Biota Neotropica 24(4): e20241686, 2024
www.scielo.br/bn

biotaneotropica
ISSN 1676-0611 (online edition)

Inventory

Frontier ants (Hymenoptera: Formicidae) unveiled: exploring the remarkable diversity of the Brazilian Far West

Amanda Martins Dias[1], Rodrigo Machado Feitosa[1]*

[1]*Universidade Federal do Paraná, Departamento de Zoologia, Laboratório de Sistemática e Biologia de Formigas, 81531–980, Curitiba, PR, Brasil.*
**Corresponding author: amandamdbio@gmail.com*

DIAS, A.M., FEITOSA, R.M. **Frontier ants (Hymenoptera: Formicidae) unveiled: exploring the remarkable diversity of the Brazilian Far West**. Biota Neotropica 24(4): e20241686. https://doi.org/10.1590/1676-0611-BN-2024-1686

Abstract: The Parque Nacional da Serra do Divisor (PNSD), renowned for its remarkable biodiversity, is a conservation unit of the Amazon biome situated at the westernmost limit of the Brazilian territory. However, the PNSD fauna is still poorly documented for most taxa. This study aimed to list the ant species (Hymenoptera: Formicidae) of the PNSD, comparing its diversity found with studies conducted in other hotspots of biodiversity of the world. Field collections were conducted in the northern region of PNSD for four days in 2016, using three collection methods: epigaeic pitfall traps, Winkler extractors, and hand collections. Even with the short sampling period, an impressive number of 261 species of ants were recorded, representing one of the highest richness documented for ants with the least sampling effort applied in a single locality worldwide. Of these species, 66 were newly recorded in the state of Acre, with six representing first-time records for Brazil. These findings highlight the critical importance of the PNSD as a strategic area for ant conservation, both in Brazil and globally.
Keywords: *Amazon; ant richness; conservation units; Formicidae; inventory; Serra do Divisor.*

Formigas fronteiriças (Hymenoptera: Formicidae) reveladas: explorando a notável diversidade do extremo oeste brasileiro

Resumo: O Parque Nacional da Serra do Divisor (PNSD), conhecido por sua notável biodiversidade, é uma unidade de conservação do bioma Amazônico situado no limite mais ocidental do território brasileiro. Contudo, a fauna do PNSD ainda é pouco documentada para a maioria dos táxons. Este estudo teve como objetivo listar as espécies de formigas (Hymenoptera: Formicidae) do PNSD, comparando a diversidade encontrada com estudos realizados em outros *hotspots* de biodiversidade do mundo. As coletas de campo foram realizadas na região norte do PNSD durante quatro dias no ano de 2016, utilizando três métodos de coleta: armadilhas epigeicas de queda, extratores de Winkler e coletas manuais. Mesmo com o período curto de amostragem, um número impressionante de 261 espécies de formigas foi registrado, representando uma das maiores riquezas documentadas para formigas com o menor esforço amostral aplicado em uma única localidade em todo o mundo. Destas espécies, 66 são novos registros para o estado do Acre, dos quais seis são registros inéditos para o Brasil. Essas descobertas destacam a importância crítica do PNSD como área estratégica para a conservação das formigas, tanto no Brasil quanto no mundo.
Palavras-chave: *Amazônia; riqueza de formigas; unidades de conservação; Formicidae; inventário; Serra do Divisor.*

Introduction

The Amazon Rainforest is known for its high diversity and its crucial role as carbon storage, which contributes to mitigating the consequences of global warming (Fearnside 2012, 2021, Marin et al. 2022). Nevertheless, the increase in deforestation rates in Brazilian Amazon over the past decade is a matter of concern among scientists due to the increasing biodiversity loss (Franco et al. 2019, Feng et al. 2021, Silva Junior et al. 2021, Portal TerraBrasilis - INPE 2024). To address this issue, one of the most effective strategies is to promote the establishment and ongoing maintenance of conservation units (Oliveira et al. 2021b, MMA 2023).

