior postsupra-alar seta. Scutellum with five pairs of setae: one short basal, two long lateral, one preapical and one strong apical; with setulae

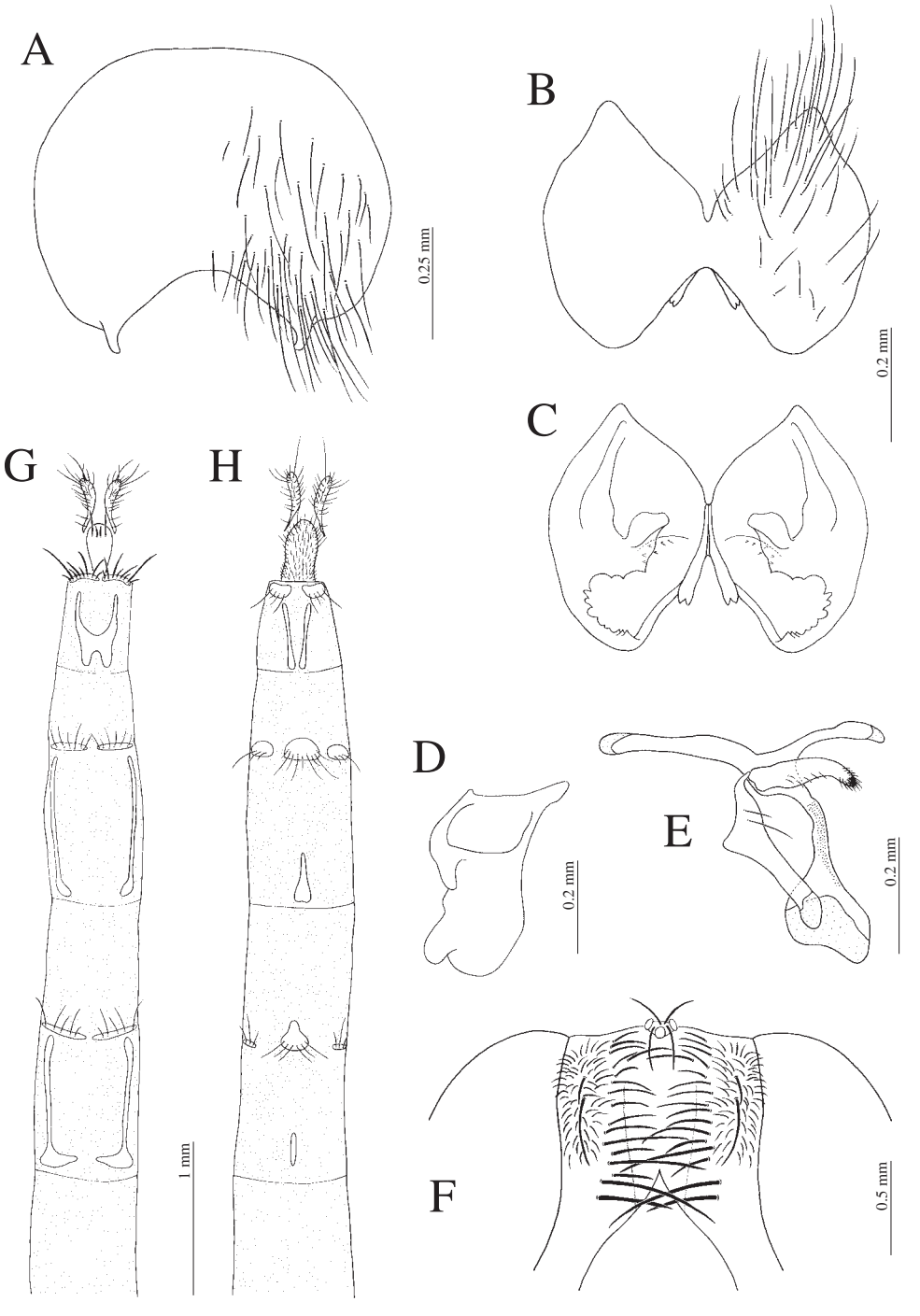

Figure 1. *Morellia (Xenomorellia) inca* Nihei and Carvalho, sp. nov. (A) Male sternite 5, ventral view; (B) male cercal plate, dorsal view; (C) same, ventral view; (D) male surstylus, inner lateral view; (E) male aedeagus, lateral view; (F) female head (partial), frontal view; (G) ovipositor, dorsal view; (H) same, ventral view.

Figure 2. Distribution map for *Morellia (Xenomorellia)* species: *M. (X.) inca* Nihei and Carvalho, sp. nov. (●); *M. (X.) maia* Carvalho and Nihei, sp. nov. (■); *M. (X.) holti* (◆) and *M. (X.) montanhesa* (⊙).

throughout, including the lateroventral portion. Postalar wall bare; anterior supra-squamal ridge setulose, posterior supra-squamal ridge setulose only on basal fourth. Prosternum bare. Proepisternum bare, except for a set of upward directed setae of variable lengths on the lower portion; proepimeron with a set of fine upward directed setae. Anepisternum densely covered with setulae; a row of strong setae on posterior margin directed backwards, setae becoming shorter downwards; without a developed upward directed seta on the upper anterior corner. Katepisternal setae 1+2. Anepimeron setulose; katatergite covered with short fine setulae; katepimeron, meron and anatergite bare; metekatepisternum setulose above coxa. Posterior spiracle with setulae on posterior margin.

