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Morfologia de machos de formigas cultivadoras de fungos: Contribuições para a taxonomia de *Mycocepurus* Forel, 1893 e *Mycetomoellerius* Solomon et al., 2019

Carlos Daniel Assis dos Santos
Magister Scientiae

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Dissertation submitted to the Entomology Graduate Program of the Universidade Federal de Viçosa in partial fulfillment of the requirements for the degree of *Magister Scientiae*.

Adviser: Jose Eduardo Serrao

Co-advisers: Tathiana G. Sobrinho
Júlio Cézar Mário Chaul

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ABSTRACT

SANTOS, Carlos Daniel Assis dos, M.Sc., Universidade Federal de Viçosa, February, 2025. **Morphology of male gungus-growing ants: Contributions to the taxonomy of *Mycocepurus* Forel, 1893 and *Mycetomoellerius* Solomon et al., 2019**. Adviser: Jose Eduardo Serrao. Co-advisers: Tathiana Guerra Sobrinho and Júlio Cézar Mário Chaul.

Fungus-growing ants (Attina) are a monophyletic group within the Attini (Formicidae: Myrmicinae), which includes species that specialize in fungal cultivation. Recent studies have highlighted significant taxonomic and phylogenetic changes, such as genus revisions and the description of new species, revealing gaps in the knowledge of reproductive caste morphology, particularly in males. Workers are the main focus to determine synapomorphies and species delimitations among ant genera. However, males play a fundamental role in ant taxonomy because their external morphology and genitalia have taxonomic potential. In this context, the present study redescribes the males of two Mycocepurus species (*M. goeldii* and *M. smithii*) and describes two new *Mycetomoellerius* species, providing an identification key and updated diagnoses for the genera *Mycetomoellerius*, *Paratrachymyrmex*, and *Trachymyrmex*.

Keywords: Attini; Myrmicinae; Species description; Comparative morphology

RESUMO

SANTOS, Carlos Daniel Assis dos, M.Sc., Universidade Federal de Viçosa, fevereiro de 2025. **Morfologia de machos de formigas cultivadoras de fungos: Contribuições para a taxonomia de *Mycocepurus* Forel, 1893 e *Mycetomoellerius* Solomon et al., 2019**. Orientador: Jose Eduardo Serrao. Coorientadores: Tathiana Guerra Sobrinho e Júlio Cézar Mário Chaul.

As formigas cultivadoras de fungos (Attina) constituem um grupo monofilético de Attini (Formicidae: Myrmicinae), que inclui espécies especializadas no cultivo de fungos. Estudos recentes destacam mudanças taxonômicas e filogenéticas significativas, como a revisão de gêneros e a descoberta de novas espécies, evidenciando lacunas no conhecimento da morfologia das castas reprodutivas, especialmente os machos. As operárias são tipicamente o foco principal e frequentemente os primeiros objetos de estudo para a determinação de sinapomorfias e a delimitação de espécies entre os gêneros. Porém, os machos podem ter um papel fundamental na taxonomia das formigas, uma vez que, além de sua morfologia externa, sua genitália possui potencial taxonômico. Neste contexto, o presente estudo redescreve machos de duas espécies de *Mycocepurus* (*M. goeldii* e *M. smithii*), e descreve duas novas espécies de *Mycetomoellerius*, fornecendo uma chave de identificação e diagnósticos atualizados para os gêneros *Mycetomoellerius*, *Paratrachymyrmex* e *Trachymyrmex*.

Palavras-chave: Attini; Myrmicinae; Descrição de espécies; Morfologia comparada

SUMÁRIO

1. INTRODUÇÃO GERAL

A Myrmicinae Lepeletier de Saint-Fargeau, 1835 é subfamília mais diversa dentre os Formicidae Latreille, 1802, com 7207 espécies válidas descritas, distribuídas em 6 tribos e 148 gêneros (BOLTON, 2024). Essa subfamília possui distribuição global, ocorrendo em praticamente todas as regiões do mundo, exceto nas áreas como os polos e regiões de clima polar (WARD et al., 2015). No entanto, sua maior diversidade e predominância são observadas na região Neotropical, onde a combinação de clima favorável e a presença de vastas florestas de angiospermas proporcionam condições ideais para sua diversificação (WARD et al., 2015; WILSON & HÖLLDOBLER, 2005). Recentemente, a classificação de Myrmicinae passou por revisões taxonômicas que reduziram o número de tribos de 25 para 6, todas monofiléticas (WARD et al., 2015; BOLTON, 2024). Com cerca de metade das espécies descritas de Formicidae, Myrmicinae destaca-se como um dos grupos mais representativos e ecologicamente importantes da família.

Myrmicinae é formada por representantes de Myrmicini Lepeletier de Saint-Fargeau, 1835, Pogonomyrmecini Ward et al., 2015, Stenammini Ashmead, 1905, Solenopsidini Forel, 1893, Attini Smith, 1858 e Crematogastrini Forel, 1893 (WARD et al., 2015). A maior diversidade de espécies está concentrada em Crematogastrini, que se destaca nos trópicos do Velho Mundo (BLAIMER et al., 2018). Attini é a segunda maior tribo em número de espécies e possui predominância na região Neotropical (WARD et al., 2015). A diversidade apresentada por essas duas tribos é resultado de diversificação que ocorreu no início e no meio do Eoceno, especialmente no chamado Ótimo Climático do Eoceno Inicial (EECO), há 51-53 milhões de anos (WARD et al., 2015; BLAIMER et al., 2018).

Attini teria se originado nos Neotrópicos por volta de 67 milhões de anos, no final do Cretáceo, e passou por processos de diversificação e eventos de dispersão para outras regiões (WARD et al., 2015). Possui atualmente 48 gêneros e 2693 espécies viventes, juntamente com um gênero e 36 espécies extintas (BOLTON, 2024). Em relação aos hábitos, dois principais grupos de especialistas se destacam: as especialistas em predação, denominadas "*Daceton* genus-group", e as especializadas no cultivo de fungos, conhecidas como "Attina" (BRANSTETTER et al., 2017).

Os dois grupos formam um clado dentro de Attini, compartilhando uma possível origem a partir de formigas caçadoras-coletoras que posteriormente se especializaram (BRANSTETTER et al., 2017). O grupo-*Daceton* é caracterizado por apresentar formigas com mandíbulas alongadas, muitas das quais são consideradas "trap-jaw", sendo predadoras

(GRONENBERG, 1996; SOSA-CALVO et al., 2010). Já Attina, é um grupo de formigas cultivadoras de fungos Agaricales, dos quais se alimentam (MEHDIABADI et al., 2012).

Atualmente, as formigas cultivadoras de fungo possuem cerca de 250 espécies distribuídas em 20 gêneros, com predominância de espécies Neotropicais (BRANSTETTER et al., 2017; HANISCH et al., 2022; BOLTON, 2024). A especialização dessas formigas em cultivar fungos surgiu no Cretáceo-Paleógeno (K-Pg) (BRANSTETTER et al., 2017). As condições proporcionadas pelas colônias de formigas para os fungos, juntamente com a redução dos recursos alimentares disponíveis para as formigas, foram provavelmente fatores cruciais para a coevolução desses dois grupos (BRANSTETTER et al., 2017; MEHDIABADI et al., 2012). Além da coevolução com os fungos, os gêneros de Attina passaram por significativos processos de diversificação durante o Eoceno, juntamente com outros gêneros de Attini (WARD et al., 2015; BRANSTETTER et al., 2017).

As Attina são divididas em dois principais grupos denominados "Paleoattina" e "Neoattina" (SCHULTZ & BRADY, 2008). Essa divisão foi estabelecida por KUSNEZOV (1963), destacando características de cada grupo e relacionado aos processos de diversificação das espécies em ambientes úmidos e secos (BRANSTETTER et al., 2017). A história evolutiva dos gêneros de Paleoattina está ligada a ambientes úmidos, enquanto os de Neoattina estão associados a ambientes secos (KUSNEZOV, 1963; BRANSTETTER et al., 2017). Os ancestrais de Attina possivelmente desenvolveram o hábito de cultivar fungos em florestas tropicais úmidas, no entanto, a domesticação real desses fungos ocorreu em ambientes considerados secos (BRANSTETTER et al., 2017).

As Paleoattina abrangem três gêneros que acumulam uma maior quantidade de características plesiomórficas (KUSNEZOV, 1961; KUSNEZOV, 1962; KUSNEZOV, 1963). Os gêneros *Apterostigma* Mayr, 1865, *Myrmicocrypta* Smith, 1860 e *Mycocepurus* Forel, 1893 compõem as Paleoattina e apresentam as seguintes sinapomorfias: pedicelo antenal curto nos machos (SOSA-CALVO & SCHULTZ, 2010), presença de uma "fenestra" (mancha clara) única apenas nas asas das rainhas (EMERY, 1913; EMERY, 1922), e pecíolo com pedúnculo longo (SOSA-CALVO et al., 2013). Em contraste, as Neoattina incluem os outros 17 gêneros de formigas cultivadoras de fungos, que compartilham as sinapomorfias: escapo antenal longo nos machos, pedicelo antenal do macho mais longo que o primeiro flagelômero e o pedúnculo do pecíolo levemente séssil (SOSA-CALVO et al., 2013).

Embora todas as Attina mantenham uma relação mutualística obrigatória com seus fungos cultivados, nem todos os fungos desta associação estão intimamente ligados às formigas de maneira obrigatória (MEHDIABADI et al., 2012). As associações das formigas com os fungos são classificadas em cinco sistemas de agricultura, refletindo uma série de relações entre cada gênero ou espécie e seus fungos cultivados (MUELLER et al., 2001; MEHDIABADI & SCHULTZ, 2010). Esses sistemas são: Agricultura inferior, Agricultura de levedura, Agricultura de fungos-de-coral, Agricultura superior e Agricultura de corte-de-folhas (MUELLER et al., 2001; MEHDIABADI & SCHULTZ, 2010). A agricultura de corte-de-folhas é o mais derivado, e em alguns casos, não é considerada como um sistema a parte, sendo uma derivação dentro da agricultura superior (SCHULTZ et al., 2024).

O primeiro sistema de agricultura praticado pelas primeiras formigas cultivadoras de fungos que deram origem aos demais grupos, é denominado agricultura inferior (SCHULTZ & BRADY, 2008). Nesse sistema, os fungos cultivados mantêm uma relação mutualística facultativa com as formigas e podem ocorrer livremente na natureza (SCHULTZ & BRADY, 2008). Possivelmente derivada da agricultura inferior, a agricultura de fungos-de-coral é exclusiva do grupo *pilosum* do gênero *Apterostigma*, sendo os únicos que cultivam fungos Pterulaceae (DENTINGER et al., 2009). A agricultura de levedura é praticada unicamente por espécies do grupo *rimosus* do gênero *Cyphomyrmex* Mayr, 1862, e seus fungos cultivados crescem em agrupamentos de nódulos unicelulares semelhantes a leveduras (SCHULTZ & BRADY, 2008). Na agricultura superior todos os fungos são mutualistas obrigatórios das formigas e não ocorrem de forma isolada na natureza, dependendo completamente das formigas para sobrevivência e dispersão (SCHULTZ et al., 2005, 2024). A agricultura de corte-de-folhas é considerada agricultura superior, sendo uma versão derivada praticada por um clado de formigas que cultivam seus jardins fúngicos com material vegetal fresco (SCHULTZ et al., 2005; SCHULTZ & BRADY, 2008).

Recentemente, a filogenia das formigas cultivadoras de fungos foi ampliada com a inclusão de um novo grupo praticante da agricultura inferior. O gênero *Paramycetophylax* Kusnezov, 1956, que havia sido previamente sinonimizado, foi reclassificado como um táxon válido (KLINGENBERG & BRANDAO, 2009). Estudos filogenéticos recentes posicionaram *Paramycetophylax* como grupo irmão do *Cyphomyrmex* grupo-*rimosus*, que pratica agricultura de levedura (HANISCH et al., 2022). Essa inclusão revelou que o gênero *Cyphomyrmex*, como tradicionalmente definido, é parafilético. A posição atual de *Paramycetophylax* na filogenia é particularmente relevante porque contribui para esclarecer as transições evolutivas entre os diferentes sistemas agrícolas, especialmente a mudança da agricultura inferior (que envolve o cultivo de fungos basais) para a agricultura de levedura. Essa transição é crucial para entender como as formigas cultivadoras de fungos diversificaram suas estratégias agrícolas ao longo da evolução, adaptando-se a diferentes recursos e ambientes (Mehdiabadi & Schultz, 2010; HANISCH et al., 2022).

Desde as primeiras revisões de *Cyphomyrmex*, a divisão do gênero em grupos distintos parafiléticos têm sido objeto de discussão (KEMPF, 1964; KEMPF, 1966). Anteriormente, *Cyphomyrmex* incluía, além dos grupos *rimosus* e *wheeleri*, o grupo *strigatus*, todos com diferenças relevantes que os separavam dentro do gênero (KEMPF, 1964; KEMPF, 1966). A primeira etapa para a estabilização taxonômica de *Cyphomyrmex* ocorreu com a transferência das espécies do grupo *strigatus* para *Mycetophylax* Emery, 1913 (SOSA-CALVO et al., 2017). Atualmente, com a divisão dos grupos *wheeleri* e *rimosus*, é necessário que ocorra a implementação de mudanças formais, como a separação de *Cyphomyrmex* em múltiplos gêneros ou a sinonímia de alguns grupos, para alcançar uma estabilização taxonômica definitiva (HANISCH et al., 2022).

Mycetosoritis Wheeler, 1907, que também pratica a agricultura inferior, passou recentemente por mudanças taxonômicas, com destaque para três espécies que foram transferidas: *Mycetosoritis aspera* (Mayr, 1887) [atualmente *Mycetophylax asper* (Mayr, 1887)], *Mycetosoritis clorindae* (Kusnezov, 1949) [atualmente *Mycetophylax clorindae* (Kusnezov, 1949)] e *Mycetosoritis explicata* Kempf, 1968 [atualmente *Xerolitor explicatus* (Kempf, 1968)] (SOSA-CALVO et al., 2017; SOSA-CALVO et al., 2018). A mudança mais significativa é que *Xerolitor explicatus* (Kempf, 1968) pratica a agricultura superior, ao contrário de *Mycetosoritis*, que pratica a agricultura inferior. Esse cenário taxonômico complexo é agravado pela dificuldade de amostragem de formigas de ambos os gêneros, o que, somado à escassez de material disponível, compromete a delimitação adequada das espécies (SOSA-CALVO et al., 2018).

Entre as formigas cultivadoras de fungos, a diversidade nos sistemas agrícolas é evidente em diferentes gêneros, sendo *Apterostigma* um exemplo importante por abrigar espécies que praticam três tipos distintos de agricultura (SCHULTZ, 2007; DENTINGER et al., 2009). Dentro de *Apterostigma*, o grupo *pilosum* pratica a agricultura de fungos-de-coral, o grupo *auriculatum* pratica a agricultura inferior, e a espécie *Apterostigma megacephala* Lattke, 1999 pratica a agricultura de corte-de-folhas (SCHULTZ, 2007; DENTINGER et al., 2009; Mehdiabadi & Schultz, 2010). Essa diversidade de práticas agrícolas sugere que *Apterostigma* ocupa uma posição crucial na compreensão das transições evolutivas entre os diferentes sistemas de cultivo dentro de Attina.

Dentre as Attina, *Apterostigma megacephala* Lattke, 1999 pertence a uma linhagem que divergiu antes das demais espécies do gênero *Apterostigma*, separando-se há cerca de 45 milhões de anos (SCHULTZ, 2007). Os parentes ancestrais de *A. megacephala* provavelmente praticavam a agricultura inferior e passaram a cultivar fungos derivados da agricultura superior por meio de transferência horizontal de cultivares (SCHULTZ et al., 2015). O fungo da agricultura superior, em especial o usado na agricultura de corte-de-folhas, *Leucoagaricus gongylophorus* Singer (Moller) (Leucocoprinae: Agaricaceae), é um cultivar derivado, com várias especializações resultantes de um processo de coevolução com as formigas que praticam a agricultura superior (SCHULTZ & BRADY, 2008; SCHULTZ et al., 2015). Além de *A. megacephala*, *L. gongylophorus* também é cultivado por espécies de *Mycetomoellerius* Solomon et al., 2019, que assim como *Apterostigma*, tem espécies que praticam três diferentes tipos de agricultura, mostrando uma plasticidade em relação aos sistemas de cultivo (SOLOMON et al., 2019).

A taxonomia das formigas cultivadoras de fungos passa por constantes mudanças, e a identificação adequada das espécies, bem como sua correta delimitação entre os gêneros, é crucial para a construção de uma filogenia robusta, embora nem sempre essas mudanças reflitam diretamente avanços filogenéticos, mas problemas históricos que ainda precisam ser ajustados (HANISCH et al., 2022). Entre as principais dificuldades nos estudos das Attina, destacam-se não apenas a escassez de amostras de gêneros ou espécies raros, como *Xerolitor* Sosa-Calvo et al., 2018, *Mycetosoritis* e *Mycetagroicus* Brandão & Mayhé-Nunes, 2001 (SOSA-CALVO et al., 2017; SOSA-CALVO et al., 2018), mas também desafios ligados à morfologia convergente, à identificação de características diagnósticas frágeis e às divergências entre dados moleculares e morfológicos. Além disso, é possível que outros gêneros surjam à medida que os estudos avancem, com grupos de espécies sendo transferidos e outros sendo elevados ao nível de gênero, como ocorreu com *Xerolitor* (SOSA-CALVO et al., 2018) e como pode acontecer com o grupo *wheeleri* de *Cyphomyrmex* (HANISCH et al., 2022).