In Brazil there are 2,859 conservation units, which represents 19% of the country's continental territory. The Parque Nacional da Serra do Divisor (PNSD) is a Conservation Unit situated in Acre state, on the western frontier of Brazil, encompassing an expanse of 8,284.51 km² of well-preserved forest (MMA 2024). However, since the creation of the PNSD, in 1989, a road that would connect the interior of Acre to Peru has been planned to cross from one boundary of the park to the other (Federal Decree Nº 97.839). This threat is added to a bill (No. 6024/2019) that is currently under consideration by the Brazilian government and provides for the change of category of the PNSD to an "Environmental Protection Area", which would allow mineral exploration in the region (Ruaro & Laurance 2021, Koga et al. 2022).

If the threats suffered by the PNSD materialize, in addition to the social losses, the environmental damage could be irreversible, since the park is the only Brazilian conservation unit that covers the transition between the Amazon region and the Andes (Ruaro & Laurance 2021, Koga et al. 2022). Furthermore, although the scarce data on the biodiversity of the PNSD, it is known that the park is home to an enormous richness of animal and plant species (MMA 1998, Calouro 1999, Whitney et al. 2004, Morato et al. 2008, Koga et al. 2022). With the imminent threat of deforestation, surveys of local fauna and flora become even more urgent to advance knowledge about the richness of species in the western limit of Brazil.

Insects reign as the most diverse group of animals worldwide, with over a million described species (Stork 2018). Found in virtually all terrestrial ecosystems, they play crucial roles in ecosystem services such as pollination, herbivory, predation, and nutrient cycling (Noriega et al. 2018, Elizalde et al. 2020). However, in recent decades, several studies have warned about the rapid decrease in insect populations, raising discussions about the urgent need to develop strategies for their conservation (Habel et al. 2019, Forister et al. 2019, Wagner 2020).

Ants are known for their remarkable abundance and omnipresence in almost all terrestrial ecosystems of the planet (Schultheiss et al. 2022). Due to their high diversity and biomass, ants are essential for maintaining ecosystem functions such as predation, seed dispersal, and soil fertility (Wills & Landis 2018, Elizalde et al. 2020). Despite the recognized importance of these insects, knowledge about the conservation status of most species is still incipient. In the latest Red Book of Brazilian Fauna Threatened with Extinction, published in 2018, only 95 out of over 1500 ant species occurring in Brazil were included (ICMBio 2018, Feitosa et al. 2022). However, even among these 95 species, more than 20% (21 species) were not evaluated due to insufficient data (ICMBio 2018).

The PNSD is located in a region of Brazil considered a priority for ant collection due to the scarce sampling efforts in this region (Divieso et al. 2020, Schmidt et al. 2022). Studies in several animal groups have revealed the potential of the PNSD not only to document new species records for Brazil but also to discover new taxa (Azevedo & Batista 2002, Whitney et al. 2004, Dolibaina et al. 2015).

Conducting rapid inventories of local fauna is one of the most important strategies for species conservation, as it allows for the delimitation of endemic areas and mapping of species distributions (Samways et al. 2020). Therefore, the goal of this study was to list the ant species of the PNSD, both to reinforce the argument for the park's biodiversity and the need for its preservation and to update information regarding ants occurrence and distribution in Brazil.

Material and Methods

1. *Study area*

The Serra do Divisor National Park is located on the western edge of the state of Acre, Brazil, covering territories in the municipalities of Mâncio Lima and Cruzeiro do Sul, between the following coordinates: North: 07°07'00" S and 73°48'20" W; East: 09°08'40" S and 72°40'00" W; South: 09°24'40" S and 73°12'40" W; West: 07°32'40" S and 73°59'20" W (Federal Decree Nº 97.839) (Figure 1). The climate of the region is classified as tropical without a dry season, characterized by the temperature of the coldest month not exceeding 18ºC and rainfall of the driest month equal to or greater than 60 mm (Alvares et al. 2013). The predominant vegetation type is lowland tropical forest, although mosaics with a typical highland composition are also present. Collections were concentrated in the northern zone of the park, probably the area with the greatest biodiversity (MMA 1998).