Wing. Some ventral cilia at the end of the basal portion of stem vein; a strong dorsal cilium on the apical portion of stem vein inserted at the level of humeral vein. Subcostal sclerite ciliated ventrally. Node of Rs ciliated dorsally and ventrally. Vein M curved forward to R_{4+5}, the distance between the end of R_{4+5} and M as long as cross-vein r-m. Upper and lower calypters dark setulose at borders; lower calypter with dorsal surface bearing short setulae.

Legs. Fore femur with a row of setae on posterodorsal and posteroventral surfaces, setae on apical two-thirds longer, and many short setae distributed throughout between these surfaces. Fore tibia with a row of short and stout setae on anterodorsal surface, other surfaces covered with setuale only, posterior surface in some specimens covered with remarkably fine setulae; a strong preapical and a strong apical seta on dorsal and posteroventral surfaces, respectively. Fore basitarsus as long as tarsal segments second to fourth combined. Mid-femur with three short and stout hook-like setae on a preapical dorsal protuberance; three to four oblique preapical setae on posterodorsal to posterior surfaces; a row of setae on basal two-thirds of the posteroventral surface, with longer setae on median third. Mid tibia with a row of short fine setae on anterodorsal surface, the first four to six basal setae short, stout and hook-like (all setae in row directed backwards); five unaligned setae on median half of the posterior to posteroventral surfaces; a preapical seta on dorsal surface, strong apical setae on anteroventral and ventral surfaces, and a shorter seta on posteroventral surface. Mid basitarsus as long as all other tarsal segments combined. Hind femur with a row of setae on anterodorsal, anteroventral and posteroventral surfaces, the anteroventral surface with shorter setae on basal third and posteroventral surface with long setae on the median third; some long setae at base of posterior surface; and one preapical seta on dorsal surface and two on posterodorsal to posterior surface. Hind tibia with a developed calcar on apical fourth of posterodorsal surface and without a developed seta on basal third; a row of setae on anterodorsal surface, with the most developed setae as long as the calcar and the basal fourth with short setae; a row of long setae on anteroventral surface, except for the bare basal fifth, longest setae about three times the tibial width at median third and setae shortening towards apex; the posteroventral surface on basal two-thirds with a dense coverage of long fine setae, longest setae twice the tibial width and with a more regular row of short setae on apical third or fourth. Hind basitarsus as long as second to fourth tarsal segments combined.

Abdomen. Sternite 1 setulose laterally. Terminalia with sternite 5 as in Figure 1(A). Cercal plate dorsally as in Figure 1(B); ventrally with a median process composed of a set of small spines oriented outward, inner lobe ending in two points directed ventrally, outer lobe with teeth (spine-like) of variable sizes on distal margin (Figure 1C). Surstilus as in Figure 1(D). Aedeagus (Figure 1E) with paramere densely setulose at apex and some sparse setulae medially; basiphallus with several microtrichiae on the constricted basal portion.

Description of female

Measurements: 7.0–8.5 mm (body length), 7.8–8.5 mm (wing length). Differs from the male in the following: dichoptic head (Figure 1F), frontal vitta broad, about 0.35 the head width at the level of lunula; eye with the anterointernal ommatidia not enlarged. About 13 frontal setae, lowermost setae more developed. Proclinate fronto-orbital seta present, together with an accessory proclinate fronto-orbital seta (a weaker seta immediately above). Fronto-orbital plate broad, about one-third the width of frons at the mid-level. Fronto-orbital plate with numerous short setulae on upper two-thirds, the upper setae mostly directed inward, lower setae mostly proclinate. Thorax and legs with setae/setulae not as dense and not as developed as in the male. Mid-femur without pre-apical hook-like setae on dorsal surface; with a row of shorter setae (when compared with the male) on basal two-thirds of the posteroventral surface, with only one or a few long setae on median third. Mid-tibia without a row of short backward

directed setae on anterodorsal surface. Hind tibia with a row of long setae on apical two-thirds of anteroventral surface, setae about 1.5 times longer than tibial width; posteroventral surface bare. Terminalia (Figure 1G,H) without microtrichiae on membrane. Tergites 6 and 7 (Figure 1G) present as a pair of elongate anterior plates and a pair of posterior transverse plates, the latter setulose; tergite 8 present as a median plate bifurcated anteriorly and posteriorly, and a pair of posterior transverse plates with strong setulae. Sternite 6 (Figure 1H) as a reduced anterior median plate and three posterior plates, median posterior plate with proclinate setulae and two lateral posterior plates with reclinate setulae; sternite 7 as a short anterior median plate and three posterior plates with proclinate setulae; sternite 8 as a pair of elongate anterior plates diverging posteriorly, and paired posterior plates with proclinate setulae.

