



Description of a new species of *Thevenetimyia* (Diptera: Bombyliidae) from Madagascar, with a revised checklist of Madagascan bee fly fauna

NATALIA MAASS¹, ZACHARY LARMORE², MATTHEW A. BERTONE³ & MICHELLE TRAUTWEIN⁴

¹University of Eastern Kentucky, Richmond, Kentucky, 40475, U.S.A. E-mail: natalia_maass@mymail.eku.edu

²North Carolina State University, Raleigh, North Carolina, 27695, U.S.A. E-mail: zslarmor@ncsu.edu

³North Carolina State University, Raleigh, North Carolina, 27695, U.S.A. E-mail: matt_bertone@ncsu.edu

⁴California Academy of Sciences, San Francisco, California, 94118, U.S.A. E-mail: mtrautwein@calacademy.org

Abstract

Madagascar is an island known for its richness of endemic species, including flies. Only eight genera of bee flies (Bombyliidae), including 17 described species (the majority of which are in the subfamily Anthracinae), are known from Madagascar. Here we describe a new species of Bombyliidae from Madagascar, *Thevenetimyia spinosavus* Maass & Bertone **sp. nov.** This fly represents the first record of the genus *Thevenetimyia* from Madagascar and the second species recorded in the Afrotropical Region. A revised checklist of Bombyliidae in Madagascar is provided, along with an appendix of associated literature. The known bee fly species likely represent only a fraction of the true diversity on the island, which has been relatively well sampled through extensive Malaise trapping of flies in Madagascar over the past decade.

Key words: Afrotropical, Madagascar, Malaise, *Thevenetimyia*, *spinosavus*

Introduction

The island of Madagascar is well-known as a biodiversity hot-spot with many endemic groups of plants and animals. In recent years, large-scale efforts by the Schlinger Foundation, in collaboration with the California Academy of Sciences (CAS), have been made to explore and catalog the arthropods of Madagascar, yet the characterization of this diversity will take many years to complete. In particular, the Madagascan Diptera fauna includes many species yet to be discovered and described. Although Madagascan flies are poorly known, the island is estimated to have approximately 1% of all the world's Diptera species (Goodman & Benstead 2003). It is predicted that Madagascar may host three times as many species and nine times as many genera than the remainder of the Afrotropical Region (Irwin *et al.* 2003).

Worldwide there are approximately 4,700 described species of bee flies (Bombyliidae) (Evenhuis & Greathead 2015a), yet only 17 species are known from Madagascar (Table 1). The majority of known Madagascan bee flies are in the subfamily Anthracinae, with seven of the nine anthracine species belonging to the genus *Exoprosopa* Macquart, and only one recorded species each in *Heteralonia* Rondani and *Villa* Lioy. The subfamily Toxophorinae is represented on the island by three genera (*Geron* Meigen, *Systropus* Wiedemann, and *Toxophora* Meigen), while two genera of Bombyliinae can be found there (*Bombylisoma* Rondani and *Systoechus* Loew), each with one described species (Table 1). To this sparse list of Madagascan bee flies, we add a new species of *Thevenetimyia* Bigot,—a genus previously unknown from Madagascar.

Thevenetimyia was first described in 1875 by Jacques Bigot and generally includes medium-sized flies with cylindrical abdomens and smoky brown wings (Bigot 1875, Kits *et al.* 2008). *Thevenetimyia* currently contains 40 species, predominantly from the Nearctic Region (28 species), with only one species known from the Afrotropical Region (Evenhuis & Greathead 1999, 2015b; Hansbenli 2005; Dils 2009). This single Afrotropical species, *T. quedenfeldti* Engel, has only been documented in the northwest portion of Africa (Mauritania, Algeria, and Tunisia (Evenhuis & Greathead 1999); though Hall (1969) mistakenly reported it from Greece, N. Evenhuis, pers. com.).

