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Author-formatted, not peer-reviewed document posted on 07/10/2022

DOI: <https://doi.org/10.3897/arphapreprints.e95996>

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Description of the male of *Erromyрма* Bolton & Fisher, 2016 (Hymenoptera, Aculeata, Formicidae, Myrmicinae)

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Abstract:

The male of myrmicine genus *Erromyрма* is described for the first time on the basis of two male specimens of *Erromyрма latinodis* collected in northern Madagascar. Moreover, CO1 barcoding confirmed the identification of the male specimens as conspecific with *Erromyрма latinodis*. We provide a male-based key to the four Myrmicinae tribes (Attini, Crematogastrini, Solenopsidini, Stenammini) and to the Solenopsidini genera (*Adelomyrmex*, *Erromyрма*, *Solenopsis*, *Syllophopsis* and *Monomorium*) for the Malagasy region.

Key words: Morphology, Myrmicinae, Solenopsidini, *Erromyрма*, male ants.

Introduction

Within the Malagasy region, Myrmicinae is one of the largest and most diverse subfamilies of Formicidae, with 30 genera in 4 tribes (Fisher 2022). The genus *Erromyрма* Bolton and Fisher 2016 (Hymenoptera: Formicidae: Solenopsidini), is represented by one species in the Malagasy region, *Erromyрма latinodis* (Mayr, 1872). The species has been introduced into many countries, including the Malagasy region, and is thought to have originated in India (Sharaf et al. 2018). The global distribution also includes Indomalaya the Southeastern Palearctic and Oceania. *Erromyрма latinodis* was originally placed in *Monomorium* but was shown to be a distinct lineage within the Solenopsidini based on molecular phylogeny (Ward et al. 2015) and placed in the newly described genus *Erromyрма* Bolton and Fisher 2016.

Here we focus on the male caste and present the first description of the previously unknown male of the genus *Erromyрма* based on males of *E. latinodis* collected in northern Madagascar. We provide a male-based key to the Myrmicine tribe and to genera for the tribe Solenopsidini of the Malagasy region.

Material and Methods

This study is based on male ant specimens collected in northern Madagascar in the town of Antsohihy (-14.89385, 47.98261) in the Region of Sofia, at ca. 11 m above sea level on April 23, 2017 by Brian L. Fisher and the Madagascar Biodiversity Center team (Team Vitsika). Two males along with workers and queens were collected by hand under the bark of a mango tree along a dirt road 1 km outside of the

town of Antsohihy (collection code identifiers BLF40204, BLF40205). The mango tree was 1.5 in diameter and approximately 5 m tall. The ants were found under bark flakes before the first branch at about 1 m in height.

DNA sampling and results

After searching for the males in colonies across Madagascar for six years, we wanted to confirm that the males were *E. latinodis* even though they were collected along with queens and workers. We sequenced 658 base pairs (bp) of mitochondrial cytochrome oxidase I (COI) gene from one of the males to evaluate similarity with COI sequenced from 33 workers of *E. latinodis* across the region. The distribution of the specimens sequenced is shown in Figure 11. DNA extraction and COI sequencing were performed at University of Guelph (Ontario, Canada), following the protocol described in Fisher & Smith (2008).

The 34 specimens sequenced (see Table 1) had a within-species sequence divergence of 0.00%. Thus based on COI, the male specimen sequenced is conspecific with the workers from throughout the region.

Morphological study

Morphological observations and measurements were carried out under LEICA stereoscopic microscopes (MZ9 5). Images are also available online on AntWeb (www.antweb.org) and are accessible using the unique identifying specimen code. All measurements and indices are expressed in millimeters.

The following characters were recorded:

HL: Length of the head capsule excluding the mandible

HW1: Head width at the level of posterior margin of eyes.

HW2: Maximum head width including eyes.

EL: Maximum length of the eye.

EW: Maximum width of the eye.

IOD: Distance between lateral ocelli.

MLD: Minimum distance between median and lateral ocelli.

OOD: Minimum distance between lateral ocelli and eye.