Type material

Holotype male (UASC) labelled as follows: "Dpto. Cochabamba/ Prov. Carrasco/ Loc. Chuwa Kocha/ 2.400 m.s.n.m./ 23.III.1991/ Bolivia", "Col./ Ramiro Rengel", "Holotipo" (red label), "Xenomorellia inca/ Nihei & Carvalho/ det. 2003".

Paratypes: BOLIVIA, same data as holotype (4 males, 5 females, UASC; 4 males, 4 females, DZUP; 1 male, 1 female, MNRJ; 1 male, 1 female, MZSP; 1 male, 1 female, BMNH); COLOMBIA, Huila Department, Parque Nacional Natural "Cueva de Los Guácharos", Cabaña Cedros (1°37' N, 76°6' W, 2100 m), 29 November to 2 December 2001, D. Campos leg. (1 male, IAVH); VENEZUELA, Merida, San Eusebio (La Carbonera), 2200 m, 5 August 1991, C.J. Rosales, L. D. Otero and J. Lattke leg. (1 female, MIZA). All paratypes labelled "Paratypo" (green label).

Additional material

COLOMBIA, Northern Santander, 50 km south of Chinacota, 8000 ft, 10–14 May 1974, S. Peck leg. (14 females, FMNH); PERU, Paltay bamba [near Cuzco], 5000 ft, 6 August 1911, Yale Peru Exp. leg. (01 female paratype of *Xenomorellia holti* Malloch, BMNH).

Type locality

Bolivia, Cochabamba Department, Carrasco Province, Chuwa Kocha [misspelling of Chuya Khocha].

Distribution

Venezuela, Colombia, Peru, Bolivia (Figure 2).

Etymology

The species epithet, *inca*, is to honour the pre-Colombian South American peopling, decimated after European occupation. Noun in apposition.

Remarks

There is one female paratype of *M. holti* at the BMNH from Peru that is conspecific with *M.* (*X.*) *inca* Nihei and Carvalho sp. nov. (See detailed comments below, under *M. holti*.)

Morellia* (*Xenomorellia*) *maia Carvalho and Nihei, sp. nov.
(Figures 2, 3)

Description of male

Measurements: 6.3–7.8 mm (body length), 6.3–7.8 mm (wing length).

Colouration. Head black in ground-colour and pale golden pruinose. Antenna light-brown, except for the first flagellomere brown with reddish-brown margins and base. Proboscis dark-brown, palpus yellowish, darker at base. Thorax black in ground-colour, with dark-blue metallic shining and greyish pruinosity; dorsally with two narrow dark vittae between acrostichal and dorsocentral setae, vittae more conspicuous on presutural area. Calypters and halter darkened. Wing mostly hyaline, with a blackish cloud from base to just beyond humeral vein, and slightly infuscated at apex of subcostal vein. Legs black. Abdomen black in ground-colour, with blue metallic shining and greyish pruinosity.

Head. Holoptic; eye with the anterointernal ommatidia greatly enlarged, nearly as large as anterior ocellus. About 20 frontal setae, uppermost setae weaker, shorter and proclinate, as long as ocellar setae. Vibrissa longer than first flagellomere; subvibrissal

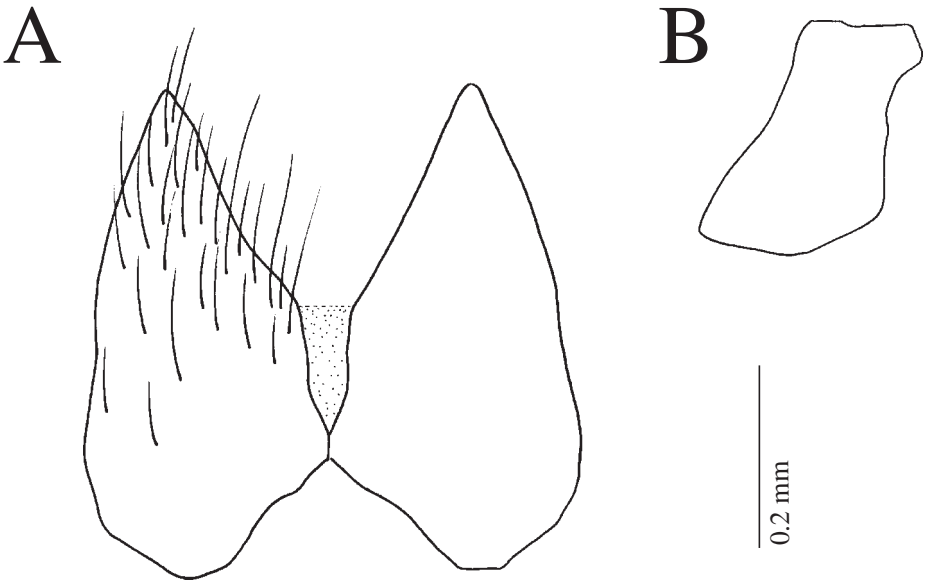

Figure 3. *Morellia (Xenomorellia) maia* Carvalho and Nihei, sp. nov. (A) Male cercal plate, dorsal view; (B) male surstylus, outer lateral view.

setae half the length of vibrissa. Arista plumose, except for the apical third bare, the longest cilia as long as the width of first flagellomere; with conspicuous secondary cilia on the inner dorsal surface. Palpus spatulate on apical half.