Both the taxonomic classification and phylogenetic placement of *Thevenetimyia* are disputed (Yeates 1994). *Thevenetimyia* has traditionally been considered part of the subfamily Ecliminae with 8 other genera of usually elongate bee flies (*Alepidophora* Cockerell, *Cyrtomyia* Bigot, *Eclimus* Loew, *Lepidophora* Westwood, *Marmosoma* White, *Palintonus* François, *Paratoxophora* Engel and *Tillyardomyia* Tonnoir) (Hall 1969; Bowden 1985; Greathead 1988). However, the most recent quantitative phylogenetic estimate of bee fly subfamilies based on morphological data relegated Ecliminae to tribal status (Eclimini) within the larger subfamily Bombyliinae (Yeates 1994) corroborating the placement suggested by Hull (1973). Evenhuis & Greathead (1999) subsequently recognized subfamily status of Ecliminae, justified by morphological differences. They followed this placement in their keys in Greathead & Evenhuis (2001), where they provided a history of the classification of the subfamily. A recent molecular study of the higher-level relationships of Bombyliidae failed to recover either a monophyletic Eclimini (or -nae) or Bombyliinae; *Thevenetimyia*, in particular, was found to have an unstable phylogenetic placement (Trautwein *et al.*, 2011). Thus further study, both morphological and molecular, of a large taxonomic and geographical sample of *Thevenetimyia* are needed to resolve the current ambiguity surrounding the classification and evolutionary relationships of this genus.

Here we describe a new species of *Thevenetimyia* from the Afrotropical Region. The holotype is a single male specimen collected by R. Harin'Hala in the Tuléar Province in Zombiste National Park in southwest Madagascar (Fig. 1). The holotype is deposited at the California Academy of Sciences, San Francisco, California, alongside an extensive collection of dipteran material from Madagascar.

Material

The holotype was collected in Madagascar from a spiny deciduous forest in the Tuléar Province (Fig. 1), using a Malaise trap with an ethanol preservative. After collection, the specimen was preserved in 95% ethanol until it was chemically dried using hexamethyldisilazane (HMDS) at North Carolina State University in Raleigh, North Carolina. The fly was examined using an Olympus SZX7 stereo dissecting microscope and photographs were taken using an Olympus BX51 compound microscope (LMPLFLN50x objective and Olympus DP71 camera), a Canon 60D with a 60mm macro lens + Raynox M-250 conversion lens, or a Canon 7D SLR with an MP-E 65 macro lens. All terminology (excluding the wing) follows Yeates (1994). Wing terminology follows the Manual of Nearctic Diptera (McAlpine, 1981).

Museums containing type material discussed in this paper are as follows:

BMNH	The Natural History Museum, London, United Kingdom
CAS	California Academy of Sciences, San Francisco, United States
MNHN	Museum National d'Histoire Naturelle, Paris, France
MRAC	Musée Royal de l'Afrique Centrale, Tervuren, Belgium
NHMB	Naturhistorisches Museum, Basel, Switzerland
NMSA	Natal Museum, Pietermaritzburg, South Africa
ZMHB	Museum für Naturkunde, Humboldt-Universität, Berlin, Germany

Taxonomy

Key to the Afrotropical species of *Thevenetimyia* Bigot

1. Body length just over 6 mm (Fig. 2); terminal antennal segment with blunt apex (Fig. 3); thorax and dorsal area of occiput without golden or brown setae; scutellum with abundant spine-like tubercles (Fig. 4A and 4B); medial crossvein curving gradually to meet posterior intercalary vein at an acute angle; M_1 vein about six times the length of anterior intercalary vein (Fig 5) *T. spinosavus* Maass & Bertone, **sp. nov.**
- Body length 9 mm; terminal antennal segment with moderately acute apex; thorax and dorsal area of occiput with at least some golden or brown setae; scutellum without abundant spine-like tubercles; medial crossvein abruptly curved to meet posterior intercalary vein at a right angle; M_1 vein four times the length of anterior intercalary vein *T. quedenfeldti* (Engel, 1885)

