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# INSECTA MUNDI

0860

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Date of issue: April 30, 2021

Center for Systematic Entomology, Inc., Gainesville, FL

**Perger R, Rubio GD. 2021.** A new species of *Myrmecotypus* Pickard-Cambridge spider (Araneae: Corinnidae: Castianeirinae) from the Bolivian orocline, imitating one of the world's most aggressive ants. Insecta Mundi 0860: 1–8.

Published on April 30, 2021 by
**Center for Systematic Entomology, Inc.**
P.O. Box 141874
Gainesville, FL 32614-1874 USA
http://centerforsystematicentomology.org/

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0860: 1–8 **INSECTA MUNDI** 2021

# A new species of *Myrmecotypus* Pickard-Cambridge spider (Araneae: Corinnidae: Castianeirinae) from the Bolivian orocline, imitating one of the world's most aggressive ants

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**Abstract.** A new species of ant-mimicking spider of the subfamily Castianeirinae, *Myrmecotypus rubrofemoratus* Perger and Rubio, **new species** (Araneae: Corinnidae), is described from the Pre-Andean area of the Bolivian orocline. Adults of *M. rubrofemoratus* **new species** resemble the carpenter ant *Camponotus femoratus* Forel, 1907, which is considered one of the most aggressive ants in the world.

**Key words.** Arachnid, Bolivia, *Camponotus femoratus*, myrmecomorph, South America.

**ZooBank registration.** urn:lsid:zoobank.org:pub:2C1B4417-EA20-48E5-80CF-02AC96976CE0

## Introduction

The Neotropical castianeirine genus *Myrmecotypus* Pickard-Cambridge is a group of slender, fast-running spiders that includes 11 species (World Spider Catalog 2020). Four species are reported from South America and three from Bolivia: *M. iguazu* Rubio and Arbino, 2009, *M. niger* Chickering, 1937, and *M. tahyinandu* Perger and Rubio, 2020 (Perger and Rubio 2020a).

Potential ant models were proposed for six species of *Myrmecotypus* (Perger and Rubio 2020a). These forms resemble morphologically specific models of the ant tribes Camponotini and Dolichoderini; all models and mimics share a moderately elongated, truncate forebody, short petiole and sub-globose abdomen. Species-specific mimicry is indicated by similarities in body color and the color and distribution of setae (Perger and Rubio 2020a).

In the present study, we describe a new species that closely resembles *M. niger* but shows, apart from distinct genitalia, differences in externally visible morphology that could be possibly attributed to the selection for mimicry of the carpenter ant *Camponotus femoratus* (Fabricius, 1804), one of the world's most aggressive ants.

## Materials and Methods

Spiders and ants were collected with a beating tray with a 1 $m^2$ white sheet from vegetation up to 1.85 m high. For beating, mid- and understory branches were sharply struck with a stout stick, while holding the beating tray beneath them to catch falling spiders and ants. Photographs of living spiders and ants and their habitats were taken with a Panasonic Lumix GX-80 system camera fitted with a Panasonic H-HS3030 macro lens. Color was described from photos of live specimens. Spiders were euthanized with ethyl acetate and stored in 80% ethanol. Preserved specimens were examined in 70% ethanol under a SMZ-U Nikon dissection microscope and identified using published descriptions and keys (e.g., Reiskind 1969; Rubio and Arbino 2009; Leister and Miller 2014; Perger and Rubio 2020a).

Female genitalia were dissected as in Levi (1965), examined after digestion in hot ~15% NaOH solution, and clarified in clove oil to examine the internal structures. Temporary preparations were observed and photographed using a Leica DM500 compound microscope and a Leica M60 stereomicroscope. Structures were sketched on incident light photograph models using a computer system for drawing and treatment of the image (Wacom digitizer tablet with GIMP, free software).

The descriptions refer to adult specimens. Morphological terms and description formats follow the recent studies on castianeirine spiders (Rubio and Arbino 2009; Leister and Miller 2014). Photos were taken with a BK Plus Lab System by Dun, Inc. with a Canon 5DS Macro camera and a Canon 65mm lens. All measurements, which were obtained with an ocular micrometer, are given in millimeters.

Body length (BL) measurement refers to the distance from the anterior margin of the carapace to the posterior margin of the abdomen. The cephalic width was measured at the level of the posterior eye row when viewed dorsally. The length of the dorsal and epigastric sclerite was measured without the petiole, which is separated from both of the aforementioned sclerites by a slight groove.