Thorax. Scutum with ground setulae dense and long. Acrostichal setae 1+1 (some specimens with 1+2, with the anterior postsutural seta weakly developed), presutural seta inserted right before the suture. Dorsocentral setae 2+4. Four humeral setae, inner setae shorter; one posthumeral seta inserted near the level of first dorsocentral and one weaker (parahumeral) seta inserted anteriorly to the posthumeral seta; presutural seta longer than notopleural setae, inserted near the level of second dorsocentral seta. Two notopleural setae, anterior seta slightly longer than posterior one. Two postsutural intra-alar setae, of equal-size; intrapostalar seta undeveloped. Prealar seta shorter than notopleurals. Two postsutural supra-alar setae, the anterior stronger and 1.5 times longer than the posterior, which is slightly longer than the pre-alar. Two postsupra-alar setae, the posterior similar to the posteriormost dorsocentral and about twice as long as anterior postsupra-alar seta. Scutellum with five pairs of setae: one short basal, two long lateral, one preapical and one strong apical; with setulae throughout, including the lateroventral portion. Postalar wall bare; anterior supra-squamal ridge setulose, posterior supra-squamal ridge setulose only on basal fourth. Prosternum bare. Proepisternum bare, except for a set of upward directed setae of variable lengths on the lower portion; proepimeron with a set of fine upward directed setae. Anepisternum densely covered with setulae; a row of strong setae on posterior margin directed backwards setae becoming shorter downwards; without a developed upward directed seta on the upper anterior corner. Katepisternal setae 1+2. Anepimeron setulose; katatergite covered with short fine setulae; katepimeron, meron and anatergite bare; metekatepisternum setulose above coxa. Posterior spiracle with setulae on posterior margin.

Wing. Some ventral cilia at the end of the basal portion of stem vein; a strong dorsal cilium on the apical portion of stem vein inserted at the level of humeral vein. Subcostal sclerite ciliated ventrally. Node of Rs ciliated dorsally and ventrally. Vein M curved forward to R_{4+5}, the distance between the end of R_{4+5} and M as long as cross-vein r-m. Upper and lower calypters dark setulose at borders; lower calypter with dorsal surface bearing short setulae.

Legs. Fore femur with a row of setae on posterodorsal and posteroventral surfaces, setae on apical two-thirds longer, and many short setae distributed throughout between these surfaces. Fore tibia with a row of short and stout setae on anterodorsal surface, other surfaces covered with setuale only, posterior surface in some specimens covered with remarkably fine setulae; a strong preapical and a strong apical seta on dorsal and posteroventral surfaces, respectively. Fore basitarsus as long as tarsal segments second to fourth combined. Mid-femur with three short and stout hook-like setae i on a preapical dorsal protuberance; three to four oblique preapical setae on posterodorsal to posterior surfaces; a row of setae on basal two-thirds of the posteroventral surface, with longer setae on median third. Mid-tibia with a row of short fine setae on anterodorsal surface, the first four to six basal setae short, stout and hook-like (all setae in row directed backwards); five unaligned setae on median half of the posterior to posteroventral surfaces; a preapical seta on dorsal surface, strong apical setae on anteroventral and ventral surfaces, and a shorter one on posteroventral

surface. Mid-basitarsus as long as all other tarsal segments combined. Hind femur with a row of setae on anterodorsal, anteroventral and posteroventral surfaces, the anteroventral surface with shorter setae on basal third and the posteroventral surface with long setae on the median third; some long setae at base of posterior surface; and one preapical seta on dorsal surface and two on posterodorsal to posterior surface. Hind tibia with a developed calcar on apical fourth of posterodorsal surface and without a developed seta on basal third; a row of setae on anterodorsal surface, with the most developed setae as long as the calcar and the basal fourth with short setae; a row of long setae on anteroventral surface, except for the bare basal fifth, longest setae about 2.0 to 2.5 times the tibial width at median third and setae shortening towards apex; the posteroventral surface on basal two-thirds with a dense coverage of long fine setae, longest setae about twice the tibial width and with a more regular row of short setae on apical third or fourth. Hind basitarsus as long as second to fourth tarsal segments combined.

Abdomen. Sternite 1 setulose laterally. Cercal plate dorsally as in Figure 3(A), lower lobes more rounded and wider than in *M.* (*X.*) *inca* sp. nov., and upper lobes more acuminate. Cercal plate ventrally very similar to *M.* (*X.*) *inca* sp. nov. Surstilus as in Figure 3(B).