Em formigas, as operárias são tipicamente o foco principal e frequentemente os primeiros objetos de estudo para a determinação de sinapomorfias e a delimitação de espécies entre os gêneros (BRANDÃO & MAYHÉ-NUNES, 2007; KELLER, 2011; BACCARO et al., 2015; BOROWIEC, 2016). As larvas também possuem potencial, sendo importantes fontes de sinapomorfias e contribuindo com dados de citogenética (SCHULTZ & MEIER, 1995; SOSA-CALVO et al., 2013). Os indivíduos reprodutivos são relativamente menos estudados, especialmente os machos, que possuem vida efêmera, são difíceis de amostrar e de se identificar adequadamente, devido à sua morfologia relativamente diferente em comparação com as fêmeas (BOUDINOT, 2013; BOUDINOT, 2019).

Normalmente, para se garantir uma identificação precisa dos machos, eles são coletados diretamente das colônias, uma vez que dessa forma, são seguramente associados às operárias que são de fácil identificação. No entanto, nem sempre é possível realizar esse tipo de associação, o que limita a identificação, já que em outros métodos de coleta, nos quais eles são coletados individualmente, a identificação se torna difícil devido às diferenças em sua morfologia em comparação com as fêmeas (BOUDINOT, 2013; YOSHIMURA & FISHER, 2012; BOROWIEC, 2016).

Os machos desempenham um papel fundamental na taxonomia e filogenia das formigas, uma vez que, além de sua morfologia externa, sua genitália possui potencial taxonômico e filogenético, com variações e padrões diagnósticos para cada gênero (BRADY & WARD, 2005; LAPOLLA et al., 2012; YOSHIMURA & FISHER, 2012). No entanto, no caso das Attina, os estudos com machos são escassos, representando um déficit Haeckeliano (FARIA et al., 2020), com pouco conhecimento sobre suas genitálias, e poucos trabalhos dedicados a descrevê-las (JEŠOVNIK & SCHULTZ, 2017; SOSA-CALVO et al., 2017; SOSA-CALVO et al., 2018).

Este estudo tem como objetivo ampliar o conhecimento sobre a morfologia e taxonomia de formigas cultivadoras de fungos, fornecendo descrições morfológicas detalhadas e novos dados que auxiliem na identificação e delimitação de espécies. Para isso, o presente estudo está dividido em dois capítulos: o primeiro capítulo redescreve machos de *Mycocepurus goeldii* (Forel, 1893) e *Mycocepurus smithii* (Forel, 1893), enquanto o segundo descreve duas novas espécies de *Mycetomoellerius* Solomon et al., 2019, incluindo um macho, apresentando uma chave para as espécies do gênero, e incrementando as diagnoses em nível de gênero de *Mycetomoellerius*, *Paratrachymyrmex* e *Trachymyrmex*.

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Male genitalia of the fungus-growing ants *Mycocepurus goeldii* (Forel, 1893) and *Mycocepurus smithii* (Forel, 1893) (Hymenoptera: Formicidae: Myrmicinae)

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The male genitalia of insects are subject sexual selection pressure, resulting in a wide variety of morphologies among different species (Snodgrass, 1941; Eberhard, 1985). Understanding the reproductive biology of these organisms can be enriched by examining the evolutionary trends reflected in male genital morphology (Heinze *et al.* 2005; Boudinot, 2013). In ants, males are poorly studied, due to its ephemeral lifespan and difficult to sampling and identification (Yoshimura & Fisher, 2012; Boudinot, 2013; Boudinot, 2019). However, currently, some studies described the male morphology in some ants (Ješovnik & Schultz, 2017; Boudinot, 2019; Tozetto & Lattke, 2020; Dias & Lattke, 2021) but some gap remains in some non-cutter fungus-growing ants.

Mycocepurus is a genus of non-cutter fungus-growing ants that was created in 1893 to include two species: *Mycocepurus goeldii* (Forel, 1893) and *Mycocepurus smithii* (Forel, 1893). Subsequently, the genus was revised, including males and queens (Kempf, 1963). The male *M. goeldii* was described based on few characters, and its genitalia is known only from the penisvalve (Kempf, 1963). The *M. smithii* male described by Kempf (1963) is in fact *Mycocepurus obsoletus* Emery (Rabeling *et al.* 2009). Previously, *M. smithii* was considered asexual with thelytokous parthenogenesis (Rabeling *et al.* 2009), but genetic data and the discovery of spermatozoa in the spermatheca of females indicated the presence of males (Rabeling *et al.* 2011). Even so, males have only recently been found in populations of *M. smithii* that reproduce sexually (Barros *et al.* 2022).

With the discovery of males, it is now known that *M. smithii* has both sexual and asexual populations (Barros *et al.* 2022). In addition to this important discovery for ant species, *M. goeldii* queens have been observed to copulate with several males (Kerr, 1961), which is not common in lower fungus-growing ants (Lower Attina) (Mehdiabadi & Schultz, 2010; Branstetter *et al.* 2017). Understanding the evolutionary pressures behind these two behaviors is important, and an adequate description of the reproductive caste, especially males and their genitalia, plays a fundamental role in this process. Here we provide redescriptions for the males of *M. goeldii* and *M. smithii*.

Five males of *M. goeldii* from four different locations and eight of *M. smithii* from two different locations were studied. The males were deposited in the following repositories: Coleção Entomológica do Laboratório de Sistemática de Coleoptera at Universidade Federal de Viçosa, Minas Gerais, Brazil (CELC), Museu de Entomologia at Universidade Federal de Viçosa, Minas Gerais, Brazil (UFVB), and Coleção Entomológica Pe. Jesus Santiago Moure at Universidade Federal do Paraná, Curitiba, Paraná, Brazil (DZUP). The penisvalve and volsella of the males were mounted on slides. Images were obtained with a Leica M205A stereomicroscope with a Leica MC170 HD camera and an Olympus type "E Microscope Body" coupled with an Opton camera. Additional specimen data were uploaded to Antweb.org. Measurements were performed according to Chaul (2022) and are presented in millimeters.

Mycocepurus goeldii (Forel, 1893)

Measurements. (5 measured) HW 1.03–1.05, HW2 0.70–0.73, HL 0.79–0.84, SL 0.72–0.77, MssctmL 0.72–0.87, MssctmW 0.73–0.84, Mssctm+MssctlL 1.07–1.28, WL 1.72–1.82, PetW 0.21–0.29, PpetW 0.57–0.61, GW 1.17–1.31,

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G1L 0.97–1.03. *Pilosity and Sculpturing*. Body opaque, with reticulate-punctate sculpture. Pilosity appressed. *Head* (Figure 1.A). Mandible with oblique striations on the dorsal surface; masticatory margin with four to five teeth. Anterior margin of the clypeus convex, without an anteromedial notch; clypeus surface slightly elevated, with a pair of tiny median tubercles. Frontal lobes subquadrate. Frontal carina short, laterally directed. Eyes occupying at least half of the head in profile view; strongly bulging. Ocelli protruded from short projections. Scape extends beyond the vertexal margin by approximately ¼ of its length; flagellomere I (antennomere 3) 2.5x as long as pedicel. Occipital corners toothed. *Mesosoma* (Figure 1.B–C). Pronotum with two pairs of small spines. Notauli shallow, medially united, fainting posteromedially. Scutoscutellar sulcus deep. Mesoscutelum posterior margin with a pair of thick projections. Propodeum with a pair of projections, with upper projection triangular, low, lamellate. *Metasoma*. Petiole with developed peduncle; rounded petiolar node without projections, with only some rugose on its surface. Postpetiole subtrapezoidal in dorsal view, slightly wider posteriorly, with some rugose on its surface. First tergum of gaster as long as wide. *Wings* (Figure 2.A). Infuscated wings covered with microtrichia. Forewings with four closed cells (basal, costal, submarginal, and marginal 1+2). Semi-complete cubitus+anal vein, almost forming a subbasal cell. Pterostigma strongly pigmented. Hindwings without closed cells, with 1 single complete vein (subcostal), and 2 incomplete visible veins (anal and media+cubitus); eight hamuli. *Genitalia*. Parameres basally wide, internal face slightly concave, apex subquadrate and spatulate (Figure 2.C–D). Digitus of volsella elongate, L–shaped, inner margin strongly curved; cuspis not evident (Figure 2.J). Penisvalve with a serrated ventral margin that has four to five denticles (Figure 2.G, black triangle), apex with a broad, round lobe (Figure 2.G, red triangle), separated from the serrated margin by a deep notch; fin–like dorsomedial extension of the valviceps (Figure 2.G, gray triangle).

Comments. In the review of the genus, the male of *M. goeldii* is only briefly described, with an illustration of the penisvalve and few data about the external morphology (Kempf, 1963). The parameres, volsella, and penisvalve showed standard features of *Mycocepurus* species, such as the apex of the valviceps separated from the ventral margin by a deep notch and the presence of a dorsomedial extension. The male of *Mycocepurus castrator* Rabeling & Bacci, 2010, a social parasite of *M. goeldii*, also has the apex of the valviceps lobed. One male of *M. goeldii* (ANTWEB1047383) presented a slight variation in the morphology of the penisvalve with five denticles on the ventral margin instead of four, it was in accordance with other *M. goeldii* males in other respects of the external morphology.

Material examined. BRA: ES, Sooretama, Faz. São Francisco, -19.133333, -40.150000, 1–XII–2014, Lopez, J. I. B. (ANTWEB1047383). BRA: MG, Dionísio, -19.840055, -42.683192, 13-21-XI-89, Armad. Malaise, Área B1, de Campos W. G. (Five specimens with the following codes: ANTWEB1047344 and ANTWEB1047309). BRA: MG, Viçosa, Mata da Biologia, -20.758220, -42.865435, 15–XII–2012, Chaul, J. (UFV–LABECOL–004883). BRA: MG, Passos, -20.726040, -46.600053, 1962–X–4–10, Claudionor, E. (ANTWEB1047371).

Mycocepurus smithii (Forel, 1893)

Measurements. (5 measured) HW 0.77–0.82, HW2 0.53–0.57, HL 0.62–0.68, SL 0.47–0.53, MssctmL 0.58–0.68, MssctmW 0.57–0.62, Mssctm+MssctlL 0.86–0.95, WL 1.25–1.45, PetW 0.18–0.20, PpetW 0.36–0.40, GW 0.72–0.80, G1L 0.70–0.77. *Pilosity and Sculpturing*. Body opaque, with reticulate-punctate sculpture. Pilosity appressed. *Head* (Figure 1.D). Mandible with oblique striations on dorsal surface; masticatory margin with three teeth. Anterior margin of clypeus straight, without anteromedial notch; clypeus surface without evident median tubercles. Frontal lobes subquadrate. Frontal carina short, laterally directed. Eyes occupying at least half of the head in profile view; strongly bulging. Ocelli inserted into short, poorly developed projections. Scape reaching and exceeding the vertexal margin of the head by approximately ¼ of its length; flagellomere I 4x as long as pedicel. Occipital corners angled, forming inconspicuous teeth. *Mesosoma* (Figure 1.E–F). Pronotum with a pair of small tubercles. Notauli deep, sometimes poorly imprinted posteriorly. Scutoscutellar sulcus deep. Mesoscutelum posterior margin with a pair of two very short, blunt tubercles. Propodeum with a pair of blunt to sharp spines. *Metasoma.* Petiole with developed peduncle; petiolar node with the anterior portion rounded, and the posterior more straight, without projections. Postpetiole trapezoidal, wider posteriorly, in dorsal view. First tergum of gaster longer than wide. *Wings* (Figure 2.B). Heavily infuscated, covered with microtrichia. Forewing with four closed cells (basal, costal, submarginal, and marginal 1+2); semi-complete cubitus+anal vein, almost forming the subbasal cell; pterostigma inconspicuous. Hindwing without closed cell, with one single complete vein (subcostal) and two incomplete visible veins (anal and media+cubitus); 7 hamuli. *Genitalia*. Parameres tapering towards the apex, with blunt tips, and strongly curved internally (Figure 2.E–F). Digitus of volsella short, hook-shaped, internally slightly curved; cuspis not evident (Figure 2.K). Penisvalve with a serrated ventral margin that has nine denticles (Figure

2.H, black triangle), its apex with a acute lobe (Figure 2.H, red triangle), separated from the serrated margin by a deep notch; dorsomedial extension of the valviceps with a slightly conical tip (Figure 2.H, gray triangle).

Comments. *Mycocepurus smithii* is easily separated from *M. goeldii* by different states of the following characters: body size, number of projections on the pronotum, impression of the notauli, projections of the posterior margin of the mesoscutelum, infuscation of the wings, pterostigma pigmentation, shape of the parameres, shape of the volsella digitus, number of denticles on the ventral margin of the penisvalva, and shape of the apex of the valviceps after the notch. *Mycocepurus smithii*, also presented variation in the number of denticles on the ventral margin of the penisvalve: although nine denticles are more commonly found, seven denticles were found in one specimen (ANTWEB1047342). The male described by Kempf (1963) as *M. smithii* and that was later considered as *M. obsoletus* (Rabeling *et al.* 2009), lacks a well-defined lobe in the apex of the valviceps (Figure 2.I). Furthermore, the male *M. obsoletus* has five denticles on the ventral margin of the penisvalve. Noteworthy that although the presence of denticles in the penisvalve seems to be common in the genus, in the parasitic species *M. castrator* they are absent (Rabeling & Bacci, 2010).

Material examined. BRA: BA, Ilhéus, -14.796994, -39.043649, 10–III–1997, 5162, Ramos, L. S. (Three specimens with the following codes: ANTWEB1047310, ANTWEB1047311 and ANTWEB1047343). BRA: PA, Belém, -1.450043, -48.433290, X–2012, Barros, L. A. (Five specimens with the following codes: ANTWEB1047341, ANTWEB1047333, ANTWEB1047336, ANTWEB1047340 and ANTWEB1047342).

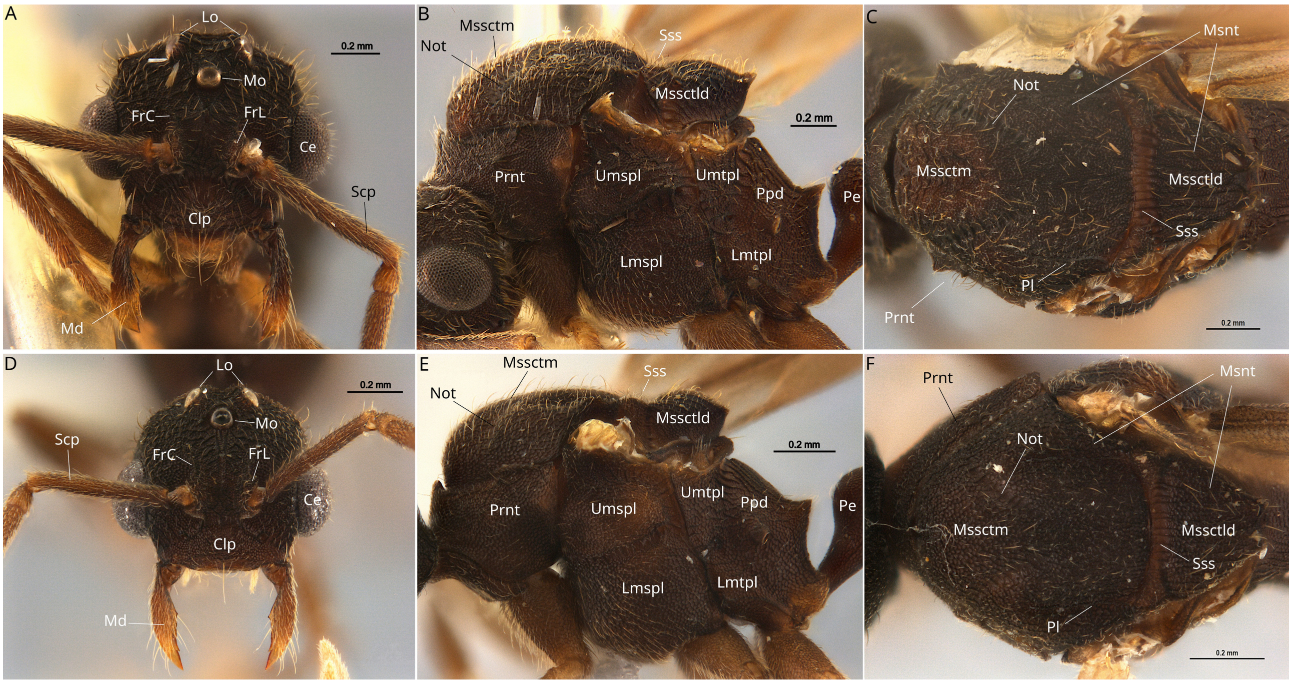

FIGURE 1. The male of *Mycocepurus goeldii* (ANTWEB1047309) and *Mycocepuru*s *smithii* (ANTWEB1047342). A–C, *M. goeldii* male in: full face-view, profile view focus on the mesosoma, dorsal view focus on the mesonotum, respectively. D–F, *M. smithii* male in: full face-view, profile view focus on the mesosoma, dorsal view focus on the mesonotum, respectively. Abbreviations: Ce, compound eye; Clp, clypeus; FrC, frontal carina; FrL, frontal lobe; Lmspl, lower mesopleuron; Lmtpl, lower metapleuron; Lo, lateral ocellus; Md, mandible; Mo, median ocellus; Msnt, mesonotum; Mssctld, mesoscutellar disc; Mssctm, mesoscutum; Not, notauli; Pe, Petiole; Pl, parapsidal line; Ppd, propodeum; Prnt, pronotum; Scp, antennal scape; Sss, scutoscutellar sulcus; Umspl, upper mesopleuron; Umtpl, upper metapleuron.