The following indices (*sensu* Reiskind 1969) were calculated: a) carapace index = carapace width / carapace length × 100; b) cephalic width index = cephalic width / carapace width × 100; c) sternum index = sternum width / sternum length × 100; d) abdomen index = abdomen widest width / abdomen length × 100.

The following abbreviations were used in the text: AER, anterior eye row; AME, anterior median eyes; ALE, anterior lateral eyes; PER, posterior eye row; PLE, posterior lateral eyes; PME, posterior median eyes.

Arachnological collections were abbreviated as follows (curators in parenthesis):

**CBF** Colección Boliviana de Fauna, La Paz, Bolivia (R. Perger)
**IBSI-Ara** Instituto de Biología Subtropical, Misiones, Argentina (G. Rubio)

**Ecoregion distribution.** The ecoregion affinities of the species were investigated by visualizing the coordinates and a shapefile of the regionalization of Bolivian ecosystems by Navarro and Ferreira (2011), by using the geographic information system QGIS (version 2.14.3, http://www.qgis.org/en/site/). Geographic coordinates are shown in decimal degrees with reference datum WGS84, and elevation in meters above sea level (m.a.s.l.).

**Ant mimicry.** In this study, an indirect, correlative method is employed to support mimicry, without studying the impact of receiver responses on mimic fitness. While correlations do not imply causality, correlative approaches are useful for investigating putative cases of resemblance between taxa and extrapolating the consequences of mimicry beyond a single, well-studied population (de Jager and Anderson 2019; Perger and Rubio 2020a, b). To illustrate adaptive divergence between mimetic and non-mimetic phenotypes, we identified derived traits in the mimic that likely evolved in association with species-specific models and receivers.

For the analysis of ant resemblance, we considered all ants that were collected in the surveyed locations and were about the same body length as the spiders. The similarity was analyzed, based on a qualitative, descriptive assessment of integument color, shine, development (e.g. appressed, erected, short, long) and color of hairs, and shape of body parts (e.g. abdomen shape: fusiform or ovate; apically pointed or rounded).

# Taxonomy

## Class Arachnida Cuvier, 1812
## Order Araneae Clerck, 1757
## Family Corinnidae Karsch, 1880
## Subfamily Castianeirinae Reiskind, 1969

### Genus *Myrmecotypus* O. Pickard-Cambridge, 1894

**Type species.** *Myrmecotypus fuliginosus* O. Pickard-Cambridge, 1894 (by original designation)

**Diagnosis.** Cephalic region wide (cephalic index range 64–89), carapace narrowed (carapace index <60), without thoracic groove but with slight depression instead; PER wider than AER and almost straight to moderately recurved, AME larger than ALE, PME–PME greater than PME–PLE, PLE situated close to lateral margin of