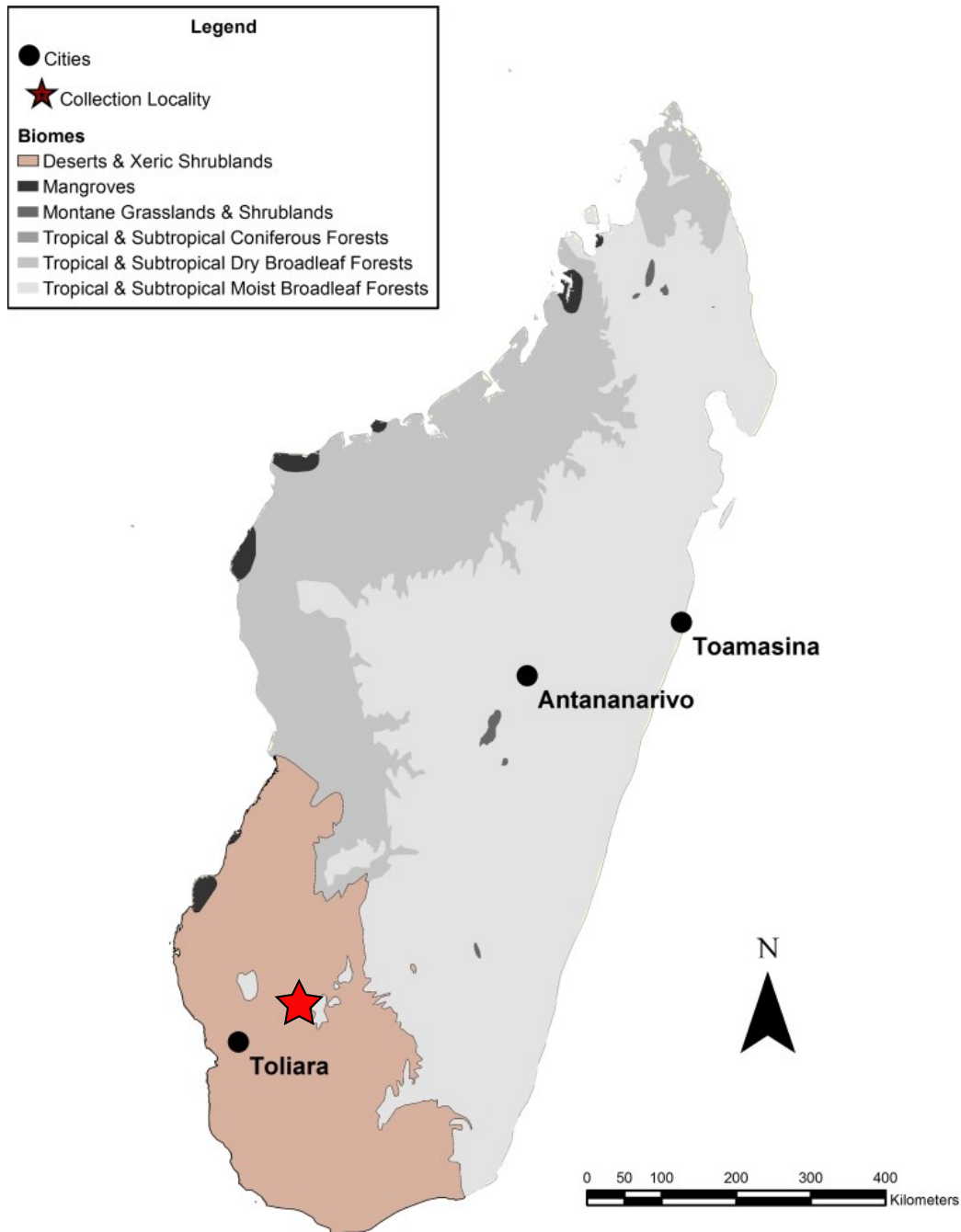


FIGURE 1. Map of Madagascar showing ecological zones, major cities (black circles), and collection locality of *Thevenetimyia spinosavus* Maass & Bertone, **sp. nov.** (red star).

***Thevenetimyia spinosavus* Maass & Bertone, sp. nov.**

Material examined. Holotype ♂: MADAGASCAR, Tuléar Province: Zombiste National Park near road, 22°50.43'S, 44°43.87'E, 822 m, 16–31 October 2002 (M. Irwin & R. Harin'Hala colls.), MAO2-13B-40.

Diagnosis. Features that distinguish this fly from the only other Afrotropical *Thevenetimyia* species include: smaller size (~6.2 mm), terminal flagellomere with blunt tip, spine-like tubercles on scutellum (Fig. 4B), body setae white or black (not golden), and features of the wing venation.