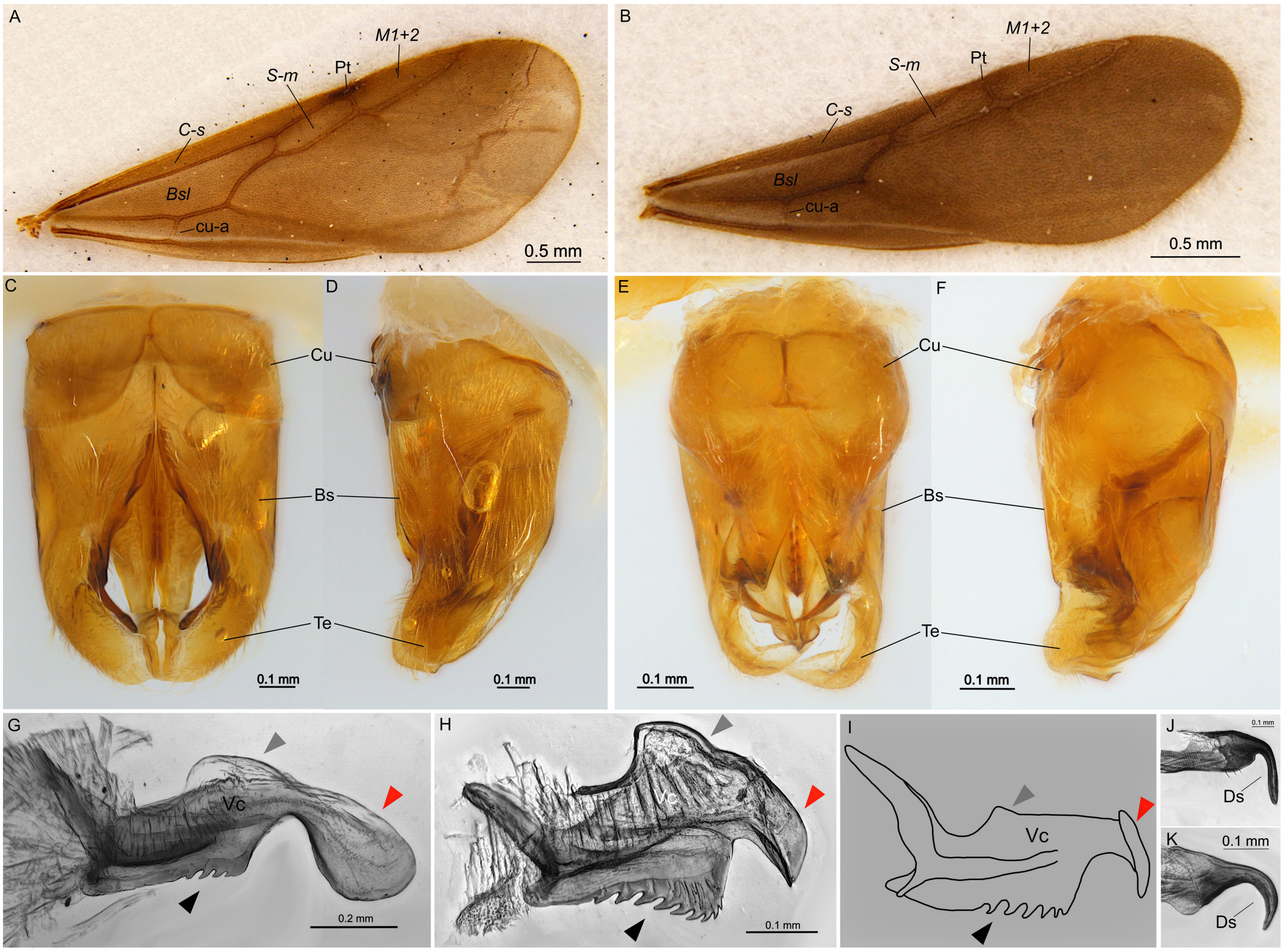

FIGURE 2. Genitalia and forewings of *Mycocepurus* Forel, 1893 males. A, forewing of *M. goeldii* (ANTWEB1047309); B, forewing of *M. smithii* (ANTWEB10473442); C, *M. goeldii* genital capsule in ventral view (ANTWEB1047309); D, *M. goeldii* genital capsule in lateral view (ANTWEB1047309); E, *M. smithii* genital capsule in ventral view (ANTWEB1047343); F, *M. smithii* genital capsule in lateral view (ANTWEB1047343); G, penisvalve of *M. goeldii* (ANTWEB1047309); H, penisvalve of *M. smithii* (ANTWEB1047333); I, illustration of the penisvalve of *M. obsoletus* (based on the original drawing by Kempf, 1963); J, *M. goeldii* volsella (ANTWEB1047309); K, *M. smithii* volsella (ANTWEB1047333). Scale bar absent in I, as it was not available from the original drawing. In the penisvalves, black arrows indicate the ventral denticles of the valviceps; red arrows indicate the apex of valviceps; and white arrows indicate a dorsomedial extension of the valviceps. Abbreviations: Bs, basimere; Bsl, basal cell; C+s, costal+subcostal cell; Cu, cupula; Ds, digitus; M1+2, marginal 1+2 cell; Pt, pterostigma; S-m, submarginal cell; Te, telomere; Vc, valviceps; wings veins: cu-a, cubitus-anal.

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Taxonomic contributions to *Mycetomoellerius* Solomon *et al.*, 2019 (Hymenoptera: Formicidae: Myrmicinae): description of two new species and a key for the genus

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Abstract

Fungus-farming ants (Myrmicinae: Attini: Attina) form mutualistic associations with Agaricales fungi. The group is divided in lower and higher attine ants. Genera *Trachymyrmex*, *Mycetomoellerius*, and *Paratrachymyrmex* are part of higher attine ants, the latter two recently erected and composed of species that were all formerly within *Trachymyrmex*. Morphological characters to distinguish the three genera are scarce. This study describes two new species of *Mycetomoellerius,* provides a multi-entry key for the species of *Mycetomoellerius*, and complements the genus-level diagnosis of *Mycetomoellerius*, *Paratrachymyrmex*, and *Trachymyrmex*. The two new species, *Mycetomoellerius janildae* **sp. nov.** and *Mycetomoellerius mesopleuralis* **sp. nov.**, increase to 32 the total number of extant species of the genus. Male genitalia traits were relevant in the delimitation of the new species. Our taxonomic results represent a step towards the understanding of *Mycetomoellerius* diversity, one of the most speciose genera among the fungus-farming ants.

Key words: Attini, Neotropics, Fungus-farming ants, Identification key

Introduction

The fungus-farming ants are a monophyletic group of myrmicines within the Attini tribe, forming a subtribe Attina, with 20 genera and 250 species (Hanisch *et al.*, 2022; Bolton, 2024). They form obligate mutualistic association with Agaricales fungi (Schultz *et al.*, 2024). Based on the type of the fungus they farm, attine ants are divided in two groups (Vo *et al.*, 2009; Mehdiabadi & Schultz, 2010). The lower attine ants, including the genera *Apterostigma* Mayr, 1865, *Cyatta* Sosa-Calvo *et al.*, 2013, *Cyphomyrmex* Mayr, 1862, *Kalathomyrmex* Klingenberg & Brandão, 2009, *Mycetagroicus* Brandão & Mayhé-Nunes, 2001, *Mycetarotes* Emery, 1913, *Mycetophylax* Emery, 1913, *Mycetosoritis* Wheeler, 1907, *Mycocepurus* Forel, 1893, *Myrmicocrypta* Smith, 1860, and *Paramycetophylax* Kusnezov, 1956 (Vo *et al.*, 2009; Mehdiabadi & Schultz, 2010), depend on the fungi, but the latter is facultatively in the relationship and can be found in a free living way. In the higher attine, though, the fungi are obligately mutualistic with the ants (Schultz & Brady, 2008; Nygaard *et al.*, 2016). The group includes nine genera, four of leafcutters (*Atta* Fabricius, 1804, *Acromyrmex* Mayr, 1865, *Amoimyrmex* Cristiano *et al.*, 2020, and *Pseudoatta* Gallardo, 1916) and five of non-leafcutters (*Sericomyrmex* Mayr, 1865, *Xerolitor* Sosa-Calvo *et al.*, 2018, *Trachymyrmex* Forel, 1893, *Mycetomoellerius* Solomon *et al.*, 2019 and *Paratrachymyrmex* Solomon *et al.*, 2019) (Branstetter *et al.*, 2017; Hanisch *et al.*, 2022).

The genus *Trachymyrmex s.l.* was recently divided into *Trachymyrmex*, *Mycetomoellerius*, and *Paratrachymyrmex* based on molecular data (Sosa-Calvo *et al.*, 2013; Sosa-Calvo *et al.*, 2018; Solomon *et al.*, 2019). Most species of *Mycetomoellerius* and *Paratrachymyrmex* occur in South America, whereas those of *Trachymyrmex* are generally

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limited to the Nearctic region and Central America (Solomon *et al*., 2019), with the three genera overlapping in Mexico (Janicki *et al*., 2016; Guénard *et al*., 2017). Because these three genera share many morphological characters, it is challenging to identify the genus correctly in the areas where they co-occur.

Prior to its separation into three genera, *Trachymyrmex s.l.* was divided into three, morphology-based species groups (Mayhé-Nunes & Brandão, 2002, 2005, 2007). The *opulentus*-group contained species with dense pilosity, generally long and flexuous setae, inconspicuous median pronotal spines, and very short propodeal spines (with the exception of *Mycetomoellerius relictus* (Borgmeier, 1934)) (Mayhé-Nunes & Brandão, 2002). The *iheringi*-group included species with large scape basal lobes (Mayhé-Nunes & Brandão, 2005). Finally, in the *jamaicensis*-group, were placed those species with subparallel and well-developed frontal and preocular carinae, that usually extend beyond the vertexal margin (Mayhé-Nunes & Brandão, 2007).

With the publication of the first comprehensive molecular work on the genus, these groups became obsolete (Solomon *et al*., 2019). For example, the species *Mycetomoellerius opulentus* (Mann, 1922), which possesses typical traits of the *opulentus*-group, did not form a clade with other members of *opulentus*-group in the phylogeny. Similarly, *Mycetomoellerius zeteki* (Weber, 1940), originally placed within the *jamaicensis*-group, does not form a clade with other members of this group and is phylogenetically closer to species from the *opulentus*-group. Moreover, several species have not been studied molecularly, and their phylogenetic placement is still unknown. *Mycetomoellerius* currently includes most of the 49 species formerly attributed to *Trachymyrmex s.l.*, with a total of 30 extant species (Solomon *et al*., 2019; Cardenas *et al*., 2023; Bolton, 2024).

Despite its diversity and broad geographic range, *Mycetomoellerius* remains one of the least studied genera among the fungus-growing ants. In the present study, we describe two new species of *Mycetomoellerius,* present a key to the species of the genus, and increment the genus-level diagnosis of *Mycetomoellerius*, *Paratrachymyrmex*, and *Trachymyrmex*.

Materials and methods

Observations were performed using an Olympus SZ40 stereomicroscope. Measurements and photographs were taken with a Leica M205 A stereomicroscope equipped with a Leica MC170 camera. The male genitalia were dissected using forceps and entomological pins under the Olympus SZ40, then photographed and studied under a Leica DM 2500 light microscope equipped with a Tucsen 10MP CMOS camera. Acquired images were processed using Zerene Stacker (Zerene Systems LLC, Richland, WA, USA) software to generate composite images with greater depth of field and edited in Gimp software (Kimball & Mattis, 1996) for image enhancement. Maps were generated in Qgis Software (QGIS Development Team, 2009).

Terminology is based on Keller (2011) for general ant morphology and Mayhé-Nunes & Brandão (2002, 2005, 2007) and Rabeling *et al*., (2007) for specific characters of fungus-farming ants. For the morphology of the male genitalia, Boudinot (2013) was used. For wing venation and additional aspects of male morphology, we followed Yoshimura & Fisher (2011, 2012).

All specimens data were uploaded to AntWeb database (http://www.antweb.org/), including full-resolution images of the types of the described species. We also uploaded the images of *Mycetomoellerius atlanticus* (Mayhé-Nunes & Brandão, 2007), *M. compactus* (Mayhé-Nunes & Brandão, 2002), *M. cirratus* (Mayhé-Nunes & Brandão, 2005), *M. ixyodus* (Mayhé-Nunes & Brandão, 2007), *M. mikromelanos* Cardenas et al., 2021, and *M. verrucosus* (Borgmeier, 1948), previously unavailable at AntWeb.

Repository institutions are:

CASC—Californian Academy of Sciences, San Francisco, California, United States of America;

CELC—Coleção Entomológica do Laboratório de Sistemática de Coleoptera, Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil;

CPDC—Formicidae Collection at Centro de Pesquisas do Cacau, Ilhéus, Bahia, Brazil;

DZUP—Coleção Entomológica Padre Jesus Santiago Moure, Universidade Federal do Paraná, Curitiba, Paraná, Brazil;

INPA—Instituto Nacional de Pesquisas da Amazônia, Coleção Sistemática da Entomologia, Manaus, Amazonas, Brazil;

JTLC—John T. Longino, personal collection, University of Utah, Salt Lake City, Utah, United States of America;

MZUSP—Museu de Zoologia da Universidade de São Paulo, São Paulo, São Paulo, Brazil;

PSWC—Philip S. Ward Collection, University of California, Davis, California, United States of America;

UFVB—Museu de Entomologia, Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil.

The new species were described following the protocols recommended by the International Code of Zoological Nomenclature.

Examined specimens in this study were obtained from the following scientific collections: Coleção Entomológica do Laboratório de Sistemática de Coleoptera (CELC) and Museu de Zoologia da Universidade de São Paulo (MZUSP) (Evenhuis, 2024). The specimens analyzed represent material previously collected and cataloged by each institution, which was verified and compared with relevant reference specimens, including species from the *opulentus*-group and other congeners that show similarities to the species described in this study, to confirm the distinction of the new species.

For species identification, a multi-entry key was created on the Xper3 platform (Ung *et al*., 2010; Vignes-Lebbe *et al*., 2017; Kerner *et al*., 2021). Keys created in this program are freely accessible and do not require software installation. They are user-friendly, accessed through the browser by a link provided, requiring only internet access. The key requires that the user chooses character states among various presented. As the process go on, the list of possible species in the right corner get smaller and, ideally, only one species remains. To support a comprehensive understanding of the multi-entry key, the character matrix used to construct the key is included in Appendix (Appendix I). In addition to the illustrated characters, images of all species are available on the right side of the key, by clicking choosing on the species name, so identification can be further checked. Geographic abbreviations used along the multi-entry key follow Ribeiro (2019) and Nations Online Project (2024), and include: **ANT**, Netherlands Antilles; **ARG**, Argentina; **ATG**, Antigua and Barbuda; **BOL**, Bolivia; **BRA**, Brazil; **COL**, Colombia; **CRI**, Costa Rica; **CUB**, Cuba; **ECU**, Ecuador; **GUF**, French Guiana; **GUY**, Guyana; **GTM**, Guatemala; **HND**, Honduras; **HTI**, Haiti; **JAM**, Jamaica; **MEX**, Mexico; **NIC**, Nicaragua; **PAN**, Panama; **PER**, Peru; **PRY**, Paraguay; **SUR**, Suriname; **TTO**, Trinidad and Tobago; **USA**, United States of America; **URY**, Uruguay; **VEN**, Venezuela. The abbreviations for the Brazilian states abbreviations are: **AC**, Acre; **AL**, Alagoas; **AP**, Amapá; **AM**, Amazonas; **BA**, Bahia; **CE**, Ceará; **GO**, Goiás; **ES**, Espírito Santo; **MA**, Maranhão; **MT**, Mato Grosso; **MS**, Mato Grosso do Sul; **MG**, Minas Gerais; **PA**, Pará; **PB**, Paraíba; **PR**, Paraná; **PE**, Pernambuco; **PI**, Piauí; **RJ**, Rio de Janeiro; **RN**, Rio Grande do Norte; **RS**, Rio Grande do Sul; **RO**, Rondônia; **RR**, Roraima; **SP**, São Paulo; **SC**, Santa Catarina; **SE**, Sergipe; **TO**, Tocantins. Images used in the multi-entry key were either produced by ourselves or taken from AntWeb; each image in the list of species of the key is credited to its author. The key will no longer be edited after the publication of this manuscript.

The following measurements were used:

HL, head length. In full-face view, a median line extending from the anterior clypeal margin to the posterior margin of the head (Fig. 1, A).

HW, head width excluding eyes. In full-face view, the width of the head just above the eyes (Fig. 1, A).

HW1, maximum head width including eyes. In full-face view, the width of head at the eye level (Fig. 1, A).

EL, compound eye length. In profile-view the length of the longitudinal line that spans the eye from the anterior to the posterior edges (males) (Fig. 1, E).

EW, compound eye width. In profile-view view the length of the horizontal line that spans the eye fom inner to outer edges (males) (Fig. 1, E).

IOD, interocular distance. In full-face view, the maximum width between the internal margin of the eyes (males) (Fig. 1, B).

OOD, ocular-ocellus distance. In full-face view, minimum distance between lateral ocellus and compound eye (males) (Fig. 1, B).

MoW, median ocellus width. In full-face view, the largest transversal line to fit within the median ocellus (males and queens) (Fig. 1, B).