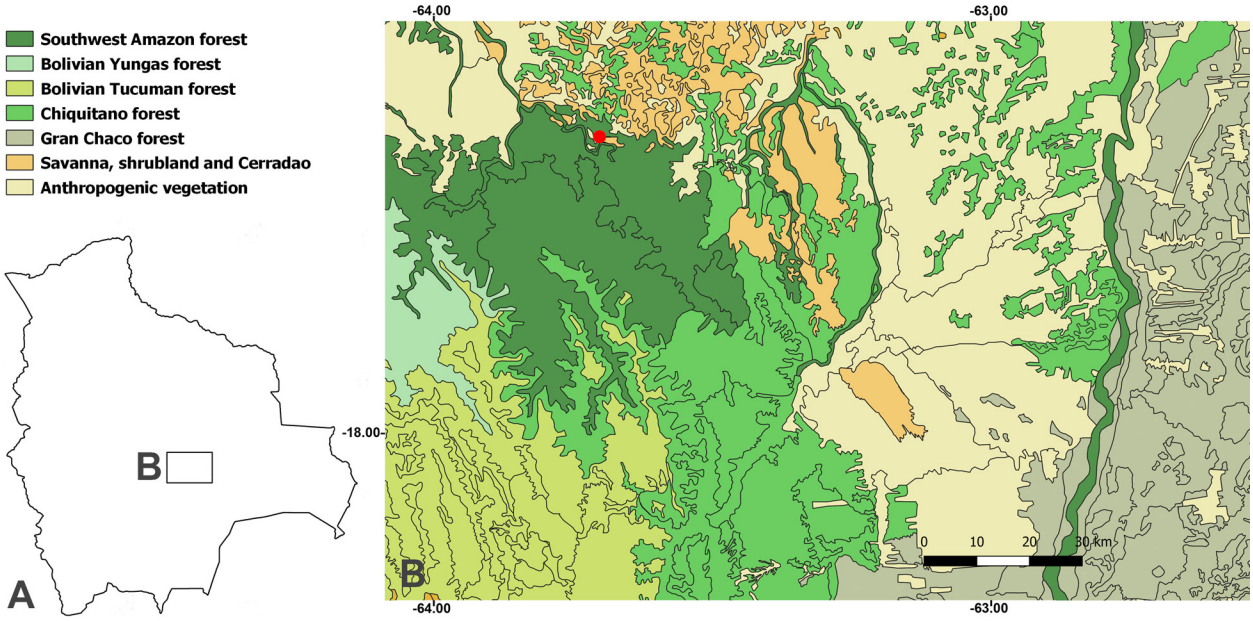


**Figure 1.** Ecoregion distribution of *Myrmecotypus rubrofemoratus* **new species**, according to the regionalization by Navarro and Ferreira (2011). Collection location indicated by red circle, map produced with QGIS (version 2.14.3, http:// www.qgis.org/en/site).

cephalic area; abdomen only very slightly petiolated; tibia I ventral spines paired in 2–2, 3–2, 3–3 or 4–4 arrangement; trochanter IV notch usually absent, with only a tiny one, if present (Perger and Rubio 2020a).

### *Myrmecotypus rubrofemoratus* Perger and Rubio, new species

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(Fig. 2–4, 5A, B)

**Type material.** Holotype ♂ (IBSI-Ara 1507) and ♀ allotype (IBSI-Ara 1467): BOLIVIA: Santa Cruz department, Cafetal coffee plantation (−17.469167°; −63.6925°), 3 km west of Buena Vista village, 342 m a.s.l., Pre-Andean southwest Amazon rainforest, edge of primary forest, small trees overgrown by climbing plants, beating tray sampling, 20–22 Jan 2016, leg. R. Perger. Paratypes same data as the holotype, 1 ♀ (IBSI-Ara), 3 ♀ (CBF).

**Diagnosis.** *Myrmecotypus rubrofemoratus* **new species** and *M. niger* are the only known species of this genus with a band of black setae with the shape of an inverted "U" on the carapace (Fig. 5A, B), running dorsally from the level of coxae I to the carapace margin at about the level of coxae III. Additionally, both species share a similar carapace shape, translucent whitish coxa II and the remaining darker, and a globose male genital bulb with a short neck and at least one terminal projection of the tegulum basal to the embolus.

*Myrmecotypus rubrofemoratus* **new species** can be separated from *M. niger* by a narrower sternum (index ~44) (50–57 in *M. niger*), chelicerae with one promarginal tooth (and a small distal denticle) (two teeth and a small distal denticle in *M. niger*), legs with reddish areas, particularly on femora (Fig. 4, 5A) (more brownish in *M. niger*; cf. Fig. 5A with Perger and Rubio 2020a: 160, fig. 7F), embolus slightly curved and a tegular projection basal to embolus, consisting of two structures resembling a squid beak (Fig. 3A) (embolus straight and one hooked tegulum projection in *M. niger*; cf. Fig. 3A with Reiskind 1969: 319, fig. 244), tibia I ventral spination 3-3 in male and 5-5 in female (4-4 in both sexes of *M. niger*), length of dorsal sclerite in female two-third of length of abdomen (three-fourth in *M. niger*), transversal bands of white setae on abdomen absent (present in *M. niger*).