Description of female

Measurements: 7.3–8.0 mm (body length), 7.3–8.3 mm (wing length). Differs from the male in the following: dichoptic head, the frontal vitta broad, about 0.30 times the head width at the level of lunula; eye with the anterointernal ommatidia not enlarged. About 13 frontal setae, lowermost setae more developed. Proclinate fronto-orbital seta present, together with an accessory proclinate fronto-orbital seta. Fronto-orbital plate narrower than in *M. inca*, about one-quarter the width of frons at the midlevel. Fronto-orbital plate with scarce setulae on upper half. Thorax and legs with setae/setulae not as dense and not as developed as in the male. Mid-femur without pre-apical hook-like setae on dorsal surface; with a row of shorter setae (when compared with the male) on basal two-thirds of the posteroventral surface, with only one or a few long setae on median third. Mid-tibia without a row of short backward directed setae on anterodorsal surface. Hind tibia with a row of long setae on apical two-thirds of anteroventral surface, longest setae about 1.2 times the tibial width; posteroventral surface bare.

Type material

Holotype male (INBio) labelled "Estación La Casona, R.B. Monteverde,/ Prov. Punta., COSTA RICA. 1500m. Jun/ 1991. N. Obando,/ L N 253250_449700 #1714", "Costa Rica/ INBio/ CRI001/ 693666", "Holotipo" (red label), "Morellia/ (Xenomorellia)/ maia Carvalho & Nihei/ C.J.B. de Carvalho det. 2007".

Paratypes (3 males and 3 females) as follows: COSTA RICA: Província Puntarenas, Reserva Biologica Monteverde, Est. La Casona, 1520 m, October 1992, N. Obando leg. (CRI000/ 817998) (1 male, INBio); Província Cartago, Parque Nacional Tapantí, Quebrada Segunda, 1300 m, 11 September 1993, M.A. Zumbado leg. (CRI001/ 931704) (1 female, INBio); Província San Jose, San Gerardo de Dota, 2000–2500 m, 22–26 February 1992 (CRI000/ 407090) (1 female, INBio); MEXICO: Guerrero, Omilteme, 800 ft, July 1888–89 (Biologia Centrali-Americana) H.H. Smith

leg. (1 male and 1 female, the male with the genitalia prepared on slide, BMNH); Guerrero, Sierra de las Aguas Escondidas, 7000 ft, July 1888–89, (Biologia Centrali-Americana) H.H. Smith leg. (1 male, with genitalia in microvial, BMNH). All paratypes labelled "Paratypo" (green label).

Type locality

Costa Rica, Província Puntarenas, Reserva Biológica Monteverde.

Distribution

Mexico (Guerrero) and Costa Rica (Figure 2).

Etymology

The species epithet, *maia*, is a homage to the pre-Colombian Central-American peopling, decimated after European occupation. Noun in apposition.

Remarks

The three type-specimens of *M.* (*X.*) *maia* sp. nov. from Mexico (deposited at BMNH) were collected under the "Biologia Centrali-Americana" and studied by Van Der Wulp (1896), who identified them as *Pyrellia suspicax* Walker, 1861 [= *Biopyrellia bipuncta* (Wiedemann, 1830)]. We examined the holotype male of *P. suspicax* and confirm here its junior synonymy with *B. bipuncta*. Moreover, we report the misidentification by Van Der Wulp as these three specimens are not conspecific with *P. suspicax*. The holotype male of *P. suspicax* (BMNH) is labelled as follows: "Holo-/ type"; "Mex."; "684" [on underside of label]; "suspicax Wlk"; "HOLOTYPE ♂/ Pyrellia/ suspicaux Walker/ 1861, Trans. ent. Soc. Lond., (2)5:312" [Adrian Pont's handwriting]. The specimen is in reasonable condition, lacking the head, the right hind tarsus and the second to fifth left hind tarsomeres.

Morellia* (*Xenomorellia*) *holti (Malloch, 1923)
(Figure 2)

Xenomorellia holti Malloch, 1923: 525. Type-locality: Peru [Brazil], Alto Itatiaya, Serra do Itatiaya.

Diagnosis

Antenna dark brown, but yellowish at apex of pedicel and margins of first flagellomere. Parafacial and gena with pale golden pruinosity. Female fronto-orbital plate with scarce short setae on upper half. Palpus yellow, darker at basis. Acrostichals 2+2 (presuturals weakly developed in some specimens). Intrapostalar seta present. Male mid-femur with three short and stout hook-like setae on a preapical dorsal protuberance. Hind femur lacking a complete posteroventral row of setae, with at most some weakly developed setae on the apical fourth. Hind tibia with a developed calcar on the apical fourth of posterodorsal surface and with a developed seta on basal third; a row

of weak setae on anterodorsal surface, with the most developed setae as long as the calcar; three or four setae on anteroventral surface on apical two-thirds, longest setae at most as long as tibial width; posteroventral surface lacking developed setae.