SL: Maximum scape length excluding condylar neck.

F1L: Maximum length of first flagellar segment.

PL: Petiolar length. Distance from anterior to posterior margin of petiolar sternum in profile view.

PW: Maximum width of petiole.

PPW: Maximum width of postpetiole.

CI: Cephalic index. $HW1/HL \times 100$.

SI: Scape index. $SL/HW1 \times 100$.

EI: Eye index. $EL/HW1 \times 100$.

PI: Petiolar index. PL/PPL

Abbreviation of depository

CASC: California Academy of Sciences, San Francisco, CA, USA

MCZ: Museum of Comparative Zoology Cambridge, MA, USA

BMNH: British Museum of Natural History, London

NHMW: Naturhistorisches Museum, Wien (= Vienna), Austria

Morphological terminology principally follows Boudinot (2013, 2015). The terminology of the anterior wing venation follows Yoshimura (2007).

“Insert Figure 1 here”

Erromyrmex latinodis (Mayr, 1872)

Monomorium latinode Mayr, 1872: 152 (w.) Primary type information: Type-material: syntype workers (number not stated). Type-locality: Malaysia (“Borneo”): Sarawak, 1865-66 (J. Doria & O. Beccari). Type-depositories: BMNH, NHMW. Type-specimen: CASENT0010941.

The workers *Erromyrmex latinodis* (Mayr, 1872) are variable in size and color and also include two junior synonyms, *Erromyrmex latinodis bruneum* (Emery, 1893) described from Sri Lanka and *Erromyrmex voeltzkowi* (Forel, 1907) collected from Pemba Island, Tanzania. A possible third synonym is *Monomorium latinodoides* Wheeler, 1928 described from Honk Kong. Wheeler (1928) notes that this species is similar to *E. latinodis* but smaller in size. We examined images of the type series at MCZ. The syntypes series are labeled Kowloon (F. Silvestri): one pin with 3 workers (MCZ-ENT00020883) and 2 workers and one dealate queen on a second pin (MCZ-ENT00727982). We formally combine the species in *Erromyrmex* and synonymize the species with *E. latinodis* (*Erromyrmex latinodoides*

(Wheeler, 1928) **comb nov. syn. nov.**). However, we exclude the queen from the type series. The queen is a *Carebara* species.

Diagnosis of Malagasy *Erromyrmex latinodis* males

1. Palp formula: 5, 3
2. Mandible well-developed, elongate triangular; basal angle rounded (Fig. 2A).
3. Four mandibular teeth (Fig. 2A).
4. Antenna with 13 segments short and filiform, first basal funicular subglobular (Fig. 2A).
5. Scape short (SI < 33; Fig. 2A).
6. Eyes large (EL/HW1 0.58; Fig. 1A).
7. Ocelli present (Fig. 1A).
8. Clypeus with anterior margin convex. (Fig. 2A).
9. Frontal lobes absent (Fig. 2A).
10. Antennal scrobe clearly absent (Fig. 2A).
11. Head without raised nuchal carina (Fig. 2B).
12. Notauli absent (Fig. 2B).
13. Single spur present on meso- and metatibia (Fig. 2C).
14. Pterostigma present on the forewing (Fig. 3).
15. First median-cubital cross-vein (1m-cu) present on the forewing (Fig. 3).
16. Forewing cubital vein fused with median vein (M+Cu) (Fig. 3).
17. Forewing cross vein 2rs-m absent (Fig. 3).
18. Petiole pedunculate (Fig. 2B).
19. Postpetiole globose in lateral view (Fig. 2C).
20. Gaster longer than broad (Fig. 2C).
21. Pygostyles present (Fig. 2C).

Male description

Male measurements ($n = 2$). HL 0.60–0.62, HW1 0.48–0.5, HW2 0.62–0.65, EL 0.28–0.29, EW 0.21–0.23, IOD 0.2–0.21, MLD 0.06–0.07, OOD 0.16–0.18, SL 0.12–0.14, F1L 0.09–0.1, PL 0.51–0.54, PW 0.2–0.21, PPW 0.33–0.34, CI 81–82, SI 28, EI 0.58

Structure.