**Description of male holotype** (IBSI-Ara 1507) (Fig. 2, 3A). Body length 5.00; carapace length 2.75, width 1.24, carapace index 45.1; cephalic width 1.04, cephalic index 83.9; sternum length 1.27, width 0.57, sternum index 44.9; abdomen length 1.97, width 1.55, abdominal index 78.7; petiole length 0.15, width 0.24; dorsal sclerite

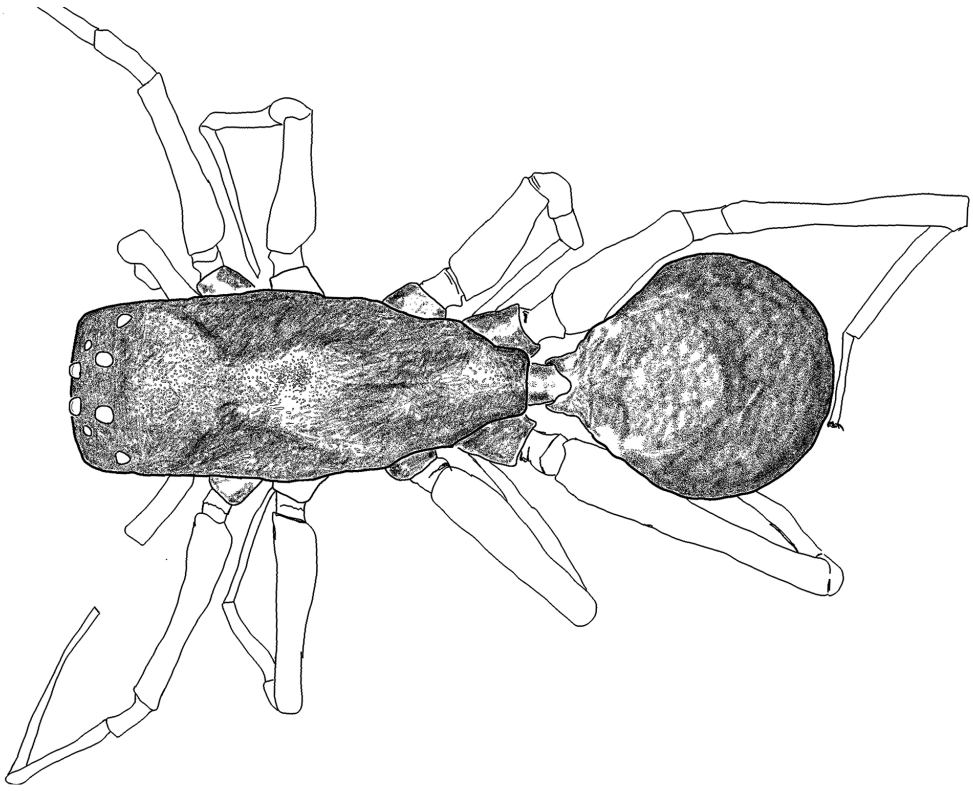

**Figure 2.** *Myrmecotypus rubrofemoratus* **new species**: Holotype male (IBSI-Ara 1507), dorsal.

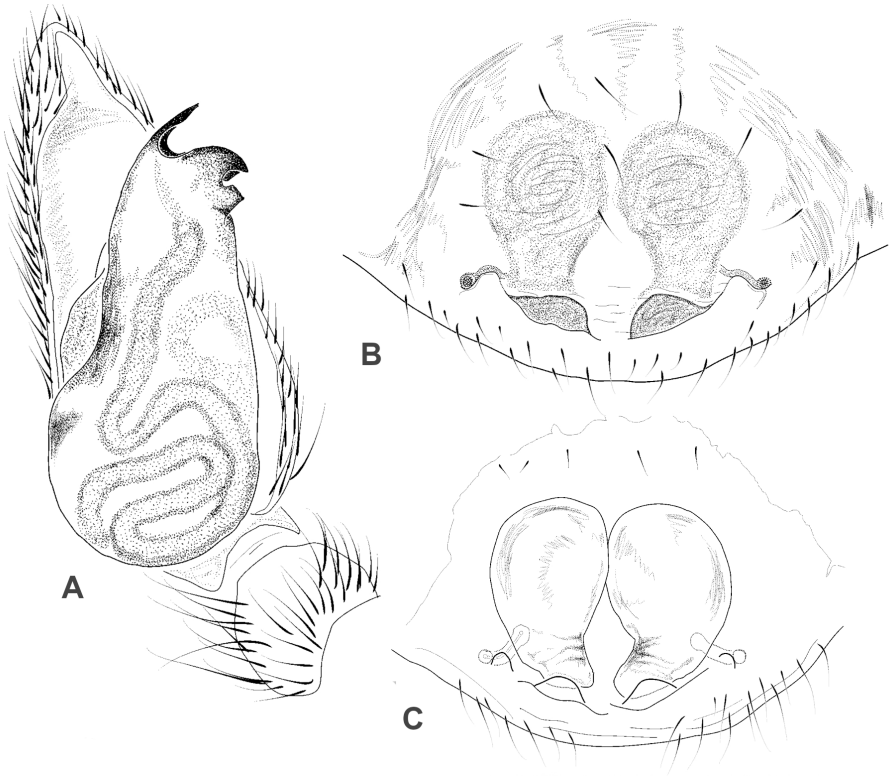


**Figure 3.** *Myrmecotypus rubrofemoratus* **new species**, genitalia. **A)** Palp male holotype (IBSI-Ara 1507), ventral view. **B–C)** Epigyne female allotype (IBSI-Ara 1467). **B)** Ventral. **C)** Same, cleared.


**Figure 4.** *Myrmecotypus rubrofemoratus* **new species**: Paratype female (CBF). **A)** Dorsal. **B)** Lateral (Please note that most hairs are broken off due to storage in ethanol). Scale bar 1 mm.

length and width agrees with abdominal width; epigastric sclerite length 0.52, width 0.97; inframamillary sclerite length 0.32, width 0.52. AER 0.57; AME-AME 0.10; AME-ALE 0.03; PER 0.92; PME-PME 0.26; PME-PLE 0.20.

*Carapace:* Obovoid, widest in middle, truncated anteriorly, front slightly convex, cephalic area laterally somewhat narrowed, slight concavity behind cephalic region when viewed laterally, thoracic part moderately convex behind concavity when viewed laterally; three slight concavities in posterior half of carapace when viewed dorsally, posterior margin straight. Dorsal integument littered with minute granules, more separated on cephalic area, latter moderately shiny, cephalic region laterally and thoracic region finely reticulated, weakly shiny; dorsum dark brown, short, appressed, simple, separate, brassy setae, relatively dense in the middle; narrow band of short, appressed black setae with shape of inverted "U", starting dorsally at level of coxa I and running to carapace margin at level of coxa III, black band posteriorly lined by narrow band of whitish setae (most setae broken off due to storage in ethanol).

*Eyes:* Eight eyes in two recurved rows; diameter AME about 20% larger than remaining, subequal eyes.

*Chelicerae:* 2 retromarginal teeth and 1 promarginal tooth (plus a distal denticle, hard to see).

*Abdomen:* Sub-globose, petiole only moderately developed, proximal margin strongly concave; dorsal scutum completely covering abdomen dorsally and laterally; inframamillary sclerite narrow, subrectangular, broader than long. Integument of dorsal sclerite littered with minute granules, finely reticulated, moderately shiny, dark brown; abdominal setae long, simple, not sclerotized, second pair longer than first; long, separate, erected, white