TABLE 1. Bombyliidae known from Madagascar (Modified from the *World catalog of bee flies (Diptera: Bombyliidae)*, (Evenhuis & Greathead, 2015b) and True flies: The natural history of Madagascar, Irwin *et al.*, 2003)

Subfamily	Genus	Species	Afrotropical Distribution	Types Available:	Described by:	
Ecliminae (but see Yeates, 1995, Trautwein 2011) Toxophorinae	<i>Thevenetimyia</i>	<i>spinosavus</i>	Madagascar	Holotype in CAS	Maass and Bertone, this study	
	<i>Geron</i>	<i>candidulus</i>	Madagascar	Holotype in NHMB	Bowden, 1974	
		<i>dilutus</i>	Aldabra, Astove Is, Cosmoledo Is, Madagascar	Holotype in MNHN	Bowden, 1974	
Bombyliinae	<i>Systropus</i>	<i>varicapillus</i>	Madagascar	Holotype in NHMB	Bowden, 1974	
		<i>limacodidarum</i>	Madagascar	20 syntypes in ZMHB; 2 syntypes in BMNH	Enderlein, 1926	
	<i>Toxophora</i>	<i>quadrinotatus</i>	Madagascar	3 syntypes in MNHN; holotype in JB	Séguy, 1934	
		<i>seynigi</i>	Madagascar	Type in MNHN	Séguy, 1934	
		<i>microlepidum</i>	Madagascar	Holotype in NMSA	Bowden, 1973	
		<i>claripennis</i>	Madagascar	Holotype (lost) in MNHN	Macquart, 1840 (as <i>Bombylius claripennis</i>) Bezzi, 1924	
	Anthracinae	<i>Exoprosopa</i>	<i>angusta</i>	Madagascar	Holotype in BMNH	Macquart, 1847
		<i>Heteralonia</i>	<i>arcuata</i>	Madagascar	Type in unknown collection (originally in de Villiers Collection)	François, 1964
			<i>flammicoma</i>	Madagascar	Holotype in MRAC	Macquart, 1850
		<i>Villa</i>	<i>madagascariensis</i>	Madagascar	Holotype in BMNH	Bezzi, 1924
<i>melanaspis</i>			Madagascar	3 syntypes in BMNH	Bezzi, 1924	
<i>nigrispina</i>			Madagascar	Holotype in BMNH	Séguy, 1934	
<i>vayssierei</i>	Madagascar		Syntype in MNHM	Bezzi, 1924 (as <i>Exoprosopa dolichoptera</i>) Macquart, 1840 (as <i>Anthrax unifasciata</i>)		
	<i>dolichoptera</i>	Madagascar	Holotype in BMNH			
	<i>unifasciata</i>	Madagascar, Mauritius, Réunion, Rodriguez	Lectotype in MNHN; Type in unknown collection (originally in de Villiers Collection); Syntype in NHRS			



FIGURE 2. Lateral habitus of *Thevenetimyia spinosavus* Maass & Bertone, **sp. nov.**

Male. Head (Fig 3): Head slightly wider than thorax. Ocellar tubercle pronounced, rounded, covered in long black setae. Eyes holoptic. Antennae with three segments, length approaching length of head, black, and dusted with grey pollinosity; pollinosity dense on scape and pedicel, more diffuse on flagellum. Scape covered in black setae of varying lengths; pedicel covered in short black setae; flagellum without setae. Scape approximately two and one-half times length of pedicel. Flagellum slightly longer than scape, about as wide as previous segments, width even throughout, and with blunt tip. Buccal cavity deep, with setose swelling under anterior rim. Palpus half-length of proboscis, covered in grey pollinosity and black setae. Terminal segment of palpus slightly swollen at about midlength and with shorter setae than previous segment. Proboscis black, about two times as long as head. Face and occipital area with long black setae. Gena and lower portions of postgena with white setae (Fig. 4A). **Thorax** (Fig 4A and B): Mesothoracic scutum and scutellum dull black. Ground color of remaining thorax similar to scutum and scutellum, but with a dense dusting of grey pollinosity, especially on the pleura. Scutum with sparse, long black setae. Sparse, irregularly spaced, prominent spines on anterior half of scutum, becoming much smaller and sparser posteriorly (need high magnification to observe on posterior half). Anterior scutal spines often with an associated seta attached to base. Scutellum prominent, projecting over first abdominal tergite, and with numerous, small, spine-like tubercles, becoming more dense on posterior face (Fig. 4B). Anepisternum densely covered with long black setae. Anepimeron, katepisternum, and ventral portion of anepisternum with patches of long white setae of varying density. Notopleural area just before wing base with three prominent black bristles (Fig. 4A). **Wings** (Fig. 5): Wings smoky brown, darker along costal margin and gradually fading posteriorly. Venation typical for genus *Thevenetimyia*. Costa with two rows of evenly spaced, spine-like setae along length, becoming more densely