2. *Collection*

Collections were conducted between November 15th and 18th, 2016, using epigaeic pitfalls, Winkler extractors and manual sampling. The pitfalls were installed on the 15th along the Formosa trail

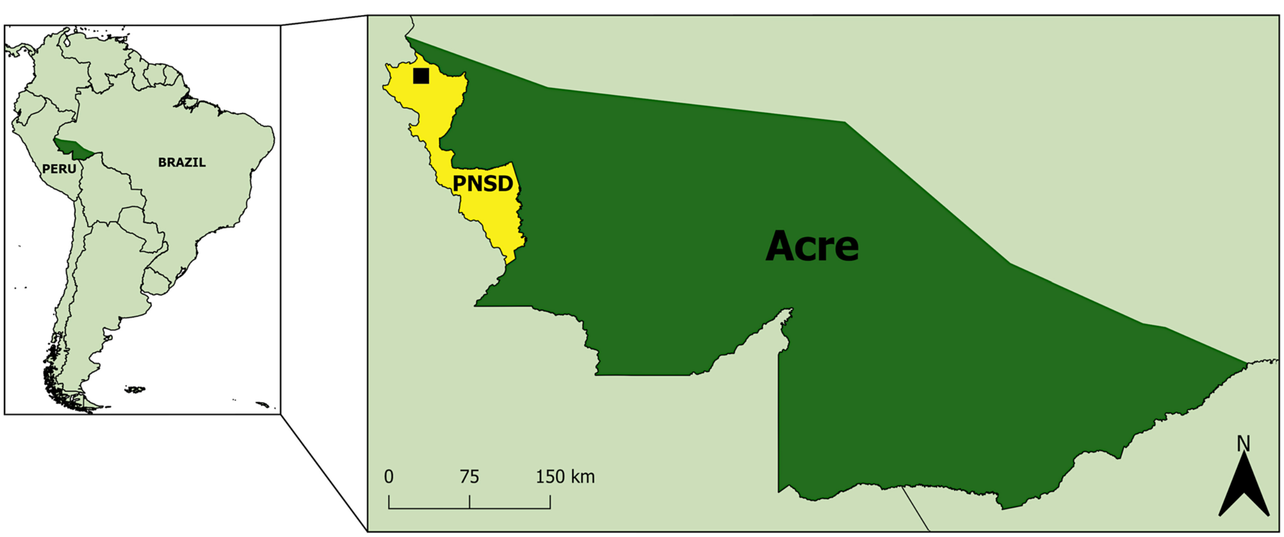

Figure 1. Location of the Serra do Divisor National Park (PNSD). The black square inside the PNSD represents the area where ant sampling was conducted.

(7º26'17.19" S 73º39'27.39" W, 245 m) and were distributed along three transects, each 500 meters long and spaced 1 km apart from each other. Each transect had 20 pitfalls, consisting of 300 mL plastic cups with a 10 cm opening, containing a solution of water and detergent. Following a 48-hour exposure period, the pitfalls were retrieved, and the ants separated.

Winkler extractor collections (33 samples, 11 each day) were qualitative and involved sieving 1 m² of leaf litter along with a small surface layer of soil. Each sieved sample was placed in a cloth bag and suspended in a Winkler extractor. A cup containing a moist damp flannel was attached to the bottom of each extractor. After three hours, the cups were removed, and their contents were emptied into a white tray to separate the live ants, which were transferred to vials containing absolute ethanol. This process was repeated after six hours and again after 24 hours. Both Winkler extractor and manual collections were conducted on November 16th, 17th, and 18th during the day along the three main trails within the PNSD: Formosa trail (7º26'17.19" S, 73º39'27.39" W 245 m); Mirante trail (7º26'56.65" S, 73º40'13.94" W, 345 m), and Barreiro trail (7º27'9.22" S 73º39'58.24" W 260 m). Manual sampling was also qualitative, involving active searches for ants both on the ground and in the vegetation in the intervals of Winkler extractor events in the three trails assessed. Hand collections were also carried out on the banks of the Moa River (7º26'58.81" S 73º39'37.83" W 245 m), which crosses the northern portion of the park.