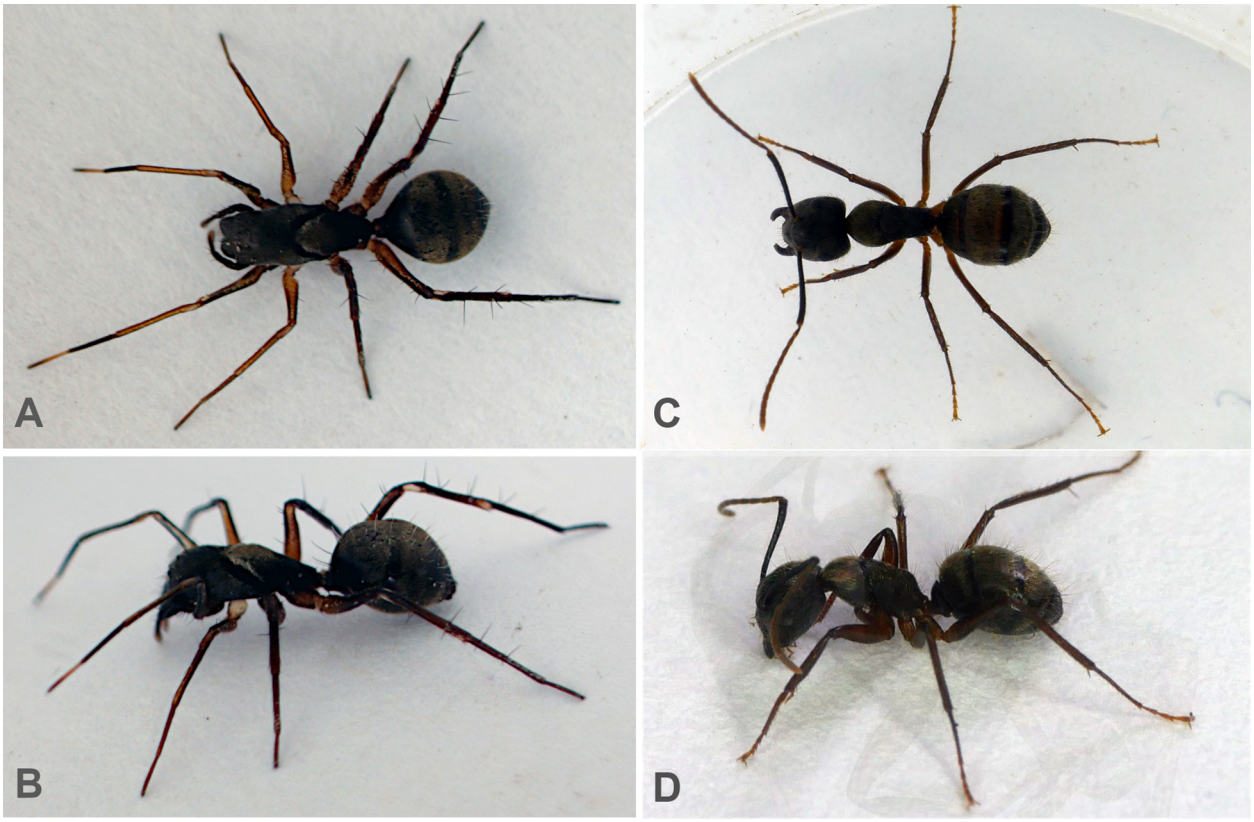


**Figure 5.** Comparison of ant-mimicking *Myrmecotypus* spider and potential ant model. **A–B)** *Myrmecotypus rubrofemoratus* **new species** female, habitus in life. **A)** Dorsal. **B)** Lateral. **C–D)** Potential ant model *Camponotus femoratus* (Fabricius, 1804). **C)** Dorsal. **D)** Lateral.

setae on dorsum, posterior two-third densely covered with simple and feathery, short, brassy setae, sparse in anterior third.

*Legs:* Coxa II translucent whitish, the remaining coxae reddish-brown; femora and tibia I+II reddish-brown, with longitudinal dark areas along edges, dark areas become broader distally; tibia III+IV and metatarsus III+IV blackish with a reddish tinge, metatarsus I and tarsus IV blackish, metatarsus and tarsus II reddish; tarsus I proximally reddish, distally blackish; legs mostly sparsely covered with fine, golden hairs, including feathery hairs, dense in some areas.

*Palp* (Fig. 3A): Margin of tibia continuous; tarsus with globose genital bulb drawn out into short neck, terminating in a slightly curved embolus and and a tegular projection basal to embolus, consisting of two structures resembling a squid beak, the basal smaller than the distal one; palpal ducts with several basal and one lateral loop.

**Female allotype** (IBSI-Ara 1467) (Fig. 3B, C). Body length 5.31; carapace length 2.75, width 1.35, carapace index 49.1; cephalic width 1.15, cephalic index 85.2; sternum length 1.30, width 1.75, sternum index 43.9; abdomen length 2.25, width 1.75, abdominal index 77.8; petiole length 0.20, width 0.30; dorsal sclerite length 1.40 (width agrees with abdominal width); epigastric sclerite length 0.62, width 0.71; inframamillary sclerite length 0.25, width 0.45. AER 0.63; AME-AME 0.10; AME-ALE 0.05; PER 0.97; PME-PME 0.26; PME-PLE 0.22.

Thoracic part dorsally more convex than in male, larger abdomen, smaller dorsal sclerite, ventral sclerite absent, tibia I ventral spination 5-5. Remaining somatic characters as in male.

*Epigyne* (Fig. 3B, C): With two widely separated, small rounded genital openings, posterolateral to spermathecae; two pouches (or furrows) slightly posterior and towards the middle of each opening (presumably for fitting of male tegular projections); conspicuous, eggplant-shaped spermathecae, copulatory ducts short, entering the spermathecae basally.