FIGURE 3. Anterior view of the face of *Thevenetimyia spinosavus* Maass & Bertone, **sp. nov.**

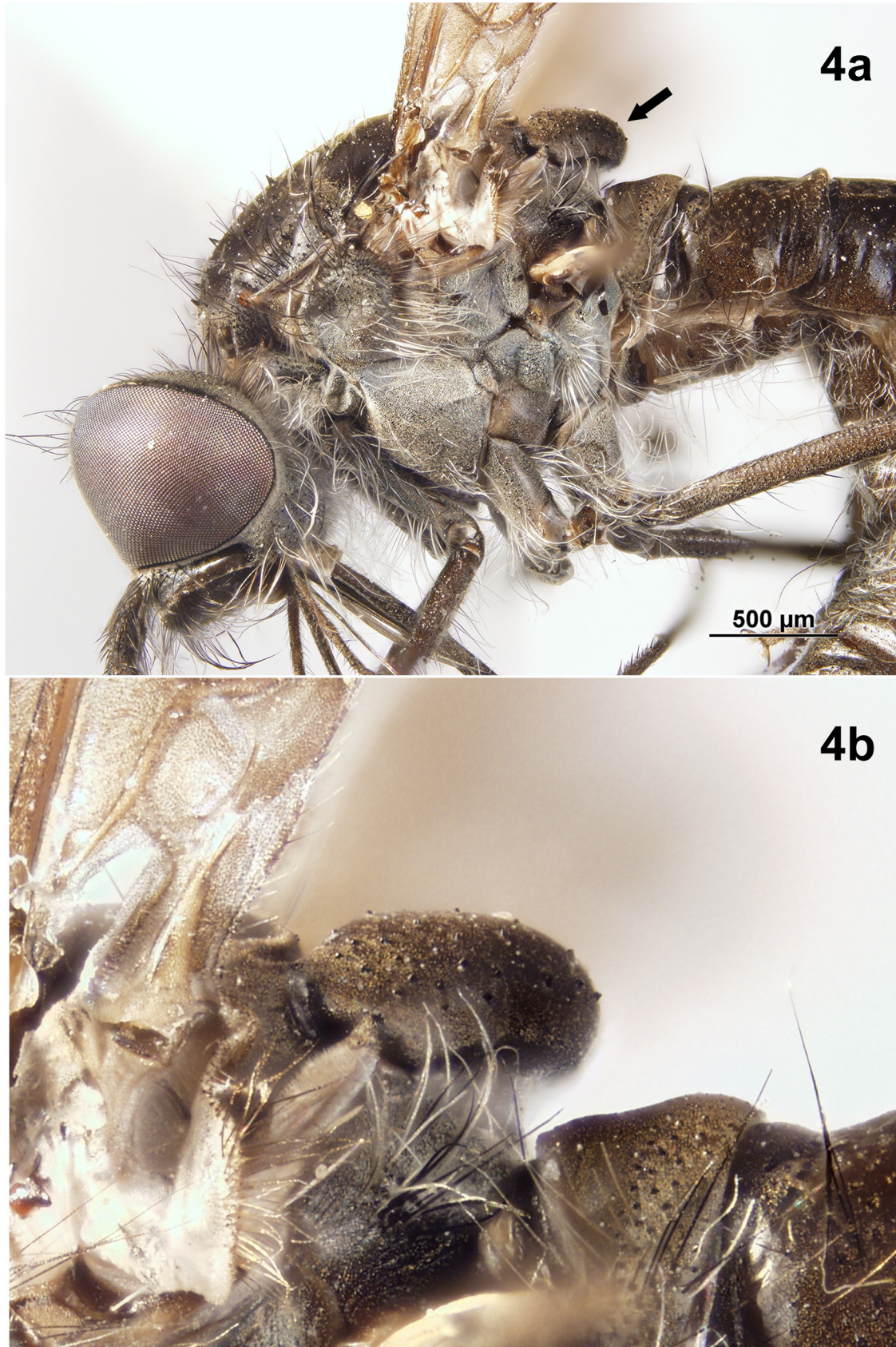


FIGURE 4. A. Lateral thoracic region of *Thevenetimyia spinosavus* Maass & Bertone, **sp. nov.** showing pleural pollinosity and setae, as well as the diagnostic spine-like scutellar tubercles (black arrow). B. Close-up of scutellar tubercles.

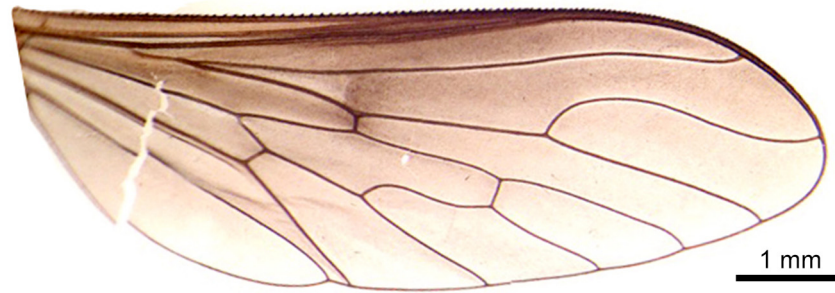


FIGURE 5. Right wing of *Thevenetimyia spinosavus* Maass & Bertone, **sp. nov.**



FIGURE 6. Ventrolateral view of posterior abdominal segments, external male genitalia, and tarsal claws of *Thevenetimyia spinosavus* Maass & Bertone, **sp. nov.**

spaced but individually finer beyond intersection of veins C and R_{2+3} . M_1 ending in the wing margin. CuA and A each terminating separately at wing margin. Crossvein r-m placed before middle of cell dm. Calypter with mixture of long black and white setae. Halter elongate with light stem and dark brown knob. **Legs:** Coxae of front, mid and hind legs dull black with even gray pollinosity and covered sparsely with long white hairs (Fig. 4A). Front leg: Femur dark brown, bare, with long setae on the underside near trochanter. Tibia brown with sparse setae and spines becoming more dense apically. Tarsi dark brown and with dense black bristles. Mid leg: Femur dark brown, bare with very few long setae near trochanter. Tibia lighter brown with evenly distributed black bristles. Apex of tibia with prominent