In full-face view, the head is slightly longer than wide when the head is measured at the posterior margin of the eye (HW1), much wider than long if the eyes are included (HW2); posterior head margin relatively rounded; head with three large rounded ocelli of the same size, situated on frontal face of the head, lateral ocelli directed 45 degrees toward lateral sides. Eye large, strongly bulging. Anterior margin of clypeus convex. Mandible well developed and elongate triangular; masticatory margin with four teeth, its basal angle rounded.

Antennae 13-segmented short and filiform, first basal funicular subglobular. Mesosoma massive, in dorsal view much broader than the head at the level of the forewing insertion. In dorsal view, pronotum short in median portion; notauli absent on the mesoscutum; mesoscutellum broader than long and smaller than mesoscutum. Metapleural glands present as in workers. In profile, propodeal angle rounded, without spines or teeth. Hind femora longer than tibia.

In lateral view, petiole distinctly pedunculated; subpetiolar process absent. In dorsal view, abdominal segment III (postpetiole) not swollen and broader than long; gaster oblong, with first gastral segment broader than the remaining abdominal tergite.

Sculpture.

Clypeus, dorsum, lateral face, and venter of head weakly smooth and shiny. Pro- and mesothorax extensively smooth or very superficially sculptured and shiny, with posterolateral area of mesoscutum and posterior zone of mesopleuron unsculptured with shiny area. Metanotum and metapleuron unsculptured and matte. Apical area of anterior slope of petiole, coxae, femora and tibiae of all legs smooth to superficially sculptured and shiny; tarsi entirely microsculptured. Gaster entirely smooth to superficially sculptured and shiny.

Color.

Mandible light brown tend to be dark apically. Ocellar region and gaster dark brown. All other parts of the body light brown.

Pilosity.

Hairs on clypeus stout. Mandible covered with standing hairs. Antennal scape and pedicel with short, decumbent, whitish hairs; flagellomeres with erect hair. Hairs on head and body moderately abundant, erect, short, and stout. Pronotum, mesoscutum, and mesoscutellum with many obliquely standing hairs; hairs on mesopleuron much sparser; metanotum and propodeum with erect hair. Femora and tibiae with appressed hairs; tarsi covered with short appressed hairs. Posterior margins of each abdominal tergite and sternite with long and suberect hairs. Parameres covered with stout hair.

“Insert Figure 2 here”

Wings.

When referring to the presence or absence of veins in the descriptions, a vein is considered present regardless of whether it is tubular, nebulous, or spectral (Mason 1986).

Forewing with four closed cells (Fig. 3); Costal vein (C) absent.

Pterostigma pigmented, visible on the leading edge of the forewing.

Radial vein fused proximally to constitute R+Sc before reaching the pterostigma.

Past the separation from R+Sc, the radial sector continues posterior to the pterostigma, first as a usually short free abscissa Rs, then merged with median vein (M) and fused (Rs+M) to constitute the last section of the free abscissae Rs.

When Rs present distally to Rs+M, it connects to the pterostigma via the second radial-radial sector cross vein (2r-rs).

Median vein (M). Further away from the leading wing margin, median vein proximally fused with the cubital vein (M+Cu); following separation continuing as a free abscissa M before joining with radial sector to form Rs+M.

Median vein (M) present past the junction with the radial sector.

Cubital vein is fused proximally with median vein (M+Cu) and with up to two free abscissae. The first median-cubital cross-vein (1m-cu) may connect the cubital vein to the median vein

Anal vein (A) running near the posterior wing margin. The abscissa fused cubital-anal cross-vein (cu-a), a connection to the cubital vein, and often two abscissae are present.

“Insert Figure 3 here”

Key to the tribes of the subfamily Myrmicinae based on males in the Malagasy region

The subfamily of Myrmicinae Malagasy is represented by 4 tribes: Attini, Crematogastrini, Solenopsidini, Stenammini.