Material examined

BRAZIL: *Paraná State*: Colombo (Embrapa), Lev. Ent. PROFAUPAR, 11August 1986 (1 female, DZUP), 15 September 1986 (1 female, DZUP), 6 October 1986 (1 female, DZUP), 20 October 1986 (1 female, DZUP), 13 April 1987 (1 female, DZUP); Ponta Grossa (Vila Velha), Lev. Ent. PROFAUPAR, 18 August 1986 (1 male, DZUP), 1 September 1986 (4 males, 1 female, DZUP), 3 November 1986 (1 female, DZUP), 19 January 1987 (1 female, DZUP), 23 March 1987 (1 male, 1 female, DZUP), 6 July 1987 (1 female, DZUP), 20 July 1987 (1 male, 1 female, DZUP), 27 July 1987 (2 females, DZUP); Guarapuava (Est. Águas Sta. Clara), 04 August 1986, Lev. Ent. PROFAUPAR (1 male, DZUP).

Distribution

Brazil (Rio de Janeiro, São Paulo, Paraná) and ?Peru (see comments below) (Figure 2).

Remarks (Misidentification of one paratype of Xenomorellia holti)

Malloch (1923) based his description of *X. holti* on material from Brazil (Rio de Janeiro, female holotype) and Peru (Paltaybamba, 1 male and 3 female paratypes), the latter collected during the Yale Peruvian Expedition in 1911. The female holotype is deposited at the USNM and was not examined. However, when visiting the British Museum, C.J.B.C. examined the only remaining Peruvian paratype. This female paratype is labelled Peru, Paltay bamba, 5000 ft [feet], 6 August 1911, Yale Peru Exp., is in reasonable condition (with the abdomen partly destroyed, right hind leg glued on abdomen; left mid and hind legs lacking). According to the handwritten notes produced by C.J.B.C., the specimen has the antenna black and fronto-orbital plate with numerous short setulae on the upper two-thirds. These features are not in agreement with the description of *M.* (*X.*) *holti* (Malloch 1923: 525), neither do they fit the material examined herein. The identity of this female paratype of *M.* (*X.*) *holti* is corrected here as *M.* (*X.*) *inca* Nihei and Carvalho sp. nov. Aside from the Brazilian holotype, only this single Peruvian paratype has been left from the type-series of Malloch (1923). For this reason, we are not sure whether *M. holti* actually occurs in Peru or not. As far as we know, no additional material from Peru has been identified as *M.*(*X.*) *holti* by subsequent authors, which puts into question the occurrence of this species in the country.

Morellia* (*Xenomorellia*) *montanhesa (Albuquerque, 1952)
(Figure 2)

Xenomorellia montanhesa Albuquerque, 1952: 2, figs. 1–13. Type-locality: Brazil, Rio de Janeiro, Itatiaia, Macieira.

Diagnosis

Antenna entirely black. Parafacial and gena with pale golden pruinosity. Female fronto-orbital plate with scarce short setae on upper half. Palpus black. Acrostichals 2+2. Intrapostalar seta present. Male mid-femur with three short and stout hook-like setae on a preapical protuberance on the dorsal surface (a fourth seta, aligned with and close to the hook-like setae is present anteriorly, with the same length, being less stout and less hook-shaped when compared with the hook-like setae, but has the tip distinctly tortuous). Male hind femur lacking the posteroventral row of setae; hind femur of female with two or three long median setae. Hind tibia with a developed calcar on the apical fourth of posterodorsal surface and with a developed seta on basal third; male with a row of relatively long setae on anterodorsal surface, the setae longer than tibial length (females have a few short setae, not a complete row); a row of setae on anteroventral surface on apical two-thirds (on females the setae as long as tibial length, on males over 1.5 times the tibial width); the posteroventral surface on males with a row of fine short setae aligned on apical one-third.

Material examined

BRAZIL: *São Paulo State*, Bocaina, November 1969, Alvarenga and Seabra leg. (1 male, BMNH); Campos do Jordão, Fazenda Guarda Pinheiro Seco (1750 m), 18 March 1964, Rabelo, P. Biase and L. Travassos F. leg. (2 females, MZSP); Campos do Jordão, Eng. Lefevre (1200 m), 28 September 1962, L.Travassos F., Papavero, Rabello, L. Silva and Zanettin leg. (1 male, MZSP); *Paraná State*: Morretes, Marumbi (500m), 13 August 1960, Laroca and O. Mielke leg. (1 male, DZUP); Morretes, February 1965, C. Dipterologia (1 male, DZUP); Piraquara, 9 May 1974, J. Ferreira leg. (1 female, DZUP); Tijucas do Sul, Vossoroca, 24 November 1979, M. Hoffmann and D. Benedito leg. (1 male, DZUP).

Distribution

Brazil (Rio de Janeiro, São Paulo, Paraná) (Figure 2).