MoL, median ocellus length. In full-face view, the length of the median line of the median ocellus (males and queens) (Fig. 1, B).

LoL, lateral ocellus length. With the head adjusted to allow a full view of the lateral ocellus, the length of the median line that runs across it (males and queens) (Fig. 1, B).

LoD, distance between the lateral ocelli. In full-face view, minimal distance between lateral ocelli (males and queens) (Fig. 1, B).

SL, scape length. Maximum length of antennal scape from medial point of base to medial point of apex, excluding bulbus and radicular constriction (Fig. 1, A).

PeL, pedicel length. Maximum length of pedicel (second antennomere) (Fig. 1, B).

An3L, antennomere three length. Maximum length of antennomere three (Fig. 1, B).

MdL, mandible length. In full-face view, a straight line from the apex of the mandible to the posteriormost visible point of its outer margin (Fig. 1, A).

MsL, mesosoma length. In profile view, diagonal length of mesosoma from anterodorsal edge of pronotum to posteroventral corner of metapleuron (Fig. 1, C).

MssctmW, mesoscutum width. Maximum width of the mesoscutum excluding the tegulae in the dorsal view of the mesosoma (males and queens) (Fig. 1, D).

MssctmL, mesoscutum length. In the dorsal view of the mesosoma, midline from anterior margin of the mesoscutum to the posterior margin, discounting scutoscutellar sulcus (males and queens) (Fig. 1, D).

MssctlL, mesoscutellum length. In the dorsal view of the mesosoma, midline from the anterior margin of mesoscutellum, discouting scutoscutellar sulcus, to the posterior margin (males and queens) (Fig. 1, D).

MssctmL + MssctlL, mesoscutum plus mesoscutellum length. In dorsal view of the mesosoma, midline from the anterior margin of the mesoscutum to the posterior margin of the mesoscutellum (males and queens).

PH, petiole height. In profile, midline from the ventral edge of the petiolar node to the dorsal edge (Fig. 1, C).

PL, petiole length including peduncle. In profile, horizontal midline from the anteriormost point of the petiole, starting from the beginning of the peduncle to the posterior (Fig. 1, C).

PPH, postpetiole height. In profile, the length of the tallest line crossing postpetiole in a dorsoventral axis (Fig. 1, C).

PPL, postpetiole length. In profile, horizontal midline from the anterior edge of the postpetiole to the posterior edge (Fig. 1, C).

HFL, hind femur length. In dorsal view, length of hind femur from articulation with trochanter to apex (Fig. 1, F).

G1L, first gastral tergite length. In profile, the length of the first tergite (Fig. 1, C).

All measurements are given in mm (Fig. 1).

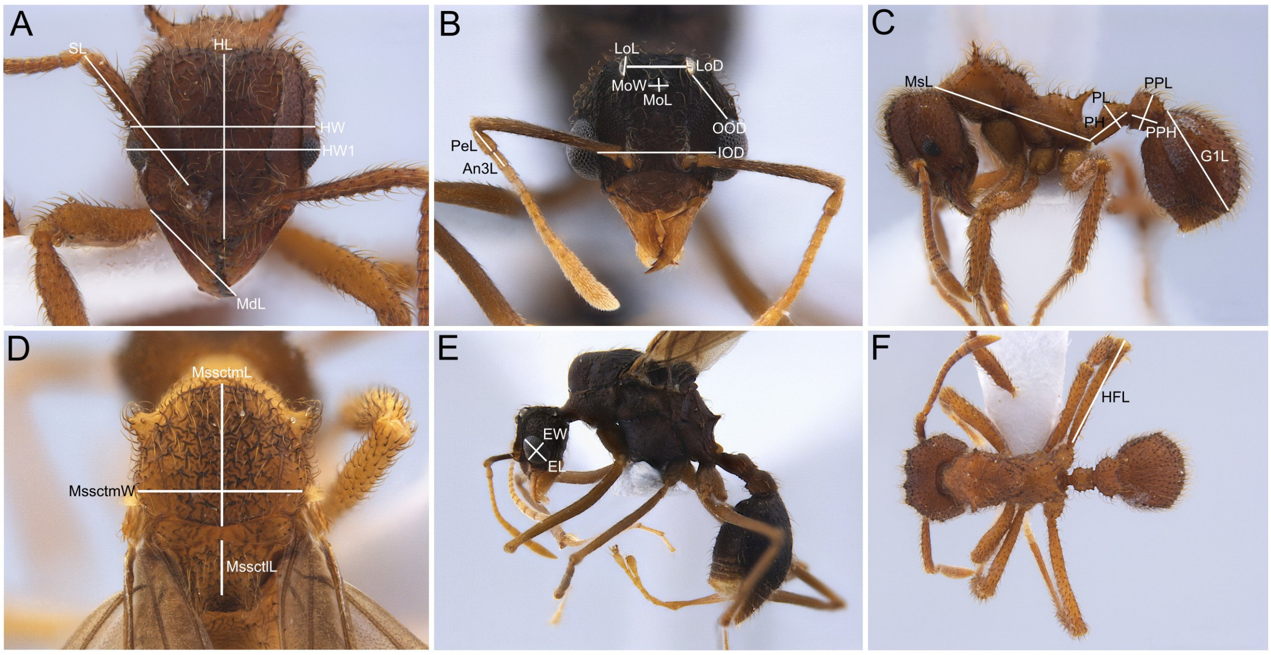

FIGURE 1. Morphological measurements taken from workers (A, C, F), queens (D) and males (B, E). Abbreviations: **An3L**, antennomere three length; **EL**, compound eye length; **EW**, compound eye width; **G1L**, first gastral tergite length; **HFL**, hind femur length; **HL**, head length; **HW**, maximum head width excluding eyes; **HW1**, maximum head width; **IOD**, interocular distance; **LoD**, distance between the lateral ocelli; **LoL**, lateral ocellus length; **MdL**, mandible length; **MoL**, median ocellus length; **MoW**, median ocellus width; **MsL**, mesosoma length; **MssctmL**, mesoscutum length; **MssctmW**, mesoscutum width; **MssctlL**, mesoscutellum length; **OOD**, ocular-ocellus distance; **PeL**, pedicel length; **PH**, petiole height; **PL**, petiole length including peduncle; **PPH**, postpetiole height; **PPL**, postpetiole length; **SL**, scape length.

Results

Genus-level diagnoses

(Fig. 2)

Mycetomoellerius

1. Median pronotal spines basally fused (Fig. 2, A), rarely separated (Fig. 2, B) [e.g. *Mycetomoellerius agudensis* (Kempf, 1967), *M. holmgreni* (Wheeler, 1925), *M. isthmicus* (Santschi, 1931), *M. ixyodus*, *M. kempfi* (Fowler, 1982), and *M. relictus* (Borgmeier, 1934)].
2. Mandible dorsum smooth (Fig. 2, C), sometimes basally striated (Fig. 2, D), rarely completely striated (Fig. 2, E) [e.g. *Mycetomoellerius iheringi* (Emery, 1888)].
3. Preocular carinae frequently well-developed (Fig. 2, C), never curved towards the frontal carinae.
4. Pilosity ranging from sparse (Fig. 2, G) to dense (Fig. 2, H).
5. Postocular protuberance generally conspicuous (Fig. 2, F).
6. Vertexal corners varying from rounded (Fig. 2, E) to angled/spiny (Fig. C, D, F).
7. Posterior margin of head generally with strong median impression (Fig. 2, F).
8. Postpetiole in lateral view without posteromedial impression (posterior margin rarely concave) (Fig. 2, H, K).
9. First gastral tergite often with conspicuous pairs of lateral and median ridges (Fig. 2, K).
10. Propodeal projections long in most species (Fig. 2, H).
11. Promesonotum usually with unequally-sized projections (Fig. 2, H) [some exeptions in *M. atlanticus*, *M. farinosus* (Emery, 1894), *M. fiebrigi* (Santschi, 1916), *M. holmgreni*, *M. iheringi*, *M. oetkeri* (Forel, 1908), *M. pruinosus* (Emery, 1906), *M. tucumanus* (Forel, 1914), *M. turrifex* (Wheeler, 1903), and *M. zeteki* (Weber, 1940)].
12. Antennal scape sometimes with basal lobe (Fig. 2, C) [e.g. *Mycetomoellerius cirratus*, *M. holmgreni*, *M. iheringi*, *M. kempfi*, *M. pruinosus*, and *M. tucumanus*]; microtubercles generally present (Fig. 2, C, D, F).

Paratrachymyrmex

1. Median pronotal spines separated (Fig. 2, B), not basally fused (Fig. 2, A).
2. Mandible dorsally striated (Fig. 2, E), sometimes solely basally striated [e.g. *P. levis* (Weber, 1938)].
3. Preocular carinae short, sometimes curved towards the frontal carinae (Fig. 2, B, E) [e.g. *Paratrachymyrmex diversus* (Mann, 1916), *P. intermedius* (Forel, 1909), and *P. mandibularis* (Weber, 1938)].
4. Pilosity sparse (Fig. 2, G).
5. Postocular protuberance inconspicuous (Fig. 2, E).
6. Vertexal corners generally rounded (Fig. 2, E).
7. Posterior margin of head usually with strong median impression (Fig. 2, E).
8. Postpetiole in lateral view often with posteromedial impression (posterior margin concave) (Fig. 2, G, J).
9. First gastral tergite often with conspicuous pair of lateral ridges, median pair usually poorly-marked or absent (Fig. 2, J).
10. Propodeal projections short in most species [except in *P. diversus*, *P. intermedius*, and *P. mandibularis*].
11. Promesonotum usually with subequal-sized projections (Fig. 2, G) [except in *P. intermedius* and *P. mandibularis*].
12. Antennal scape never with basal lobe; microtubercles tiny (Fig. 2, B, E).

Trachymyrmex

1. Median pronotal spines separated (Fig. 2, B), if basally fused, then their apexes are considerably distant from each other [e.g. *Trachymyrmex arizonensis* (Wheeler, 1907)].
2. Mandible dorsum striated (Fig. 2, E).
3. Preocular carinae short, frequently curved towards the frontal carinae (Fig. 2, B).
4. Pilosity sparse (Fig. 2, G).
5. Postocular protuberance inconspicuous (Fig. 2, B).
6. Vertexal corners slightly rounded (Fig. 2, E).

7. Posterior margin of head with mild median impression (Fig. 2, B).
8. Postpetiole in lateral view with posteromedial impression (posterior margin concave) (Fig. 2, G, I).
9. First gastral tergite generally with inconspicuous pairs of lateral and median ridges (Fig. 2, I).
10. Propodeal projections spiny (Fig. 2, G), rarely blunt [e.g. *Trachymyrmex desertorum* (Wheeler, 1911)].
11. Promesonotum with subequal-sized projections (Fig. 2, G).
12. Antennal scape never with basal lobe; microtubercles tiny (Fig. 2, B, E).

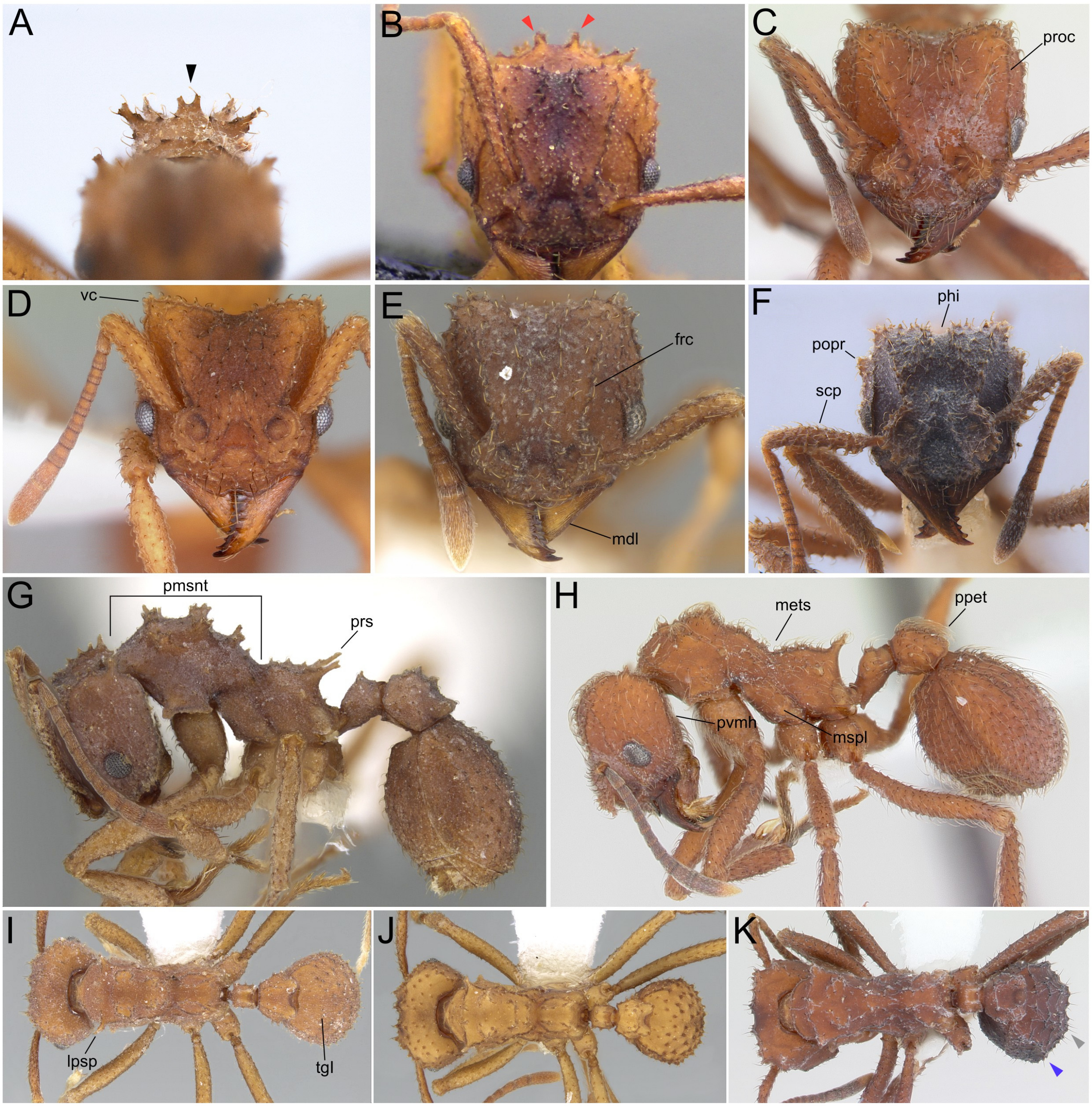

FIGURE 2. Comparison between *Mycetomoellerius*, *Paratrachymyrmex* and *Trachymyrmex* species. **A,** *M. oetkeri* (UFV-LABECOL-005130); **B,** *T. septentrionalis* (ANTWEB1060085); **C,** *M. kempfi* (CASENT0178107); **D,** *M. turrifex* (CASENT0104760); **E,** *P. bugnioni* (CASENT0919968); **F,** *M. mesopleuralis* (MZSPHYM0136546); **G,** *T. septentrionalis* (CASENT0919975); **H,** *M. kempfi* (CASENT0178107); **I,** *T. pakawa* (CASENT0919984); **J,** *P. intermedius* (CASENT0919970); **K,** *M. holmgreni* (CASENT0178106). Black arrowheads, median pronotal spines basally fused; Red arrowheads, median pronotal spines separated; Blue arrowheads, pair of lateral ridges on first gastral tergite; Grey arrowheads, pair of median ridges on first gastral tergite. Abbreviations: **frc**, frontal carinae; **lpsp**, lateral pronotal spines; **mdl**, mandibles; **mets**, metanotal suture; **mspl**, mesopleura; **phi**, posterior margin of head impression; **pmsnt**, promesonotum ; **popr**, postocular protuberance; **ppet**, postpetiole; **proc**, preocular carinae; **prs**, pronotal spines; **pvmh**, posterior section of ventral margin of head; **scp**, scape; **vc**, vertexal corners; **tgI**, first tergum of the gaster.

Mycetomoellerius species list:

Mycetomoellerius agudensis (Kempf, 1967)
Mycetomoellerius atlanticus (Mayhé-Nunes & Brandão, 2007)
Mycetomoellerius cirratus (Mayhé-Nunes & Brandão, 2005)
Mycetomoellerius compactus (Mayhé-Nunes & Brandão, 2002)
Mycetomoellerius dichrous (Kempf, 1967)
Mycetomoellerius echinus (Weber, 1938)
Mycetomoellerius farinosus (Emery, 1894)
Mycetomoellerius fiebrigi (Santschi, 1916)
Mycetomoellerius gaigei (Forel, 1914)
Mycetomoellerius guianensis (Weber, 1937)
Mycetomoellerius haytianus (Wheeler & Mann, 1914)
Mycetomoellerius holmgreni (Wheeler, 1925)
Mycetomoellerius iheringi (Emery, 1888)
Mycetomoellerius isthmicus (Santschi, 1931)
Mycetomoellerius ixyodus (Mayhé-Nunes & Brandão, 2007)
Mycetomoellerius janildae Santos, Chaul & Serrão **sp. nov.**
*Mycetomoellerius jamaic*ensis (André, 1893)
Mycetomoellerius jamaicensis antiguensis (Weber, 1938)
Mycetomoellerius kempfi (Fowler, 1982)
Mycetomoellerius mesopleuralis Santos, Chaul & Serrão **sp. nov.**
Mycetomoellerius mikromelanos Cardenas *et al*., 2021
Mycetomoellerius oetkeri (Forel, 1908)
Mycetomoellerius opulentus (Mann, 1922)
Mycetomoellerius papulatus (Santschi, 1922)
†*Mycetomoellerius primaevus* (Baroni Urbani, 1980)
Mycetomoellerius pruinosus (Emery, 1906)
Mycetomoellerius relictus (Borgmeier, 1934)
Mycetomoellerius ruthae (Weber, 1937)
Mycetomoellerius squamulifer (Emery, 1896)
Mycetomoellerius tucumanus (Forel, 1914)
Mycetomoellerius turrifex (Wheeler, 1903)
Mycetomoellerius urichii (Forel, 1893)
Mycetomoellerius verrucosus (Borgmeier, 1948)
Mycetomoellerius zeteki (Weber, 1940)

Key to the worker caste of *Mycetomoellerius*

The multi-entry interactive key based on the Xper3 platform contains 27 characters and, as terminals, 30 species, representing almost all described species of *Mycetomoellerius*, except for *M. echinus*, *M. gaigei*, and *M. guianensis*, that were excluded due to lack of clear information or available specimens for study. It can be accessed through the following link: https://app.xper3.fr:443/xper3GeneratedFiles/publish/identification/7441939563843895946

Taxonomic synopsis

Species accounts

Mycetomoellerius janildae Santos, Chaul & Serrão sp.nov.