1 – In full-face view, occipital portion posterior to the ocellar region elongated to a long neck; in profile, occipital carina strongly developed, forming a nuchal collar (Fig. 4A) 2

Stenammini

– In full-face view, occipital portion posterior to the ocellar region broadened; in profile, occipital carina invisible or lamellate without a raised crest (Fig. 4B).....2

“Insert Figure 4 here”

2(1) – With the head in full-face view, head width at the level of mandibular insertion less than half of the maximum head width (HW1) and if not, the forewing 2r-m present (Fig. 5A) **Attini**

– With the head in full-face view, head width at the level of mandibular insertion is more than half of the maximum head width (HW1). (Fig. 5B).....**3**

“Insert Figure 5 here”

- 3(2) – Abdominal segment III dorsally or broadly attached to abdominal segment IV. (Fig. 6A)..... **Crematogastrini (Part 1)**
- Abdominal segment III narrowly attached to abdominal segment IV. (Fig. 6B).....**4**

“Insert Figure 6 here”

- 4(3)– Head (excluding mandible) slightly longer than broad (Fig. 7A)..... **Solenopsidini**
- Head (excluding mandible) at least 1 1/3 times as long as broad. (Fig. 7B).....**Crematogastrini (Part 2)**

“Insert Figure 7 here”

Male-based key to genera of the tribe Solenopsidini in the Malagasy region

The tribe Solenopsidini is represented by five genera: *Adelomyrmex*, *Erromyrmex*, *Monomorium*, *Solenopsis* and *Syllophopsis* in the Malagasy region.

- 1– Antennae 12-segmented.....***Solenopsis***
- Antennae 13-segmented.....**2**
- 2(1) – First basal funicular subglobular (Fig. 8A); masticatory margin of mandible with exactly 4 teeth.....***Erromyrmex***
- First basal funicular not globular, more cylindrical (Fig. 8B).....**3**

“Insert Figure 8 here”

- 3(2) – Forewing with five closed cells, m–cu vein present (Fig. 9A). In profile, petiole pedunculate (Fig. 9C); masticatory margin of mandible with 3 teeth.....***Syllophopsis***
- Forewing with four closed cells, m–cu vein absent (Fig. 9B). In profile, petiolar peduncle absent or shorter than postpetiolar length (Fig. 9B).....**4**

“Insert Figure 9 here”

- 4(3) – Mandible with rounded basal margin; masticatory margin with 3 to 4 teeth (Fig. 10A).....***Monomorium***
- Mandible linear and pointed with a single large tooth (Fig. 10B) (Seychelles).....***Adelomyrmex***

“Insert Figure 10 here”

Comments

Solenopsidini tribe is easily separated from other Malagasy myrmicine tribes by the following combination of characters: with the head in full-face view, mandibles reduced; antennal scrobe clearly absent; first basal flagellar segment not more elongated than the remaining segments; ocelli moderate and situated on the frontal face of the head, lateral ocelli directed toward oblique front sides; occipital carina invisible; head (excluding mandible) slightly longer than broad. In lateral view, the anterodorsal margin of mesopleuron lower than the highest point of the wing process; forewing venation: cross vein 2r-m absent, radial sector down curved and never reaching to the costal margin; propodeal spines absent; pygostyle present; abdominal segment III attached anteriorly to abdominal segment IV; single tibial spur present on the front leg. In dorsal view, notauli absent.

Eromyrma can be distinguished from three other genera *Adelomyrmex*, *Monomorium* and *Sylophopsis* by its first basal flagellar subglobular segment. It can be easily separated from the genus *Solenopsis* by the number of its antennal segment.

Discussion

In the Malagasy region, *Eromyrma latinodis* was collected from Comoros, Madagascar, and Mayotte (See Table 1). The species inhabits montane rainforest, mangrove, Uapaca woodland, dry forest, and anthropogenic habitats from elevations of 2 to 1726 meters. Workers were collected from a range of microhabitats and methods including from foraging on low vegetation or on the ground or collected in ground nests, sifted litter, under stones, rotten wood or from dead twigs above ground. The males were collected along with workers and queens under bark on the main trunk Mango tree along a village road.