Cladistic analysis

A preliminary analysis, including all 22 characters, resulted in one single cladogram in which *Xenomorellia* was not recovered as monophyletic. *Morellia* (*T.*) *trichops* was nested within *Xenomorellia*, near *M.* (*X.*) *montanhesa*. This close relationship was based on three colour-based characters: (1) colouration of palpus: black in *M.* (*T.*) *trichops* and *M.* (*X.*) *montanhesa* and yellow in all other species included in the analysis; (2) colouration of first flagellomere: entirely black in *M.* (*T.*) *trichops* and *M.* (*X.*) *montanhesa* but yellow in *M.* (*M.*) *paulistensis* and *M.* (*P.*) *maculipennis*, and dark brown with reddish-brown/yellow margins in *M.* (*X.*) *holti*, *M.* (*X.*) *inca* and *M.* (*X.*) *maia*; (3) colouration of pedicel: dark brown in *M.* (*T.*) *trichops*, *M.* (*X.*) *inca* and *M.* (*X.*) *montanhesa*, and yellow in *M.* (*P.*) *maculipennis*, *M.* (*M.*) *paulistensis* and *M.* (*X.*) *maia*.

As colour-based features are very homoplastic within Muscidae, we carried out a further analysis without those three chromatic characters mentioned above. With the three characters excluded, the analysis now including 19 characters (Tables 1

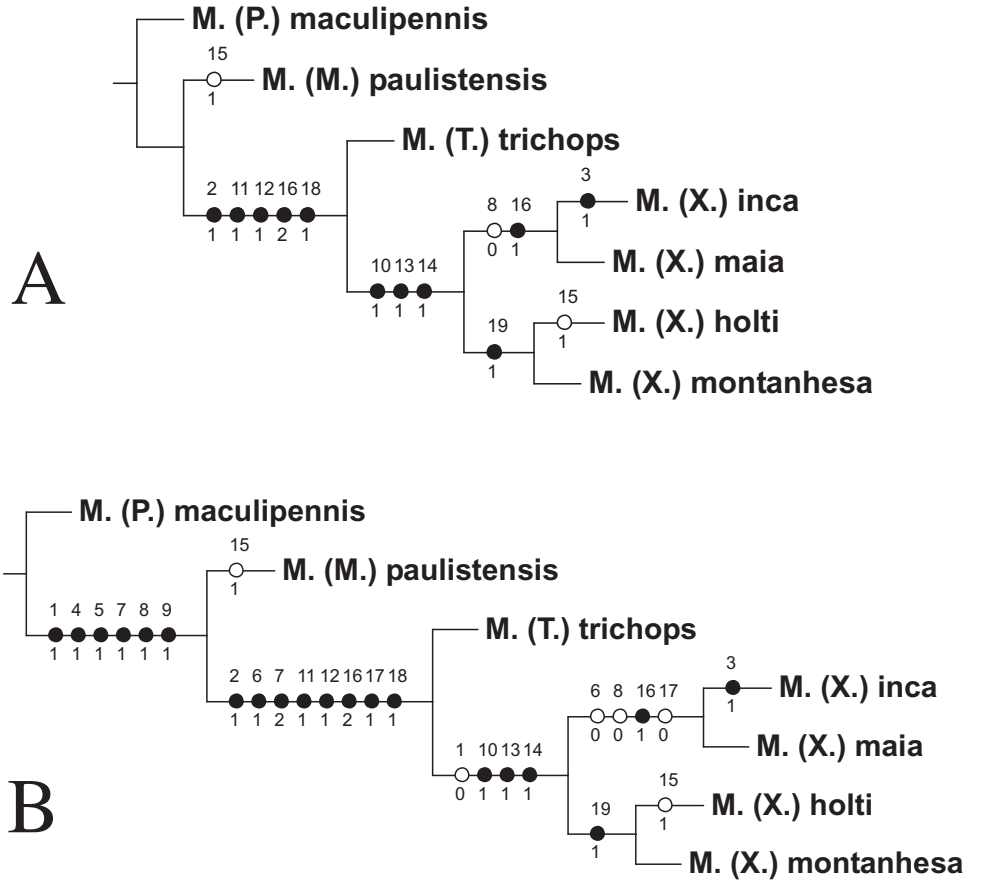

Figure 4. Single most parsimonious cladogram obtained (26 steps, ci 80, ri 76). (A) Unambiguous characters only; (B) ACCTRAN optimization.

and 2), none related to colouration, resulted in one single most parsimonious cladogram with 26 steps, ci 80 and ri 76 (Figure 4). The two cladograms depicted differ only by the character optimization: one showing only the unambiguous transformations (Figure 4A), and other with characters under ACCTRAN optimization (Figure 4B). All characters mentioned are unambiguous transformations, unless when it is clearly stated. Monophyly of *Xenomorellia* was recovered, with a sister-group relationship with *Trichomorellia*. Five synapomorphies support this arrangement: (1) female with proclinate fronto-orbital seta (character 2); (2) presence of a preapical pair of scutellar setae (character 11); (3) lower calypter glossiform (character 12); (4) male hind tibia with short anteroventral setae (character 16); and (5) abdominal sternite 1 setulose only laterally (character 18). The monophyly of *Xenomorellia* is supported by three synapomorphies, as follows: (1) anterior suprasquamal ridge setulose (character 10); (2) subcostal sclerite setulose ventrally (character 13); and (3) vein R_{4+5} bare dorsally (except on node) (character 14).