(Figs. 3–7)

Type material. *Holotype*: BRA: MG, Viçosa, -20.761430, -42.862560, 2019-07-25, Amaro, G. (1 worker, ANTWEB1047947) [CELC]. *Paratypes*: BRA: BA, Ilhéus, CEPEC - Herbário do Centro de Pesquisas do Cacau, -14.790194, -39.213208, 1986-10, Delabie, J. (1 worker, MZSPHYM0136551) [MZUSP]. BRA: MG, Viçosa, Fundos Entomologia, -20.758200, -42.867617, 2019-07-25, de Souza, D. & Chaul, J. (1 dealate queen, UFV-LABECOL-005123, and five workers with the following codes: UFV-LABECOL-005124, ANTWEB1053547, ANTWEB1047925, ANTWEB1047924, and ANTWEB1053546) [CELC]. BRA: MG, Viçosa, -20.761430, -42.862560, 2019-07-25, Amaro, G. (1 alate queen, ANTWEB1047948, and 1 alate male, ANTWEB1047950) [CELC]. BRA: MG, Viçosa, -20.761430, -42.862560, 2019-07-25, Amaro, G. (1 worker, UFV-LABECOL-011016) [CELC]. BRA: MG, Viçosa, -20.761430, -42.862560, 2019-08-25, Amaro, G. (1 worker, UFV-LABECOL-010956) [DZUP]. BRA: MG, Viçosa, Mata do Paraíso, -20.805528, -42.853417, 2016-07-12, Raimundo, A. P., Ferreira, L., Chaul, J. & Paolucci, L. (1 worker, ANTWEB1047927) [JTLC]. BRA: MG, Viçosa, Mata do Paraíso, -20.80395, -42.85510, 2021-04-17, Figueiredo, G. & Chaul J. (1 worker, ANTWEB1053564) [CASC]. BRA: MG, Viçosa, Mata São Geraldo SG, -20.816667, -42.916667, 2010-01, Audino, L. (Two workers with the following codes: ANTWEB1047928, and ANTWEB1047929) [ANTWEB1047928 in CELC, and ANTWEB1047929 in UFVB]. BRA: MG, Viçosa, Mata da Biologia, -20.757517, -42.865306, 2023-08-25, Figueiredo, G. & Santos, C. D. (Twelve workers in twelve pins with the following codes: ANTWEB1047926, ANTWEB1047946, ANTWEB1047554, ANTWEB1047555, ANTWEB1047556, ANTWEB1047557, ANTWEB1047558, ANTWEB1047559, ANTWEB1047560, ANTWEB1047561, ANTWEB1047562, and ANTWEB1047563) [all in CELC, except ANTWEB1047946 which is in DZUP, ANTWEB1047554 in CPDC, ANTWEB1047555 in PSWC, ANTWEB1047560 in INPA, and ANTWEB1047561 in MZUSP].

Non-type material examined. VEN: Falcón, Serranía de San Luis, 11.215858, -69.641154, 1993-08-18, Mayhé-Nunes, A. & Lattke, J. (Two workers, MZSPHYM0136549) [MZUSP]. VEN: Falcón, Serranía de San Luis, 11.215858, -69.641154, 1993-08-18, Mayhé-Nunes, A. & Lattke, J. (1 worker, MZSPHYM0136550) [MZUSP]. VEN: Falcón, Serranía de San Luis, 11.215858, -69.641154, 1993-08-18, Mayhé-Nunes, A. & Lattke, J. (Two workers, MZSPHYM0136552) [MZUSP].

Worker measurements (holotype): HL 0.81, HW 0.88, HW1 0.90, SL 0.70, PeL 0.13, An3L 0.06, MdL 0.58, MsL 1.21, PH 0.20, PL 0.34, PPH 0.27, PPL 0.25, HFL 1.13, G1L 0.95.

Measurements in mm (10 paratypes measured): HL 0.71–0.89, HW 0.75–0.90, HW1 0.83–0.93, SL 0.5–0.75, PeL 0.09–0.13, An3L 0.05–0.07, MdL 0.52–0.63, MsL 1.02–1.31, PH 0.17–0.22, PL 0.28–0.39, PPH 0.22–0.30, PPL 0.21–0.27, HFL 0.89–1.14, G1L 0.75–1.0.

Diagnosis. Body pilosity dense, with long and flexuous hairs. Lateral pronotal spines well-developed; median pronotal spines inconspicuous. Mesonotum without well-defined projections; mesopleural surface without tubercles. Frontal lobes subtriangular, with a weakly crenulate anterolateral margin; frontal carinae extending to the vertexal margin. Postocular protuberance inconspicuous; preocular carinae developed, without projections on the vertexal margin. Rounded vertexal corners, vertexal margin with shallowly median emargination. Mandibles basally with oblique striations. First gastral tergite with tubercles linked laterally and forming a pair of longitudinal marginations, and some small crenate margins in dorsal region. Worker mildly bicolored, dark brown cephalic capsule and gaster, slightly lighter brown to ferruginous appendages, mesosoma, and metasoma.

Worker description. Relatively small species for the genus standards; without strong polymorphism. Dense setae covering the body, larger setae on dorsum of head, small subdecumbent setae on antennomeres, mesosoma and metasoma flexuous, those on legs suberect. Integument dull; mildly bicolored: most of the body light brown to ferruginous, head and gaster dark brown. *Head*. Eye weakly convex, not fully surpassing head lateral margin. Mandibles shiny, except for oblique striation at base; masticatory margin with a total of nine teeth: a large apical tooth, an intermediate-sized subapical, followed by six, subequall and small teeth and a large basal tooth. Anterior clypeal margin with a median notch about as wide as the maximum scape width. Frontal lobes subtriangular, with mildly crenulate anterolateral margin; frontal carinae extending to the vertexal margin. Frons shallowly concave. Vertexal carinae parallel, poorly-defined. Preocular carinae reaching the vertexal margin, but not surpassing it as a projection in full-face view; postocular carinae inconspicuous, postocular protuberance tiny. Vertexal corners rounded, vertexal margin with shallowly median emargination. In profile view, posterior section of ventral margin of head with a feeble carinae, without protuberances. Antennal scape maximum width just posterior to midlength, with small piligerous tubercles, exceeding the vertexal margin by a little less than its maximum width when retracted;

totaling eleven antennomeres. *Mesosoma*. Pronotal medial pair of spines absent or reduced, when present without fused bases; pronotum with a pair of well-developed anterolateral spines, sometimes with truncate tips. Mesonotum without projections, except for a few piligerous minute tubercles; mesopleural surface without tubercles. Metanotal suture shallow and wide. Propodeum dorsum bordered laterally by piligerous tubercles; pair of propodeal spines posterolaterally directed, slightly longer than the distance between their internal bases; propodeal spiracle projected from surrounding surface, posteriorly directed. *Metasoma*. In dorsal view, petiolar node subquadrate; postpetiole wider than long. Anterior subpetiolar and subpostpetiolar processes small. Petiolar node, postpetiole tergite and first gastral tergite unevenly covered with pilligerous tubercles; on first gastral tergite the tubercles are linked laterally and form a pair of longitudinal marginations, forming carinae, and some small tubercles forming interconnected carinae in dorsal region.

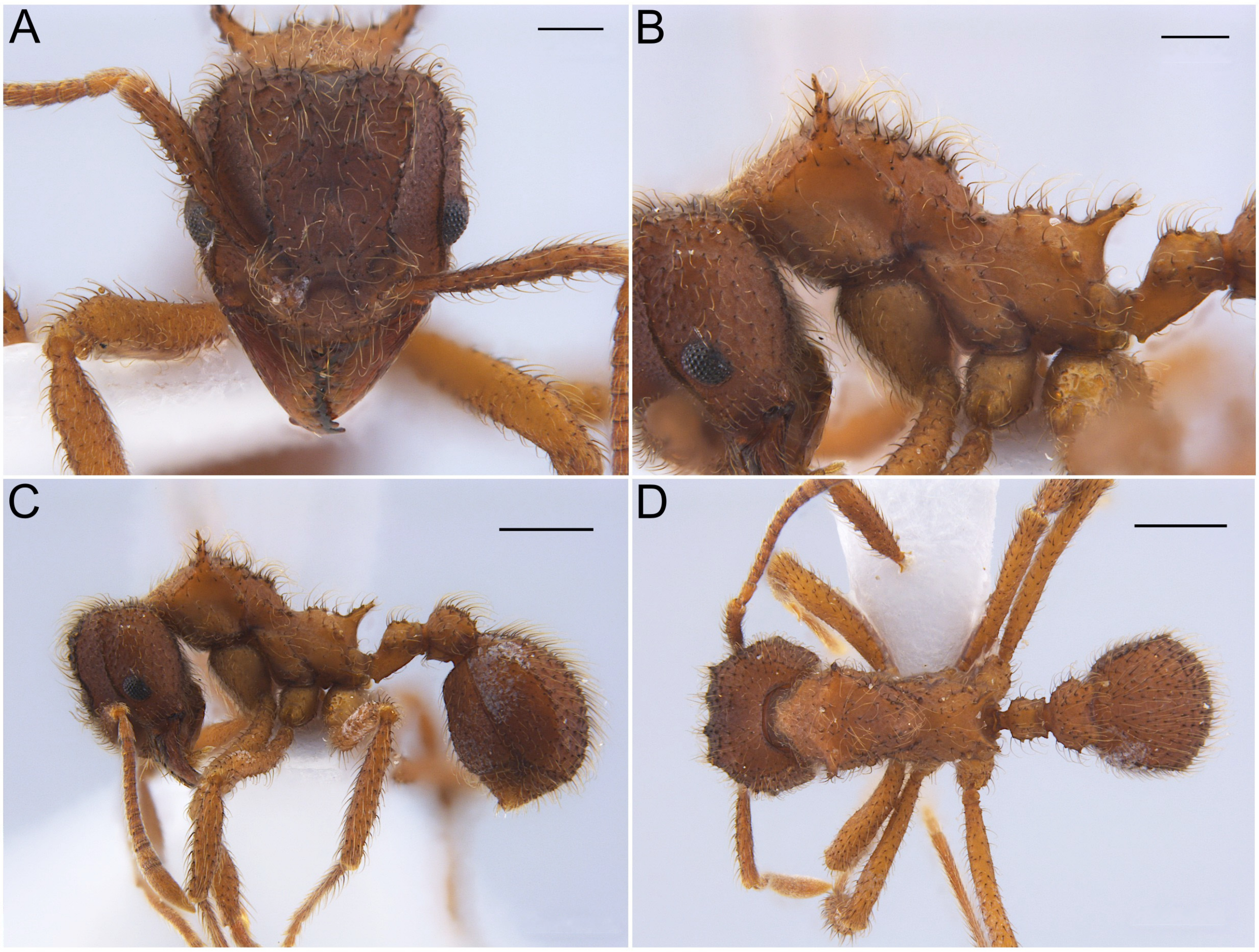

FIGURE 3. *Mycetomoellerius janildae* holotype (ANTWEB1047947). **A,** full-face view; **B,** mesosoma and petiole in profile view; **C,** profile view; **D,** dorsal view. Scale bars 0.2 mm (A and B), 0.5 mm (C and D).

Queen measurements (2 measured): HL 0.91–1.04, HW 0.92–1.17, HW1 0.93–1.17, MoW 0.05–0.07, MoL 0.04–0.04, LoL 0.05–0.05, LoD 0.27–0.29, SL 0.63–0.68, PeL 0.11–0.13, An3L 0.08–0.10, MdL 0.71–0.72, MsL 1.49–1.72, MssctmW 0.82–0.95, MssctmL 0.70–0.82, MssctlL 0.26–0.33,MssctmL + MssctlL 1.10–1.28, PH 0.28–0.30, PL 0.41–0.53, PPH 0.37–0.44, PPL 0.28–0.28, HFL 1.32–1.38, G1L 1.42–1.62.

Queen description. Similar to worker, except for the caste differences such as presence of ocelli, mesosoma with a well-developed mesonotum, and wings. Ocelli similar-sized. Pronotum with a pair of robust blunt anterolateral projections. In dorsal view, mesoscutum and mesoscutelum with abundant piligerous tubercles. Scutoscutellar suture broad and shallow; mesoscutellum posterior margin with a pair of robust projections. Propodeal spines with robust bases. *Wings*. Slightly infuscated; covered with microtrichia; forewing with eight closed cells (basal, costal+subcostal, discal 2+3, marginal 1+2, subbasal, subdiscal, submarginal 1, and submarginal 3+4); pterostigma slightly pigmented.

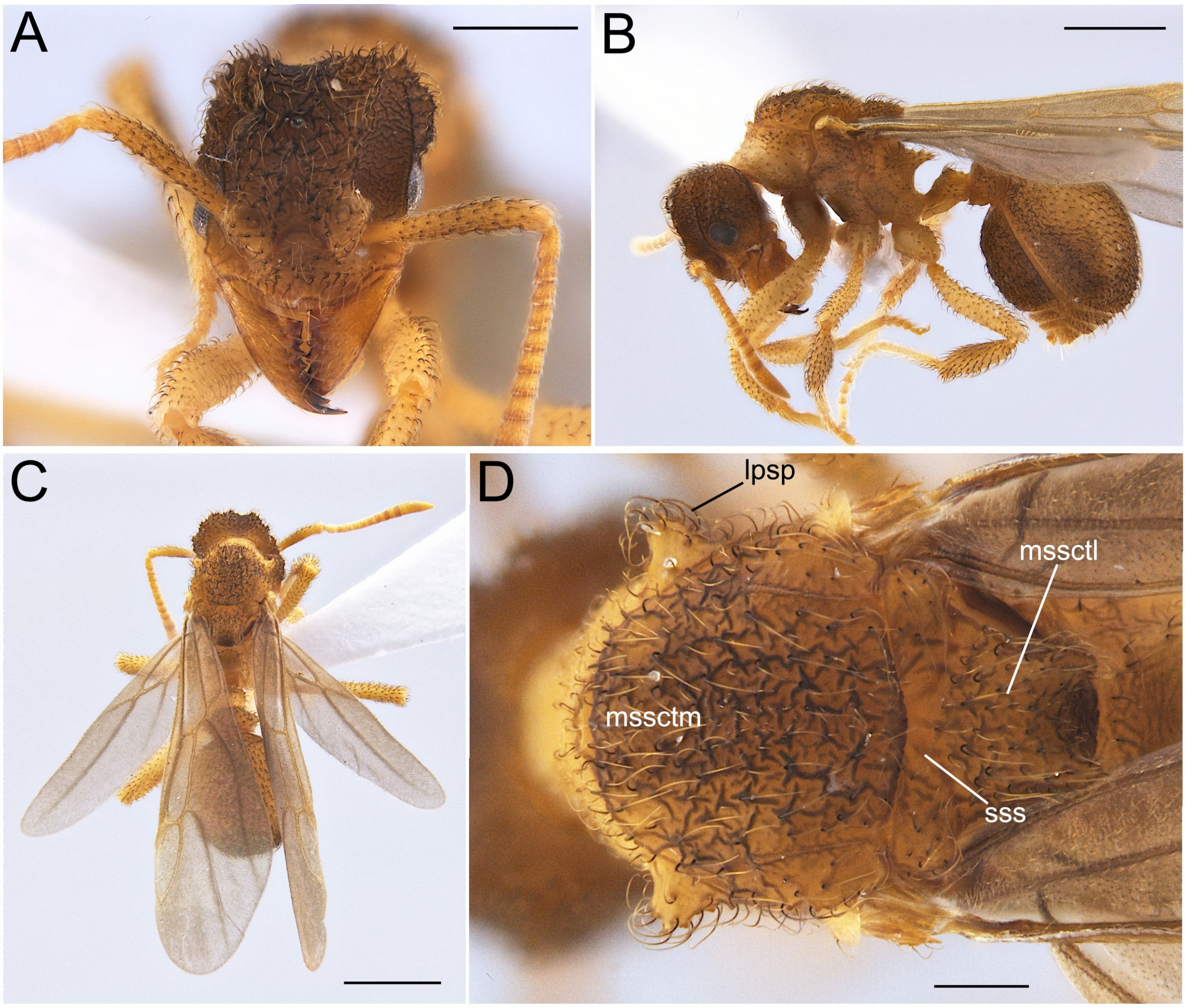

FIGURE 4. *Mycetomoellerius janildae* paratype queen (ANTWEB1047948). **A,** full-face view; **B,** profile view; **C,** dorsal view; **D,** mesosoma in dorsal view. The head of this queen has a slight depression in the upper left corner, likely resulting from a malformation during its development. Abbreviations: **lpsp**, lateral pronotal spines; **mssctl**, mesoscutelum; **mssctm**, mesoscutum; **sss**, scutoscutellar suture. Scale bars 0.5 mm (A), 1 mm (B and C), and 0.2 mm (D).