The males for this species were only collected after six expeditions to locate the males. The males of this species were not collected by traditional means of collecting males. For example, they were not present in any of the Malaise traps sampling or UV light samples from the region. Initial expeditions to known localities in northern Madagascar did not find the males. Colonies were kept a live for over a year without the production of males. Two males were finally found at one of the known collection sites.

The C01 data confirms the identification of the males and also shows an interesting pattern of 0% sequence divergence between the samples from Madagascar, Comoros and Mayotte. The lack of sequence divergence across island systems supports the hypothesis that this species is introduced in the region. Low sequence diversity could also be explained by other factors such as reproductive systems. The difficulty of finding males could be linked to a reproductive system that would reduce sequence divergence.

Acknowledgements

I would like to express my special thanks of gratitude to everyone at the Madagascar Biodiversity Center. Team Vitsika gave me the opportunity to do this project. We are grateful to Balsama Rajemison, Jean Claude Rakotonirina, Andrianjaka Ravelomanana, Tanjona Ramiadantsoa, Jean-Jacques Rafanomezantsoa, Chrislain Ranaivo, Nicole Rasoamanana, Claver Randrianandrasana, Miranto Razafindranaivo. We thank Stefan Cover, Whit Farnum and Crystal Maier for providing access and imaging the type specimens of *Monomorium latinodoides* Wheeler, 1928. The research was supported by the Lakeside Foundation Funds of the California Academy of Sciences.

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Table and figure captions

Table 1. *Erromyrmex latinodis* specimens sequenced for mitochondrial cytochrome oxidase I (COI) gene, including Genbank accession number, and caste. All voucher specimens are housed at the California Academy of Sciences.

Figure 1: Illustration of measurement of *Erromyrmex latinodis* (CASENT0788835) **A**: head in full face view. **B**: body in dorsal view. **C**: body in lateral view.

Figure 2: *Erromyrmex latinodis* (CASENT0788835) **A**: Head in full-face view. **B**: Body in dorsal view. **C**: Body in lateral view.

Figure 3: Male forewing veins of *Erromyrmex latinodis* (CASENT0788835). Abbreviations: **C** costa; **Pt** pterostigma; **Sc** subcosta; **R**, **r** radius; **Rs**, **rs**, radial sector; **M**, **m**, media; **Cu** cubitus; **A**, **a**, anal.

Figure 4: Body in profile view, showing occipital carina. **A**: *Aphaenogaster bressleri* (CASENT0495103). **B**: *Cataulacus mg01* (CASENT0071712).

Figure 5: Head in full-face. **A**: *Strumigenys ambatrix* (CASENT0135807). **B**: *Calyptomyrmex km01* (CASENT0136409).

Figure 6: Body in lateral view. **A**: *Carebara jajoby* (CASENT0494540). **B**: *Crematogaster maina* (CASENT0132785). **C**: *Meranoplus mayri* (CASENT0062813).

Figure 7: Head in full-face view. **A**: *Erromyrmex latinodis* (CASENT0788835). **B**: *Eutetramorium mocquerysi* (CASENT049519).

Figure 8: Head in full-face view showing the basal funicular. **A**: *Erromyrmex latinodis* (CASENT0788835). **B**: *Sylophopsis cryptobia* (CASENT0103340).

Figure 9: In profile view showing forewing, petiole and post petiole. **A-C**: *Sylophopsis modesta* (CASENT0135642). **B**: *Monomorium nigrican* (CASENT0440974). **D**: *Monomorium termitobium* (CASENT0135952).

Figure 10: Mandible in frontal view. **A**: *Monomorium madecassum* (CASENT0209350) **B**: *Adelomyrmex sc01* (CASENT0160764).

Figure 11. Distribution of *Erromyrmex latinodis* in the Malagasy region. Red indicates localities of sequenced specimens.