Based on the latter analysis (Figure 4), the subgenus *Xenomorellia* is divided in two clades: one Caribbean–Andean clade, including *M.* (*X.*) *maia* + *M.* (*X.*) *inca*, and a clade with species from the southeastern portion of South America, *M.* (*X.*) *holti* + *M.* (*X.*) *montanhesa*. Each clade is supported by a single synapomorphy. The first clade shares the presence of very long anteroventral setae on the hind tibia of the male (short in *holti* and *montanhesa*) (character 16). The clade including *M.* (*X.*) *holti* + *M.* (*X.*) *montanhesa* shares the male cercal plate with truncate lower lobe (rounded in *inca* and *maia*) (character 19). Besides the synapomorphies mentioned above, the species in the clade *M.* (*X.*) *maia* + *M.* (*X.*) *inca* share some interesting characters, as the loss of the intra-postalar setae (character 8) and the hind tibia with a single seta (the calcar) on the posterodorsal surface (character 17, under ACCTRAN optimization). On the other hand, *M.* (*X.*) *holti* and *M.* (*X.*) *montanhesa* have one intra-postalar seta and two posterodorsal setae on the hind tibia.

Acknowledgements

We are indebted to Jaime I. Rodriguez-Fernandez (Department of Zoology, Universidade Federal do Paraná) who kindly brought on loan the specimens from the Bolivian collection making their examination possible. We also thank our fellow curators who loaned material or allowed us access to their collections: James Boone (FMNH), Jose Clavijo (MIZA), José Enrique Castillo (IAVH), Manoel Zumbado (Instituto de Biodiversidad, Costa Rica), Marcia Couri (MNRJ), María Julieta Ledezma (UASC), Michael Sharkey (Department of Entomology, University of Kentucky, Lexington, KY, USA), and Nigel Wyatt (BMNH). Silvio Nihei thanks Adrian Pont and the staff of the Oxford University Museum of Natural History (Oxford, UK) for the facilities, and David Notton and Nigel Wyatt for the facilities at the BMNH. Financial support received from CNPq, proc. n. 303897/2008-2 (S.S.N.) and 300873/2008-5 (C.J.B.C.), from CAPES, proc. n. 0321/03–6 (S.S.N.), and from FAPESP, proc. n. 2007/50836-7 (S.S.N.).

References

Albuquerque DO. 1952. Sôbre alguns gêneros metálicos de Phaoninae Neotropicais e descrição de uma *Xenomorellia* nova (Diptera, Muscidae). Bol Mus Nac (N Sér, Zool). 116:1–21.

Carvalho CJB De. 1989. Revisão das espécies e posição sistemática de *Palpibracus* Rondani (Diptera, Muscidae). Rev Bras Zool. 6:325–376.

Carvalho CJB De, Couri MS, Pont AC, Pamplona DM, Lopes SM. 1993. Part II. Muscidae. A catalogue of the Fanniidae and Muscidae (Diptera) of the Neotropical region. São Paulo: Sociedade Brasileira de Entomologia. 201 pp.

Carvalho CJB De, Couri MS, Pont AC, Pamplona DM, Lopes SM. 2005. A catalogue of the Muscidae (Diptera) of the Neotropical Region. Zootaxa 860:1–282.

Goloboff PA. 1993. NONA, version 2.0. Program and documentation distributed by the author.

Huckett HC, Vockeroth JR. 1987. Muscidae. Manual of Nearctic Diptera, vol. 2, pp. 1115–1131. Ottawa: Research Branch Agriculture Canada Monograph.

Malloch JR. 1923. Exotic Muscaridae (Diptera). XI. Ann Mag Nat Hist. 9:505–528.

McAlpine JF. 1981. Morphology and terminology – adults. Manual of Nearctic Diptera, vol. 1, pp. 9–63. Ottawa: Research Branch Agriculture Canada Monograph.

Nihei SS, Carvalho CJB De. 2007. Phylogeny and classification of Muscini (Diptera, Muscidae). Zool J Linn Soc. 149:493–532.

Nihei SS, Carvalho CJB De. 2009. The Muscini flies of the World (Diptera, Muscidae): identification key and diagnoses for genera. Zootaxa 1976:1–24.

Nixon KC. 2002. WINCLADA. Program and documentation distributed by the author.

Page RDM. 2001. NEXUS, version 0.5.0. Program distributed by the author.
Pont AC. 1972. 97. Family Muscidae. A catalogue of the Diptera of the Americas South of the United States. São Paulo: Museu de Zoologia, Universidade de São Paulo. 111 pp.
Van Der Wulp FM. 1896. Muscidae. Muscidae Calypterae. Group Muscinae. Biologia Centrali-Americana, vol. 2. London.
Wiens JJ. 1998. Polymorphism in systematics and comparative biology. *Annu Rev Ecol Syst.* 30:327–362.