**Etymology.** The specific epithet, *rubrofemoratus*, refers to the reddish femora of this species.

**Geographical and ecoregion distribution.** This species is only known from the type locality in Buena Vista, Santa Cruz department, Bolivia. Specimens of *M. rubrofemoratus* **new species** were collected along an edge of a primary forest fragment, on small trees overgrown by climbing plants. According to the ecoregion delineation by Navarro and Ferreira (2011), the forest in this area is considered the Pre-Andean southwest Amazon rainforest (Fig. 1). Along the same forest edge, individuals of *M. niger*, *M. tahyinandu* and two species of *Castianeira* Keyserling were collected. However, individuals of all these species were obtained from different trees, co-occurring with different potential ant models (see below).

**Ant mimicry.** Adults of *M. rubrofemoratus* **new species** were obtained close to aggregations of the carpenter ant *Camponotus femoratus*. Both shared a similar body length (~5 mm), a dark brown body with appressed, short, brassy and erected, long, white setae and legs with reddish areas, forebody obovoid, truncate anteriorly and sub-globose abdomen (Fig. 5). During the beating tray collecting in branches with nests of *C. femoratus*, these ants immediately launched annoying mass attacks with several ants administering painful bites and spraying formic acid. The spiders appeared to avoid direct contact with the ants, as they were only collected in branches several meters away from the ants. In more distant areas of the sampled forest edge without *Camponotus femoratus*, no specimen of *M. rubrofemoratus* **new species** was found.

# Discussion

The morphological resemblance of *M. rubrofemoratus* **new species** to *C. femoratus* (Fig. 5) supports the idea that *Myrmecotypus* species are generally selected for species-specific resemblance to members of Camponotini or Dolichoderini (Perger and Rubio 2020a). The potential mimetic relationship between *M. rubrofemoratus* **new species** and *C. femoratus* was additionally supported by microhabitat presence-absence pattern along the sampled forest edge and the absence of both species in locations where other castianeirine species with their potential specific ant model species were observed (see Perger and Perger 2017; Perger and Rubio 2020a). We assume that future surveys in Amazon forests, where *C. femoratus* can be commonly found (Vicente et al. 2014), will also reveal more specimens of *M. rubrofemoratus* **new species**. Although *C. femoratus* does not possess a stinger, similar to other Camponotini, the first authors' painful experience with the bites of this ant suggests that it represents a highly suitable model for mimetic relationships with castianeirine spiders. This territorially-dominant arboreal ant is considered one of the world's most aggressive ant species, defending its ant gardens with fierce mass attacks (Wilson 1987). *Camponotus femoratus* was also proposed as a model for black morphs of the castianeirine species *Myrmecium bifasciatum* Taczanowski, 1874 and *M.* cf. *gounellei* Simon, 1896 in the Brazilian Amazon forest (Oliveira 1988). Wilson (1987) hypothesized a mimetic relationship between the morphologically resembling *C. femoratus* and *Dolichoderus bidens* (Linnaeus, 1758) (cited as *Hypoclinea bidens*).

Considering the recent description of the closely related species *M. tahyinandu* and *M. iguazu* and their potential ant model species (Perger and Rubio 2020a), *M. rubrofemoratus* **new species** and *M. niger* comprise the second known pair of two closely related *Myrmecotypus* species in which externally visible differences are possibly attributed to the selection for resemblance to specific ant models. *Myrmecotypus rubrofemoratus* **new species** and *C. femoratus* have reddish legs and lack bands of white setae on the abdomen, whereas *M. niger* and its model *Dolichoderus bispinosus* (Olivier, 1792) have such bands of white setae and more brownish legs with reddish trochanters (cf. Perger and Rubio 2020a). With the description of an additional pair of *Myrmecotypus* and *Camponotus* species with close morphological resemblance, another promising example for the study of ant mimicry becomes available.

# Acknowledgments

Many thanks are extended to Jonathan Reiskind (Department of Biology, University of Florida) and Cristian J. Grismado (División Aracnología, Museo Argentino de Ciencias Naturales "Bernardino Rivadavia"- CONICET, Argentina) for reviewing the manuscript, and to Claudio J. Silva-Junior (Museu Paraense Emílio Goeldi-MPEG, Belém, Pará, Brazil) for commenting on the manuscript.

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**Received February 25, 2021; accepted March 11, 2021.**
**Review editor Lawrence Hribar.**