Male measurements (1 measured): HL 0.61, HW 0.65, HW1 0.73, EL 0.28, EW 0.20, IOD 0.48, OOD 0.22, MoW 0.05, MoL 0.04, LoL 0.06, LoD 0.23, SL 0.68, PeL 0.11, An3L 0.08, MdL 0.40, MsL 1.43, MssctmW 0.72, MssctmL 0.73, MssctlL 0.25, MssctmL + MssctlL 1.04, PH 0.18, PL 0.36, PPH 0.24, PPL 0.19, HFL 1.60, G1L 0.8.

Male diagnosis. Frontal carinae extending beyond the posterior level of the eyes, reaching lateral ocelli. Preocular carinae well-developed, slightly converging apically and reaching the lateral ocelli. Lateral pronotal projections very short, with relatively wide bases. Propodeal projections short and blunt, twice as long as those of pronotum. Notauli narrow, strongly impressed anteriorly, and slightly posteriorly, forming a 'Y'; mesoscutellum as wide as long, with a pair of tiny blunt projections on the posterior edge. Mandible triangular; reticulate-punctate at basal half, apical half smooth; masticatory margin with six teeth, basal and apical larger than the others, with the remaining teeth unequally spaced. Anterior clypeal margin mildly bilobed. Pilosity dense, with ferruginous to dark brown setae all over the body, most strongly curved, but sometimes suberect. Penisvalva ventral margin with about 20 sharp, minute denticles; apex of valviceps round. Body dark brown, except for legs, mandibles, antennae and posterior portion of gaster (from abdominal segment V backward) which are light brown.

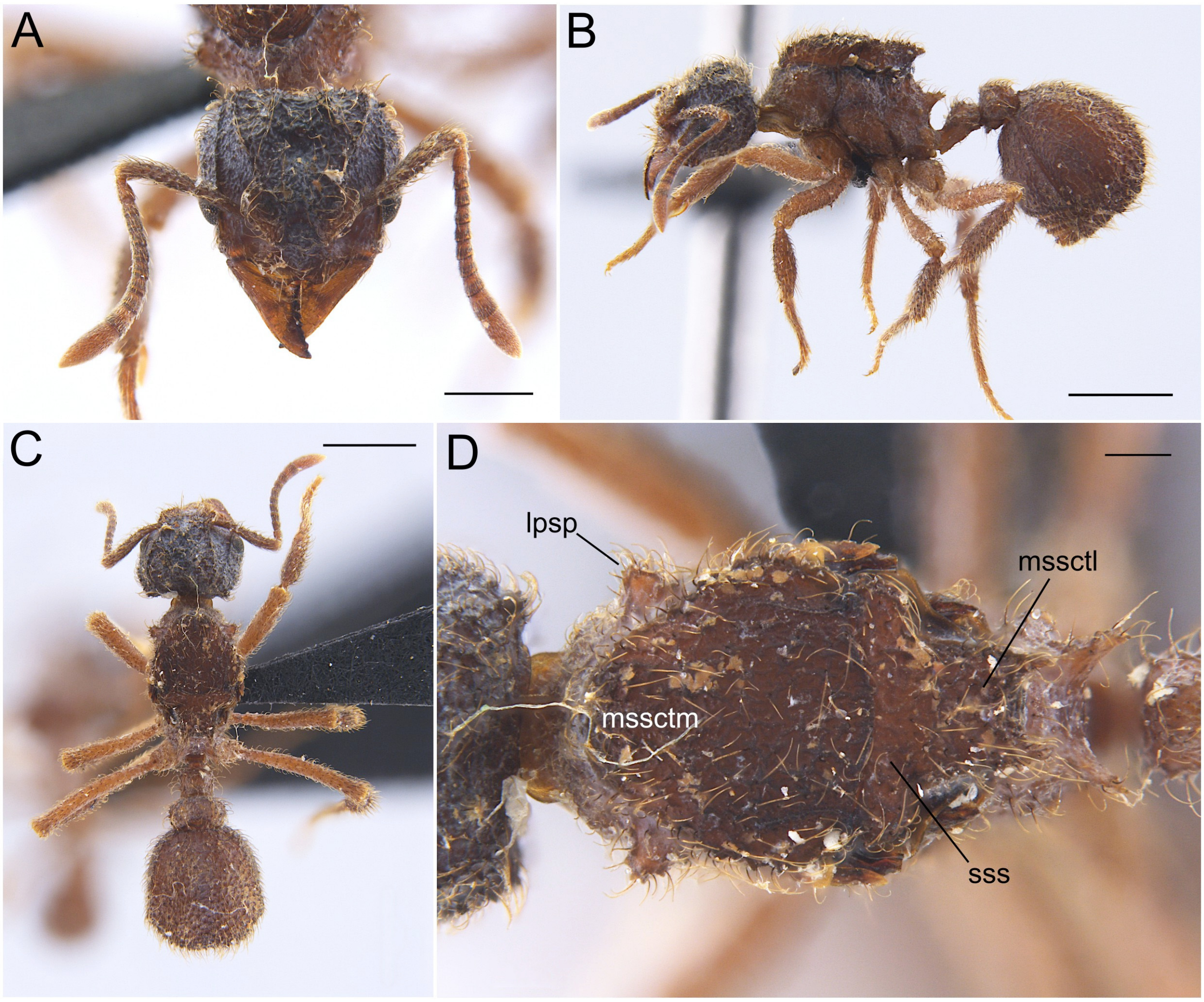

FIGURE 5. *Mycetomoellerius janildae* second paratype queen (UFV-LABECOL-005123). **A,** full-face view; **B,** profile view; **C,** dorsal view; **D,** mesosoma in dorsal view. Abbreviations: **lpsp**, lateral pronotal spines; **mssctl**, mesoscutelum; **mssctm**, mesoscutum; **sss**, scutoscutellar suture. Scale bars 0.5 mm (A), 1 mm (B and C), and 0.2 mm (D).

Male description. Overall reticulate-punctate sculpturing. Pilosity dense, with ferruginous to dark brown setae all over the body, most strongly curved, but sometimes suberect. *Head*. Mandible triangular; reticulate-punctate at basal half, apical half smooth; masticatory margin with six teeth, basal and apical larger than the others, with the remaining teeth unequally spaced; basal margin fit tightly again anterior clypeal margin when mandible is closed; outer margin slightly sinuous. Anterior clypeal margin mildly bilobed. Frontal lobes subcircular and poorly developed, only partially covering the scape bulbus; frontal carinae extending beyond the posterior level of the eyes, touching lateral ocelli. Frons rugulose. Preocular carinae well-developed, curving slightly at apex touching the lateral ocelli. Antennal scape in rest position exceeding the posterior margin of the head by the length of antennomeres I and II combined, remaining twelve antennomeres slightly longer than wide, the last three being more robust than the others. Bulging eyes. *Mesosoma*. Lateral pronotal projections small, with a relatively wide base. Wide sulci between upper mesopleura and lower mesopleura, and between upper mesopleura and upper metapleura. Propodeal projections short and blunt, twice as long as those of pronotum. Notauli narrow, strongly impressed anteriorly, and slightly posteriorly, forming a 'Y'. Mesoscutum wider posteriorly than anteriorly, scutuscutellar sulcus broad and shallow. Mesoscutellum as wide as long, with a pair of tiny blunt projections on the posterior edge. *Metasoma*. Petiole, in dorsal view, subquadrate, with a pair of pointed projections posterolaterally. Postpetiole with a posteromedial shallow concavity. First tergum of the gaster longer than wide. *Wings*. Infuscated; covered with microtrichia; forewing with eight closed cells (basal, costal+subcostal, discal 2+3, marginal 1+2, subbasal, subdiscal, submarginal 1, and submarginal 3+4), with the medial (M) and cubital (Cu) veins less proeminent at apex; pterostigma slightly pigmented. *Genitalia*. Sternite IX distal margin round. Telomeres strongly curved internally, narrowing apically, with round apexes. Volsella digitus spatular (wider apically), mildly curved internally; cuspis forming a rounded lobe. Ventral margin of penisvalva with about 20 minute denticles; valviceps apex round.

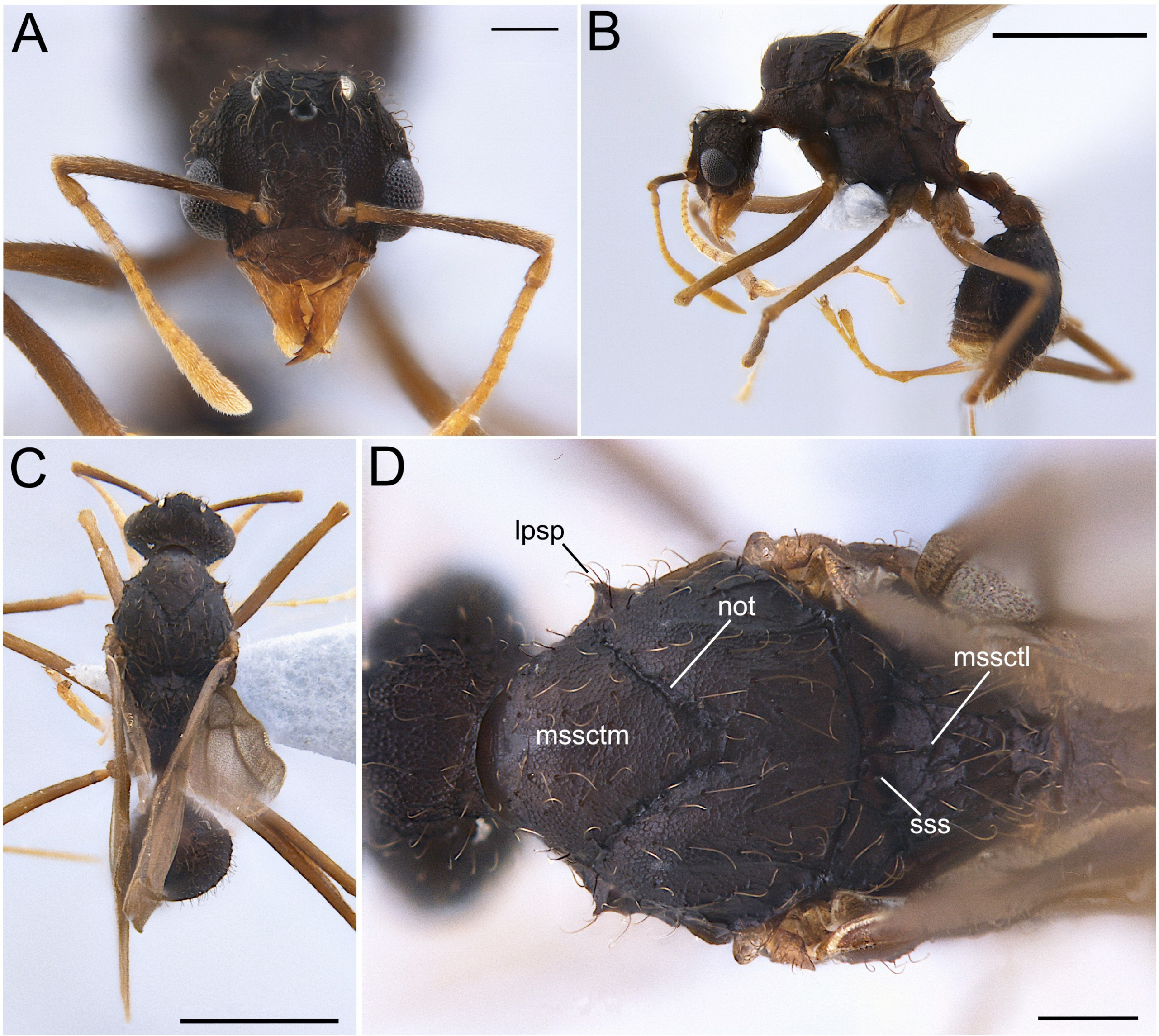

FIGURE 6. *Mycetomoellerius janildae* paratype male (ANTWEB1047950). **A,** full-face view; **B,** profile view; **C,** dorsal view; **D,** mesosoma in dorsal view. Abbreviations: **lpsp**, lateral pronotal spines; **mssctl**, mesoscutelum; **mssctm**, mesoscutum; **not**, notauli; **sss**, scutoscutellar suture. Scale bars 0.2 mm (A and D), and 1 mm (B and C).

Geographic distribution. Brazil (Bahia, Minas Gerais, Rio de Janeiro, and São Paulo), Panama, and Venezuela.

Comments. *Mycetomoellerius janildae* is similar to *M. relictus*, and some records of the latter could be of *M. janildae*. *Mycetomoellerius relictus* worker differs by the following characters: median pronotal spines present and not basally fused, vertexal margins angled, mesonotal projections blunt if present, abundant setae but that are shorter than those of *M. janildae*. Males of *M. janildae* and *M. relictus* are relatively similar, sharing the small lateral pronotal projections, narrow notauli, mesoscutellum with a pair of tiny blunt projections on the posterior edge, and propodeal spines short and blunt (Fig. 9). However, upon examining the genitalia differences can be observed, for example, the penisvalva of *M. relictus* has larger teeth on its ventral margin (Fig. 9, H), but smaller numbers than that of *M. janildae* (Fig. 9, G). Furthermore, a slight difference was observed in the shape of the apex of the penisvalva between the species, being more rounded in the case of *M. janildae* than in *M. relictus*. Despite these differences, both penisvalva follow a simple morphological pattern within Formicidae (Snodgrass, 1941), without major variations such as those observed in males of *Apterostigma* and *Mycocepurus*, which present notches and projections in certain regions of the penisvalva, in addition to a significant variation in the shape of its apex (Santos *et al*., 2024). Related to the volsella of males, a pattern common to species of the genus was observed, with the digitus internally curved and spatulate, with a slight difference in the cuspis lobe position.

Etymology. Named in honor of Janilda Aparecida Assis dos Santos, the mother of the first author. The name is formed by the addition of the singular Latin genitive case suffix -ae to the first name of a female person; the orthography of an eponym is unchangeable and is not dependent on the generic name in which the epithet is applied.

Biology. The entrance to the underground nest is approximately 4 mm in diameter at the base and is situated at the bottom of a small mound of moist soil, measuring approximately 1.5 cm in height. A chamber was found at a depth of 15–20 cm, containing 12 workers and a small fungal garden, but no queens. Despite further excavation, no additional chambers were located, though deeper chambers may exist. Workers have been observed to transport frass and fragments of flowers, which are likely to be used to cultivate their symbiotic fungus. The fungus displayed a spongy texture and a yellowish hue.

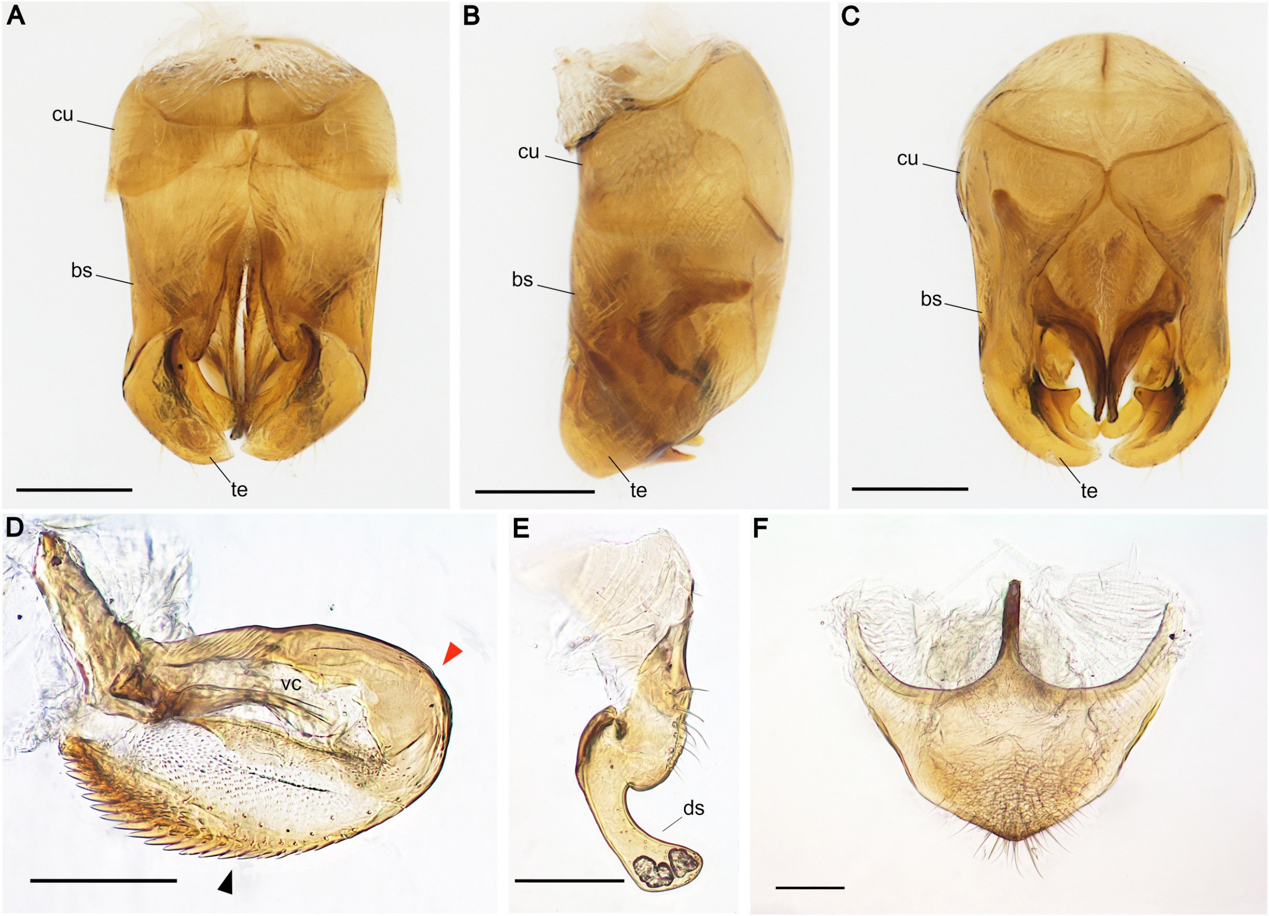

FIGURE 7. *Mycetomoellerius janildae* paratype male genitalia (ANTWEB1047950). **A,** genital capsule in ventral view; **B,** genital capsule in lateral view; **C,** genital capsule in dorsal view; **D,** penisvalva; **E,** volsella; **F,** sternite IX. Abbreviations: **bs**, basimere; **cu**, cupula; **ds**, digitus; **te**, telomere; **vc**, valviceps. Scale bars 0.1 mm.