spurs. Tarsi dark brown and densely packed with black bristles. Hind leg: Hind legs notably longer than front and mid legs (similar to other members of genus *Thevenetimyia*). Femur dark brown with sparse black bristles and setae. Tibia lighter brown with evenly distributed black bristles. Apex of tibia with prominent spurs. Tarsi dark brown and densely packed with black bristles. All pulvilli well developed, slightly more than half the length of claws, white and with dense hairs. Claws simple (Fig. 6). **Abdomen:** About twice the length of thorax. Ground color of tergites dark brown with gray pollinosity on the lateral portion. Tergite I with predominantly long white hair. Tergite II with long dark brown hair. Amount of hair decreases drastically on lateral portion posteriorly

to tergite IV. No other remarkable hairs on tergites V–VII. Sternites brown with white hair of varying lengths, predominantly short, found evenly throughout all sternites. Long black bristle-like setae present on epandrium and sternite VII. Black bristles do not continue onto cerci, although cerci have shorter hairs. Dissection of male genitalia was not conducted due to only one specimen being known (Fig. 6).

Etymology. The name is a noun in apposition based on a combination of *spinosus* (Latin = “thorny”) and *avus* (Latin = “grandfather”), referring to the spines present on the scutum and scutellum, and the fly’s “elderly” appearance (many white hairs found on the body and grey pollinosity).