Mycetomoellerius mesopleuralis Santos, Chaul & Serrão sp.nov.

(Fig. 8)

Type material. *Holotype worker*: BRA: SP, Agudos, -20.758332, -42.864533, 1959-04-30, Kempf, W. (1 worker, MZSPHYM0136545) [MZUSP]. *Paratypes workers*: BRA: SP, Agudos, -20.758332, -42.864533, 1959-04-30, Kempf, W. (Twelve workers with the following codes: MZSPHYM0144990, MZSPHYM0144991, MZSPHYM0136543, MZSPHYM0136544, MZSPHYM0144992, MZSPHYM0144993, MZSPHYM0136545, MZSPHYM0144994, MZSPHYM0144995, MZSPHYM0136546, MZSPHYM0144996, and MZSPHYM0144997) [all in MZUSP, except MZSPHYM0144991 which is in DZUP]. BRA: SP, Luiz Antônio, Estação Ecológica Jataí, -21.573941, -47.734546, Rogerio & Adriana col. (1 worker, MZSPHYM0136547) [CELC]. BRA: SP, Mogi Guaçu, Fazenda Caipirinha, -22.226970, -47.091813, Leal, I. R. (Two workers with the following codes: MZSPHYM0136548 and MZSPHYM0144998) [MZUSP].

Worker measurements (holotype): HL 0.93, HW 1.06, HW1 1.09, MdL 0.72, SL 0.85, PeL 0.14, A3L 0.07, MsL 1.41, PH 0.25, PL 0.39, PpH 0.25, PpL 0.33, HfL 1.19, G1L 1.13.

Measurements in mm (10 paratypes measured): HL 0.89–1.01, HW 0.93–1.10, HW1 0.96–1.10, MdL 0.65–0.73, SL 0.7–0.95, PeL 0.12–0.15, An3L 0.05–0.08, MsL 1.27–1.48, PH 0.20–0.26, PL 0.35–0.46, PPH 0.23–0.32, PPL 0.29–0.33, HFL 1.19–1.36, G1L 0.85–1.2.

Diagnosis. Body pilosity sparse, setae long and curved. Lateral pronotal spines well-developed; median pronotal spines well-developed, slightly basally fused. Mesonotum with two pairs of protuberances, anterior pair larger than posterior; mesopleural surface, apart from microtubercles, with one distinct digitiform protuberance anteroventrally directed. Frontal lobes subcircular, with crenulate margins; frontal carinae reach the vertexal margin. Postocular protuberance well-developed; preocular carinae extending to the vertexal margin. Vertexal corners angled, vertexal margin with distinct median emargination. Mandibles basally with oblique striations. First gastral tergite with linked tubercles, and a pair of lateral ridges.

Worker description. Medium-sized to large species for the genus standards; without strong polymorphism. Setation sparse on body, slightly longer and curved on dorsum of mesosoma and metasoma, shorter on head, suberect on legs and scape, appressed in flagelomeres. Integument matte, mildly farinose; uniformly brown, with head only slightly darker and appendages slightly lighter. *Head*. Eye mildly convex, slightly surpassing head lateral border. Mandibles shiny, except for oblique striations at base; masticatory margin with a total of ten teeth: apical tooth large followed by nine smaller, subequally-sized teeth. Anterior clypeal margin with a median notch about as wide as the maximum scape width. Frontal lobes subcircular, with crenulate margins; frontal carinae reaching vertexal margin. Frons shallowly concave. Vertexal carinae oblique, well-defined, extending towards the occipital region of head. Preocular carinae surpassing the vertexal margin as a projection in full-face view; postocular carina poorly developed, postocular protuberance well-developed. Vertexal corners angled, vertexal margin with distinct median emargination. In profile view, posterior section of ventral margin of head with a developed carina which has protuberances. Antennal scape slightly exceeding the vertexal margin, its maximum width just posterior to midlength, with many well-developed tubercles; totaling eleven antennomeres. *Mesosoma*. Pronotal medial pair of spines well-developed, with slightly fused bases; pronotum with a pair of well-developed anterolateral spines, sometimes with truncate tips. Mesonotum with two pairs of protuberances, an anterior larger pair, and a posterior reduced pair; mesopleural surface with several microtubercles and one prolonged digitiform protuberance directed anteroventrally in the inferior region of lower mesopleuron. Metanotal suture shallow and wide. Propodeum dorsum with well-developed tubercles, without well-defined lateral borders; pair of propodeal spines posterolaterally directed, slightly longer than the distance between their internal bases; propodeal spiracle projected from surrounding surface, posteriorly directed. *Metasoma*. In dorsal view, petiolar node subquadrate; postpetiole wider than long. Subpetiolar process merely a bump, and subpostpetiolar process tiny and digitiform. Petiolar node, postpetiole tergite and first gastral tergite covered by randomly distributed pilligerous tubercles; on first gastral tergite the tubercles are linked laterally and form a pair of longitudinal marginations, forming carinae, and some small tubercles forming interconnected carinae in dorsal region.

Queen and male. Unknown.

Geographic distribution. Brazil (São Paulo).

Comments. The new species is distinguishable from the others in the genus by the lower mesopleuron projection, which, in other species such as *M. janildae*, is limited to just a small edge of the cuticle, or located on the upper mesopleuron (as in *M. holmgreni*). *Mycetomoellerius mesopleuralis* shows some resemblance to *M. relictus* and *M. janildae* for sharing with them the well-developed lateral pronotal spines. Short tubercles, a common feature of the genus, are much more developed and evident in *M. mesopleuralis* than in most other species, particularly on the antennal scapes and the first gastral tergite. The species is only known from three localities in the Atlantic forest domain.

Etymology. The specific epithet '*mesopleuralis*' refers to the projection on the lower mesopleuron, with the Latin suffix '-alis' indicating relationship or belonging.

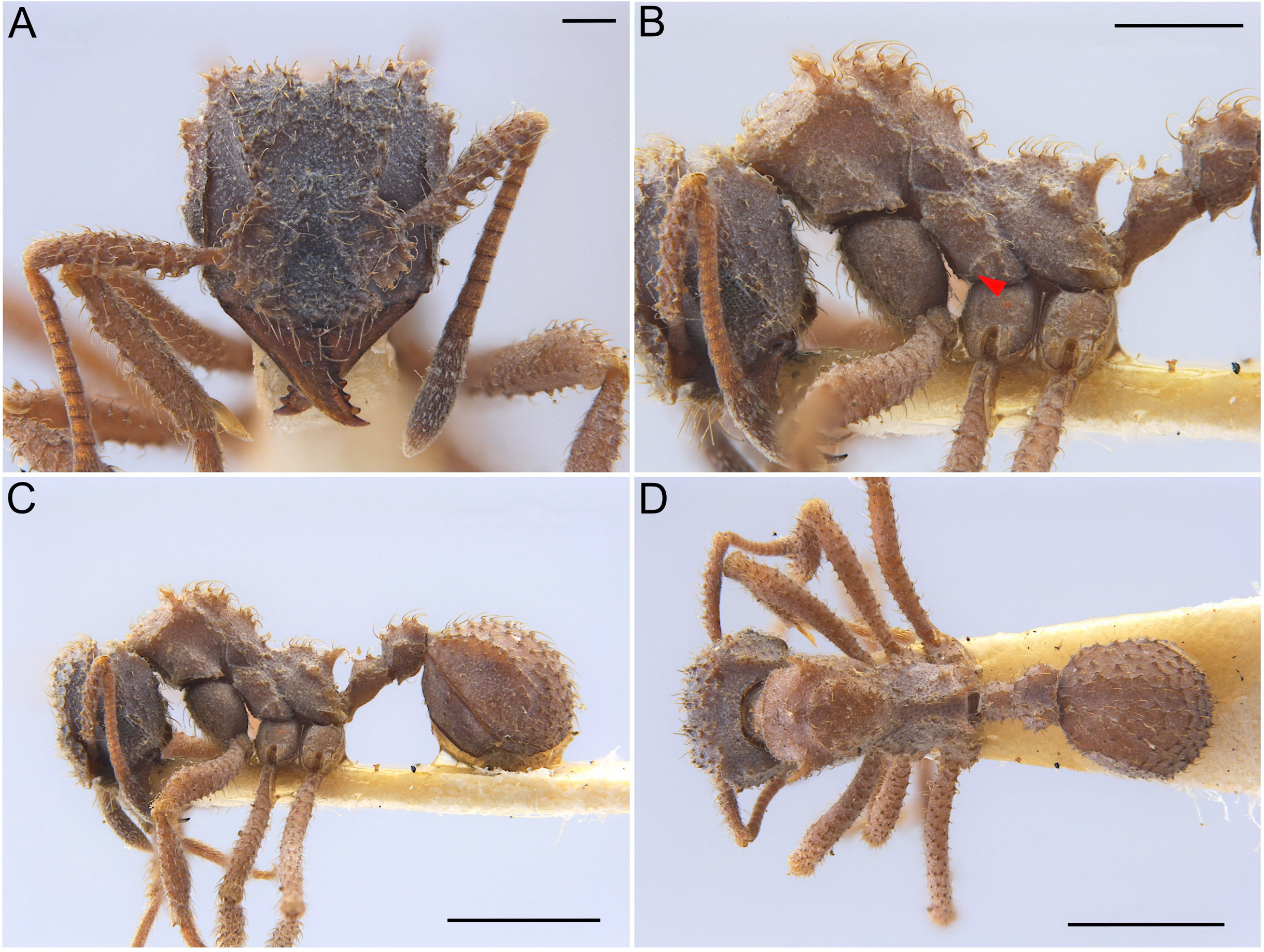

FIGURE 8. *Mycetomoellerius mesopleuralis* holotype (MZSPHYM0136545). **A,** full-face view; **B,** mesosoma, petiole and postpetiole in profile view; **C,** profile view; **D,** dorsal view. Red arrowhead, prolonged digitiform protuberance in the inferior region of lower mesopleuron. Scale bars 0.2 mm (A), 0.5 mm (B), and 1 mm (C and D).

Discussion

With the description of the two new species in this work, *Mycetomoellerius* now comprises 32 species, in addition to one fossil species from the Dominican Amber (Bolton, 2024), being, therefore, one of the most diverse genera within fungus-growing ants, together with *Acromyrmex* (34 species), *Apterostigma* (44 species), and *Myrmicocrypta* (27 species) (Bolton, 2024). Recently published reviews or studies have addressed some of these taxonomic gaps in fungus-farming ants, particularly by clarifying species boundaries and describing previously undocumented species (e.g. Sosa-Calvo & Schultz, 2010; Ješovnik & Schultz, 2017; Sosa-Calvo *et al*., 2017; Sosa-Calvo *et al*., 2018; Cardenas *et al*., 2021), and the present study, although small, represents another such advance, providing an updated key to the species of *Mycetomoellerius* and describing two new species, one of them, *Mycetomoellerius janildae*, including the queen and male.

Considering the ant male genitalia in species descriptions is important, for they are likely the result of intense Natural selection, and particularly Sexual selection, processes (Hosken & Stockley, 2004). However, the absence of males is commonplace in the descriptions of new ant species, which are usually worker-based (Yoshimura & Fisher, 2012; Boudinot, 2013; Boudinot, 2019). However, integrating males in ant taxonomy is becoming more common and has proven helpful in taxonomic investigations at the generic and the species level (Ješovnik & Schultz, 2017; Boudinot, 2019; Tozetto & Lattke, 2020; Dias & Lattke, 2021; Santos *et al*., 2024). The genital capsule between males of closely related species may exhibit variations in overall shape, particularly in the parameres. By dissecting it and exposing the penisvalvae and volsellae, further characters can be compared between the species. The males of *M. janildae* and *M. relictus* are very similar in their external morphology, however, significant differences were noted upon examining the penisvalva and volsella (Fig. 9).

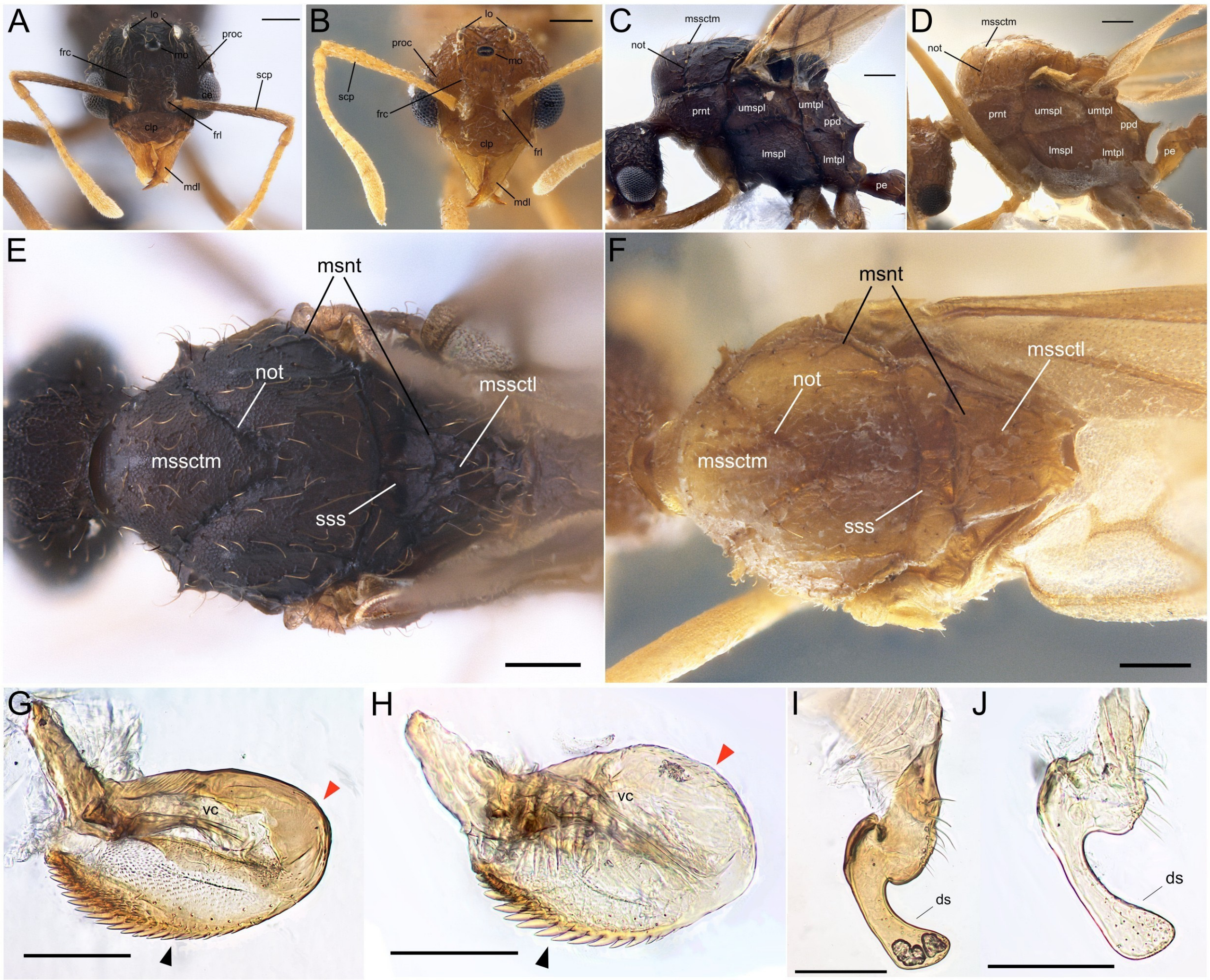

FIGURE 9. The male of *Mycetomoellerius janildae* (ANTWEB1047950) and *Mycetomoellerius relictus* (ANTWEB1053569 and MZSPHYM0135894). A, C, E, G, I, *M. janildae* male in: full face-view, profile view focus on the mesosoma, dorsal view focus on the mesonotum, penisvalva, volsella, respectively. B, D, F, H, J, *M. relictus* male in: full face-view, profile view focus on the mesosoma, dorsal view focus on the mesonotum, penisvalva, volsella, respectively. Photos of two different males of *M. relictus* were used, with the photo of the head (B) belonging to specimen ANTWEB1053569, and the remaining photos (D, F, H, J) to MZSPHYM0135894. Abbreviations: **ce**, compound eye; **clp**, clypeus; **ds**, digitus; **frc**, frontal carina; **frl**, frontal lobe; **lmspl**, lower mesopleuron; **lmtpl**, lower metapleuron; **lo**, lateral ocellus; **mdl**, mandible; **mo**, median ocellus; **msnt**, mesonotum; **mssctl**, mesoscutelum; **mssctm**, mesoscutum; **not**, notauli; **pe**, petiole; **ppd**, propodeum; **prnt**, pronotum; **proc**, preocular carinae; **scp**, antennal scape; **sss**, scutoscutellar sulcus; **umspl**, upper mesopleuron; **umtpl**, upper metapleuron; **vc**, valviceps. Red arrowhead, apex of valviceps; black arrowhead, ventral margin of penisvalva. Scale bars 0.2 mm in A–F and 0.1 mm in G–J.