Discussion

The description of a new species of *Thevenetimyia* from the Afrotropical Region is notable, not only because the genus has not been recorded from Madagascar, but also because the only other described Afrotropical species, *T. quendenfeldti*, is found in northwestern Africa, a considerable distance from Madagascar. *Thevenetimyia* has a very limited range outside of the Nearctic region. The majority of species in *Thevenetimyia* are distributed throughout the pine and chaparral belt of western North America (Hall 1969).

Thevenetimyia spinosavus Maass & Bertone, **sp. nov.** generally resembles the only other Afrotropical species *T. quendenfeldti*, but is notably smaller in size and lacks the distinctive golden setae found on the dorsum of the head and thorax of *T. quendenfeldti*. Both flies have long hind legs, mesoscutal spines, and infuscated wings. *Thevenetimyia spinosavus* can be distinguished from other species in the genus by the small spine-like tubercles on the scutellum (Fig. 4B).

As with so many other bee flies, little is known about the life histories of the members of the genus *Thevenetimyia*. Adults are generally considered flower visitors, though some are also associated with dry wood (Hull, 1973, Hall 1969). Known larvae of *Thevenetimyia* have been documented parasitizing wood associated beetles such as Ptinidae *s.l.* (including Anobiidae) and Cerambycidae (Hall 1969).

The identification of *Thevenetimyia spinosavus* was made from an initial assessment of CAS’s extensive collection of bee flies in alcohol from Madagascar Malaise traps. Madagascar’s endemic species richness alludes to the likelihood that more bee fly genera and species will be identified and described from the island with further examination of CAS’s material.

Acknowledgments

We thank the Schlinger Foundation, Evert Schlinger, Mike Irwin, and the local Malagasy team for their extensive Malaise trap sampling in Madagascar - the material from which this bee fly was identified. Thanks also go to Bob Blinn for specimen preparation and to Roland Kays for assistance in creating the map. We very much appreciate Paula Rodrigues for taking photographs of *T. quedenfeldti* and Kyle Kittelberger for help in forming the scientific name and verifying the etymology. Finally, we are most grateful for the thorough and valuable reviews provided by bee fly experts, Paula Rodrigues and Neal Evenhuis. This study is the result of undergraduate internships funded by NSF grant DEB 1257960.

References

- Bigot, J.M.F. (1875) Description d’une nouvelle espèce de diptère. *Bulletin Bimensuel des Séances de la Société Entomologique de France*, 1875 (18), 195–97.
- Bowden, J. (1985) The tribal classification of the Bombyliinae with particular reference to the Bombyliini and Dischistini, and the description of a new genus from South America (Dipt., Bombyliidae). *Entomologist’s Monthly Magazine*, 121, 99–107.
- Dils, J. (2009) A new species of the genus *Thevenetimyia* (Diptera: Bombyliidae, Ecliminae) from Iran with notes about the male of *Thevenetimyia hirta*. *Phegea*, 37 (4), 121–125.
- Engel, E.O (1885) Über von Herrn M. Quedenfeldt in Algier gesammelte Dipteren. *Entomologische Nachrichten*, 11, 177–179.
- Evenhuis, N.L. & Greathead, D.J. (1999) *World catalog of bee flies (Diptera: Bombyliidae)*. Backhuys Publishers Leiden, Netherlands, 756 pp.

- Evenhuis, N.L. & Greathead, D.J. (2015a) Introduction [to] World catalog of bee flies (*Diptera: Bombyliidae*). Revised September 2015. Available at: <http://hbs.bishopmuseum.org/bombcat/intro-revised.pdf>
- Evenhuis, N.L. & Greathead, D.J. (2015b) World catalog of bee flies (*Diptera: Bombyliidae*). Available from: <http://hbs.bishopmuseum.org/bombcat/bombcat2015.pdf> (revised September 2015)
- Goodman, S.M. & Benstead, J.P. (2003) *The natural history of Madagascar*. University of Chicago Press, Chicago, 1728 pp.
- Greathead, D.J. (1988) The relationships of *Tillyardomyia* Tonnoir with a redefinition of the subfamily Ecliminae (Diptera: Bombyliidae). *New Zealand Entomologist*, 11, 14–21.
<http://dx.doi.org/10.1080/00779962.1988.9722530>
- Greathead, D.J. & Evenhuis, N.L. (2001) Annotated keys to the genera of African Bombylioidea (Diptera: Bombyliidae; Mythicomyiidae). *African Invertebrates*, 42, 105–224.
- Hall, J.C. (1969) A review of the subfamily Cylleniinae with a world revision of the genus *Thevenemyia* Bigot (*Eclimus* auct.) (Diptera: Bombyliidae). *University of California Publications in Entomology*, 56, 1–85.
- Hasbenli, A. (2005) A new species of *Thevenetimyia* Bigot, 1892 (Diptera, Bombyliidae, Ecliminae) from Turkey. *Journal of the American Entomological Society*, 116 (1), 11–14.
- Hull, F.M. (1973) *Bee flies of the world: The genera of the family Bombyliidae*. Smithsonian Institution, Washington Press, 687 pp.
- Irwin, M.E., Schlinger, E.I. & Thompson, F.C. (2003) Diptera, true flies. In: Goodman, S.M. & Benstead J.P. (Eds.), *The natural history of Madagascar*. The University of Chicago Press, Chicago, pp. 692–698.
- Kits, J.H., Marshall, S.A. & Evenhuis, N.L. (2008) The bee flies (Diptera: Bombyliidae) of Ontario, with a key to the species of eastern Canada. *Canadian Journal of Arthropod Identification*, 6, 2–52.
<http://dx.doi.org/10.3752/cjai.2008.06>
- McAlpine, J.F. (1981) Morphology and Terminology-Adults. In: McAlpine, J.F., Peterson, B.V., Shewell, G.E., Teskey, H.J., Vockeroth, J.R. & Wood, D.M. (Coordinated by), *Manual of Nearctic Diptera*, Research Branch Agriculture Canada. Volume 1, pp. 9–37.
- Trautwein, M.D., Wiegmann, B.M & Yeates, D.K. (2011) Overcoming the effects of rogue taxa: evolutionary relationships of the bee flies. *PLoS Currents*, 3, RRN1233.
<http://dx.doi.org/10.1371/currents.RRN1233>
- Yeates, D.K. (1994) The Cladistics and Classification of the Bombyliidae (Diptera: Asiloidea). *Bulletin of the American Museum of Natural History*, 191, 219 pp.

APPENDIX. Literature describing Madagascan Bombyliidae

- Bezzi, M. (1924) *The Bombyliidae of the Ethiopian Region*. British Museum (Natural History), London, 390 p.
- Bowden J. (1973) Studies in African Bombyliidae. VII. On *Dischistus* Loew and related genera, and *Bombylisoma* Rondani, with some zoogeographical considerations. *Journal of the Entomological Society of Southern Africa*, 36, 139–518.
- Bowden, J. (1974) Studies in African Bombyliidae. VII. On the Geroninae. *Journal of the Entomological Society of Southern Africa*, 37, 87–108 pp.
- Enderlein, G. (1925) Zur Kenntnis der Bombyliiden-Subfamilie Systropodinae (Dipt.). *Wiener Entomologische Zeitung*, 43, 69–92.
- François, F. (1964) Un *Exoprosopa* nouveau de Madagascar: *E. flammicoma* (Diptera: Bombyliidae). *Bulletin et Annales de la Société Royale d'Entomologie de Belgique*, 100, 309–133.
- Macquart, P. (1840) *Diptères exotiques nouveaux ou peu connus*. Tome deuxième.—1^{re} partie. N.E. Roret, Paris, 5–135 pp.
- Macquart, P. (1847) *Diptères exotiques nouveaux ou peu connus*. 2^{me} supplément. N.E. Roret, Paris, 5–104 pp.
- Macquart, P. (1850) *Diptères exotiques nouveaux ou peu connus*. 4^{me} supplément. *Mémoires de la Société Royal des Sciences, de l'Agriculture et des Arts, Lille*, 309–479 pp.
- Séguy, E. (1934) Diptères d'Afrique. *Encyclopédie Entomologique, Series B, II Diptera*, 7, 63–80.