In the taxonomic key to workers presented in this article, two species have many steps that can lead to each of them, *M. urichii* and *M. oetkeri*. Both are problematic species which need to be revised, each probably representing species complexes (sensu Bickford *et al*., 2006). These are only two examples, but species such as *M. farinosus* and several others may represent similar cases. Some species of *Mycetomoellerius* have few morphological data available, and in some cases, even holotypes may have been lost (*M. gaigei,* Fernández & Serna, 2019). Considering these factors and without a extensive revision of the genus, it is challenging to develop a solid and well-supported identification key at the moment. *Mycetomoellerius echinus*, *M. gaigei*, and *M. guianensis* were excluded from the identification key. *Mycetomoellerius echinus* has only been recorded from Bolivia (Janicki *et al*., 2016; Guénard *et al*., 2017), and its description is similar to that of *Trachymyrmex* (= *Paratrachymyrmex*) *phaleratus* Wheeler, 1925 (Weber, 1938). Due to the lack of specimens (either images or for direct investigation), and its limited distribution, the species was excluded from the key. The species *M. gaigei* and *M. guianensis* are both similar to *M. urichii,* but with limited morphological information available. *Mycetomoellerius gaigei* has a distribution limited to Colombia, and *M. guianensis* to Guyana (Janicki *et al*., 2016; Guénard *et al*., 2017).

The geographic distribution of *M. janildae* is broad, occurring in Brazil (Bahia, Minas Gerais, Rio de Janeiro, and São Paulo), as well as in Panama and Venezuela (Fig. 10). In contrast, *M. mesopleuralis* is currently known only from the state of São Paulo, with records from the eastern side of the state, in the Atlantic forest biome, where the distribution of both potentially overlaps (Fig. 10). Geographic restriction of *M. mesopleuralis* might be due to our own limited examined material, which was not composed of an extensive examination of all Brazilian ant collections. Extensive sampling and accurate occurrence records from museum specimens will be essential to accurately map the real distribution of *M. janildae* and *M. mesopleuralis*.

FIGURE 10. Distribution maps of *Mycetomoellerius janildae*, *M. mesopleuralis*, and *M. relictus* in South America.

Considering *Mycetomoellerius* taxonomic complexity, the use of molecular data is needed in order to understand the phylogenetic relationships within it. In the most recent phylogeny of the genus (Solomon et al. 2019), eight undescribed species were recovered as closely related to *M. relictus*, suggesting a species group around that species. Through morphology alone, *M. janildae* and *M. mesopleuralis* are likely phylogenetically related to *M. relictus*. Of the 30 described species of *Mycetomoellerius*, Solomon et al. (2019) included only 13 in their phylogeny. Formerly delimited species groups (Mayhé-Nunes & Brandão, 2002, 2005, 2007) can only be confirmed, corrected, or abolished in face of a molecular study of the genus that includes the majority of the described species. Future use of molecular data is an important step to precisely circumscribe this putative group of species and others within the genus formerly delimited species groups (Mayhé-Nunes & Brandão, 2002, 2005, 2007) can only be confirmed, corrected or abolished in face of a molecular study of the genus that includes the majority of the described species.

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Appendix 1

List of characters and their states and scored matrix for *Mycetomoellerius* species. Slashes (/) were used when both states were observed for each species; '-' was used when character states could not be determined for a given species.

01. First gastral tergite with strong lateral marginations, forming lateral swellings.

Absent (0); Present (1)

02. Scape basal lobe.

Absent (0); Present (1)

03. Pilosity.

Sparse (0); Dense (1)

04. Scape basal lobe development.

Well-developed (0); Reduced (1)

05. Frontal lobes shape.

Subtriangular (0); Subcircular (1)

06. Median pronotal spines.

Basally fused (0), Separated (1); Strongly basally fused (2); Absent (3)

07. Carina connecting lateral pronotal spines.

Absent (0); Present (1)

08. Pair of median ridges on first gastral tergite.

Absent (0); Present (1)

09. Comparative size between mesonotal projections.

Anterior projections taller than posterior projections (0); Anterior projections similar size to later ones, or smaller (1)

10. Propodeal spines.

Well-developed (0); Short (1)

11. Vertexal corners.

Angled (0); Curved (1)

12. Mesonotal projections.

Reduced (0); Well-developed (1)

13. Setae shape and size.

Erect (0); Curved (1); Long and flexible (2); Short and strongly curved (3); Short and spatulate (4)

14. Postocular protuberances.

Slightly developed (0); Well-developed (1)

15. Anterior mesopleural projection.

Absent (0); Present (1)

16. Median pronotal spines shape.

Simple (0); Each tooth apically bifurcated (1)

17. Scape basal lobe prominence.

Prominent basally and dorsally (0); Slightly prominent basally and dorsally (1)

18. Setae on first gastral tergite.

Only erect or suberect setae (0); Both erect and curved setae (1)

19. Mesopleural projection shape.

Wide and round lobe (0); Various shapes, never a wide round lobe (1)

20. Microtubercles on scape.

Different sizes, never well-developed (0); Well-developed (1)

21. Farinose tegument.

Absent (0); Generally present (1)

22. Metanotal suture.

Narrow (0); Broad (1)

23. First gaster tergite with well-developed tubercles, forming interconnected carinae.

Absent (0); Present (1)

24. Vertexal margin shape.

Roughly straight (0); Distinctly concave (1)

25. Preocular carinae.

Complete, without a median gap interrupting their development (0); Incomplete, with a median gap interrupting their development (1)

26. Median pronotal spines base size.

Wider than long (0); Longer than wide (1); As long as wide (2)

27. Posterodorsal margin of postpetiole.

Roughly straight (0); Distinctly concave (1)

Characters	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**
Mycetomoellerius agudensis (Kempf, 1967)	-	0	0	-	0	1	-	-	1	1	0	1	-	0
Mycetomoellerius atlanticus (Mayhé-Nunes & Brandão, 2007)	0	0	0	-	1	2	-	1	0 / 1	-	0	1	0 / 1	0
Mycetomoellerius cirratus (Mayhé-Nunes & Brandão, 2005)	0	1	0 / 1	0	1	0	1	1	-	0	1	0	3	0
Mycetomoellerius compactus (Mayhé-Nunes & Brandão, 2002)	0	0	1	-	1	-	-	-	-	1	0	0	2	-
Mycetomoellerius dichrous (Kempf, 1967)	0	0	1	-	1	-	-	-	0	1	1	1	2	0
Mycetomoellerius farinosus (Emery, 1894)	1	0	0	-	-	-	-	-	0	0	0	1	1	-

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Appendix 1 (Continued)

Mycetomoellerius fiebrigi (Santschi, 1916)	0	0	0	-	1	0	-	-	1	0	0	1	0 / 1	-
Mycetomoellerius haytianus (Wheeler & Mann, 1914)	0	0	0	-	-	2	-	-	0	0	0	1	0 / 1	0
Mycetomoellerius holmgreni (Wheeler, 1925)	0	1	0	0 / 1	-	1	-	-	-	0	-	0 / 1	0 / 1	1
Mycetomoellerius iheringi (Emery, 1888)	0	1	0	0	-	0 / 1	-	-	-	0	-	0	1	0
Mycetomoellerius isthmicus (Santschi, 1931)	0	0	0	-	-	1	-	-	0	1	0	1	0 / 1	1
Mycetomoellerius ixyodus (Mayhé-Nunes & Brandão, 2007)	0	0	0	-	1	1	-	1	1	0	0	-	0 / 1	0 / 1
Mycetomoellerius jamaicensis (André, 1893)	0	0	0	-	1	0 / 1 / 3	-	1	0	0	0	1	0 / 1	1
Mycetomoellerius jamaicensis antiguensis (Weber, 1938)	0	0	0	-	1	-	-	0	-	0	0	0	0 / 1	-
Mycetomoellerius janildae Santos, Chaul & Serrão, 2024	0	0	1	-	-	1 / 3	-	-	-	0	1	0	2	0
Mycetomoellerius kempfi (Fowler, 1982)	0	1	1	0	0	1	-	0	-	0	-	0	2	0
Mycetomoellerius mesopleuralis Santos, Chaul & Serrão, 2024	0	0	0	-	-	0 / 1	-	0	-	0 / 1	0	0	1	1
Mycetomoellerius mikromelanos Cardenas et al., 2021	0	0	0	-	-	0	-	0	1	0	0	1	0 / 1	1
Mycetomoellerius oetkeri (Forel, 1908)	0	0	0	-	-	0	-	0	0 / 1	-	0	1	0 / 1	-
Mycetomoellerius opulentus (Mann, 1922)	0	0	1	-	-	0	-	-	0	1	0	1	2	-
Mycetomoellerius papulatus (Santschi, 1922)	0	0	0	-	-	0	-	0	-	-	1	0	0 / 1	0
Mycetomoellerius pruinosus (Emery, 1906)	0	1	0	1	-	-	-	-	-	-	-	0 / 1	0 / 1	0
Mycetomoellerius relictus (Borgmeier, 1934)	0	0	1	-	-	1	-	-	-	-	0	0	2	-
Mycetomoellerius ruthae (Weber, 1937)	1	0	0	-	-	0 / 1	-	-	-	-	-	0	0 / 1	-
Mycetomoellerius squamulifer (Emery, 1896)	0	0	0	-	1	0	-	-	1	0	1	1	0 / 1	0
Mycetomoellerius tucumanus (Forel, 1914)	0	1	0	1	-	0	-	-	-	0	1	0 / 1	0 / 1	0
Mycetomoellerius turrifex (Wheeler, 1903)	0	0	0	-	1	0 / 2	-	-	1	0	0	1	0 / 1	0
Mycetomoellerius urichii (Forel, 1893)	0	0	0	-	-	0	-	-	0 / 1	0	0	1	0 / 1	1
Mycetomoellerius verrucosus (Borgmeier, 1948)	1	0	0	-	-	-	-	-	-	0	0	1	0 / 1	-
Mycetomoellerius zeteki (Weber, 1940)	0	0	0	-	-	0	-	-	0 / 1	0	0	1	0 / 1 / 4	1

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Appendix 1 (Continued)

Characters	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**
Mycetomoellerius agudensis (Kempf, 1967)	1	-	-	-	0	0	0	-	-	-	-	-	-
Mycetomoellerius atlanticus (Mayhé-Nunes & Brandão, 2007)	-	0	-	-	1	0	0	-	1	-	-	1	1
Mycetomoellerius cirratus (Mayhé-Nunes & Brandão, 2005)	1	0	-	0 / 1	1	0	0	-	1	-	-	-	-
Mycetomoellerius compactus (Mayhé-Nunes & Brandão, 2002)	-	-	-	-	1	0	0	0	-	-	-	-	-
Mycetomoellerius dichrous (Kempf, 1967)	-	-	-	-	1	0	0	-	0	-	-	-	-
Mycetomoellerius farinosus (Emery, 1894)	-	-	-	-	1	1	1	-	0	-	-	-	-
Mycetomoellerius fiebrigi (Santschi, 1916)	-	0	-	-	1	0	-	-	-	0	0	2	-
Mycetomoellerius haytianus (Wheeler & Mann, 1914)	-	0	-	-	1	0	0	-	-	-	-	1	0
Mycetomoellerius holmgreni (Wheeler, 1925)	1	0 / 1	-	0	1	0	0	-	1	-	-	-	-
Mycetomoellerius iheringi (Emery, 1888)	-	0	-	1	1	0	0	-	-	-	-	-	-
Mycetomoellerius isthmicus (Santschi, 1931)	-	0	-	-	1	0	0	-	1	-	-	-	-
Mycetomoellerius ixyodus (Mayhé-Nunes & Brandão, 2007)	1	0	-	-	1	0	0	0	-	-	-	-	-
Mycetomoellerius jamaicensis (André, 1893)	-	0	-	-	1	0	0	1	0	-	-	2	-
Mycetomoellerius jamaicensis antiguensis (Weber, 1938)	-	-	-	-	1	0	0	-	-	-	-	-	-
Mycetomoellerius janildae Santos, Chaul & Serrão, 2024	0	0	-	-	1	0	0	-	0	-	-	-	-
Mycetomoellerius kempfi (Fowler, 1982)	-	0	-	0 / 1	1	0	0	-	0	-	-	-	-
Mycetomoellerius mesopleuralis Santos, Chaul & Serrão, 2024	1	0	-	-	1	1	-	-	1	-	-	-	-
Mycetomoellerius mikromelanos Cardenas et al., 2021	-	0	-	-	1	0	-	-	1	1	0	-	-
Mycetomoellerius oetkeri (Forel, 1908)	-	0	-	-	1	0	0	-	-	-	1	-	-
Mycetomoellerius opulentus (Mann, 1922)	-	0	-	-	1	0	0	-	1	-	-	-	-
Mycetomoellerius papulatus (Santschi, 1922)	-	0 / 1	-	-	1	0	0	-	-	-	-	-	-
Mycetomoellerius pruinosus (Emery, 1906)	1	-	1	-	1	0	-	-	-	-	-	-	-
Mycetomoellerius relictus (Borgmeier, 1934)	-	0	-	-	1	0	0	1	0	-	-	-	-
Mycetomoellerius ruthae (Weber, 1937)	-	-	-	-	1	0	0	-	1	-	-	-	-
Mycetomoellerius squamulifer (Emery, 1896)	-	-	-	-	1	0	1	-	1	-	-	-	-

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Appendix 1 (Continued)

Mycetomoellerius tucumanus (Forel, 1914)	1	-	0	-	1	0	0	-	-	-	-	-	-
Mycetomoellerius turrifex (Wheeler, 1903)	-	-	-	-	1	0	0	-	-	1	0	0	-
Mycetomoellerius urichii (Forel, 1893)	-	1	-	-	1	0	0	-	-	-	-	-	-
Mycetomoellerius verrucosus (Borgmeier, 1948)	0	1	-	-	1	1	0	-	-	-	-	-	-
Mycetomoellerius zeteki (Weber, 1940)	-	1	-	-	1	0	1	-	1	-	-	-	-

3. CONSIDERAÇÕES FINAIS

O presente estudo contribui de forma significativa para a taxonomia e morfologia de formigas cultivadoras de fungos, com foco especial na descrição e redescrição de espécies de *Mycocepurus* Forel, 1893 e *Mycetomoellerius* Solomon et al., 2019. Os resultados obtidos reforçam a importância de integrar informações morfológicas detalhadas de machos junto às operárias para a compreensão e delimitação adequada de espécies.

Machos de *Mycocepurus goeldii* (Forel, 1893) e *Mycocepurus smithii* (Forel, 1893) foram redescritos, destacando características morfológicas pouco exploradas, como a morfologia das genitálias. Essas redescrições adicionam informações valiosas e fornecem uma base sólida para estudos futuros voltados para a taxonomia do gênero. Os machos de formigas são difíceis de serem devidamente identificados, porém, com trabalhos voltados para suas descrições, e de forma comparativa, a identificação tende a ser facilitada. Com o estudo, foi possível determinar caracteres essenciais para a diferenciação dos machos das espécies de *Mycocepurus*, e com isso, favorecendo a identificação precisa dos machos.

Dentre as formigas cultivadoras de fungo, o gênero *Mycetomoellerius* é um dos mais especiosos, e tem potencial para aumentar ainda mais o número total de espécies descritas. Na filogenia mais recente para o gênero, é possível identificar uma série de espécies novas que necessitam serem descritas. O presente estudo contribui para essa lacuna descrevendo duas novas espécies de *Mycetomoellerius*, incluindo o macho e a rainha de uma das espécies, aumentando o total de espécies viventes do gênero para 32. Foi apresentada uma chave de identificação multi-entrada para o gênero, pata identificação e delimitação das espécies, que anteriormente não possuíam chave atualizada. Além disso, foram apresentadas diagnoses para *Mycetomoellerius* e seus gêneros similares, *Trachymyrmex* Forel, 1893 e *Paratrachymyrmex* Solomon et al., 2019, facilitando a diferenciação entre os mesmos.

Com o estudo morfológico da genitália dos machos, foi possível notar diferenças significativas entre as espécies de *Mycocepurus* Forel, 1893, e entre as espécies de *Mycetomoellerius* Solomon et al., 2019, reforçando a importância dessa casta para estudos taxonômicos. A continuação de estudos taxonômicos detalhados, incluindo machos, é crucial para o avanço da taxonomia de formigas. A descrição de novas espécies é um fator fundamental para o conhecimento da biodiversidade, e a adição de descrições de machos e rainhas é essencial para trabalhos mais robustos, que reflitam corretamente as espécies, reduzindo ainda mais as lacunas de conhecimento acerca da biodiversidade.