3. Identification

Ants were identified to genus level using Baccaro et al. (2015). For identification at species level, specific keys available for each genus were used: Gonçalves (1961); Kempf (1966); Watkins (1976); Mackay (1996); Lattke (1997); Bolton (2000); Fernández (2003); Longino (2003); Longino & Fernández (2007); Wild (2007); Arias-Penna (2008); Fernández (2008); Mackay & Mackay (2010); Pacheco & Mackay (2013); Ješovnik & Schultz (2017); Fernández & Guerrero (2019); Fernández & Serna (2019); Oliveira & Feitosa (2019); Ortiz-Sepulveda et al. (2019); Solomon et al. (2019); Ward (2019); Camacho et al. (2020); Chaul (2020); Ladino & Feitosa (2020); Longino & Branstetter (2020); Ulysséa & Brandão (2021); Fernandes et al. (2021); Oliveira et al. (2021a); Barrera et al. (2022); and Williams et al. (2022). For the genus *Camponotus*, which lacks a key for Brazilian species, we compared our morphospecies with images of type specimens on Antweb (https://www.antweb.org). Additionally, specialists were consulted for taxa currently under taxonomic study, namely Frederico Marcineiro (*Pachycondyla*); Eder França (*Dolichoderus* and *Odontomachus*); Paloma Andrade (*Neocerapachys* and *Syscia*); Jaqueline Paes (*Nomamyrmex*); Lívia Prado (*Megalomyrmex* and *Octostruma*); Otávio Silva (*Rogeria*); and Alexandre Casadei-Ferreira (*Pheidole*). All specimens were deposited at the Padre Jesus Santiago Moure entomological collection, Universidade Federal do Paraná, Curitiba, Brazil (DZUP).

4. Literature revision

In order to compare the diversity found in this survey with previous studies in Brazil, we consulted Feitosa et al. (2022). Additionally, we also conducted a brief literature review to gather lists of ant species around the world. This involved searching in the Web of Science database the keywords "ants" and "list" in the Web of Science collection spanning all years. We then filtered the retrieved papers by removing the proceedings papers. In total, the abstracts of 775 works were analyzed (Supplementary material).

To verify possible new records of occurrence in the state of Acre or in Brazil, we compared the species found in the present study with lists of species from Acre previously published by Miranda et al. (2012) and Schmidt et al. (2020), as well as with the list of Brazilian species by Feitosa et al. (2022). Additionally, we consulted revision works for each genus (cited previously in the "Identification" section). Furthermore, we searched the antmaps.org database for species (Janicki et al. 2016, Guénard et al. 2017). For all records found on antmaps.org, we consulted the cited sources to ensure data accuracy.

5. Data processing

The map illustrating the location of the park was generated using the QGIS 3.32 software. Three shapefile files were used in the construction of the maps: one for the delimitation of the countries of South America (ANA 2010), one to delimit the state of Acre (IBGE 2022) and finally another with the delimitation of the PNSD (ICMBio 2024).

Seven species (Figure 2) were photographed using the Zen 2.3 software and the Zeiss Stereo Discovery V20 stereomicroscope, equipped with the Zeiss Axiocam 305 color video camera. Images and boards were processed using GIMP 2.10.34.

Results

A total of 261 species were collected distributed among 56 genera and 10 subfamilies. Among these, 171 were identified, five were indicated as near to known species (*nr.*) and 85 remained unidentified and were here considered as morphospecies. Notably, among the unidentified species, at least 23 are new to science, one of them being a new genus (Table 1) (Dias & Feitosa in prep., Silva et al. in prep., França et al. in prep., Feitosa et al. in prep.). The genera with the highest number of species were *Pheidole* (58), *Hypoponera* (15), *Strumigenys* (15), and *Camponotus* (14).

The method that collected the greatest diversity was the pitfall sampling accounting for 138 species, followed by the Winkler extractor with 121 species, and hand collections with 75 species. Remarkably, the majority of species (198) were exclusively captured by a single method, with pitfall traps recording the highest number of exclusive species (85), followed by the Winkler extractor (74), and hand collections (39).

An impressive number of 66 species were recorded for the first time in the state of Acre, six of which were also the first records for Brazil: *Apterostigma callipygium*, *Linepithema piliferum*, *Pheidole cuevasi*, *Pheidole demeter*, *Pheidole gilva* and *Pheidole sagax* (Table 1, Figure 2).

Discussion

Based on the diversity uncovered in the present survey and considering the short period of sampling (four consecutive days) and the effort employed (three collection methods), it can be inferred that the PNSD is one of the places with the highest ant diversity in Brazil, and perhaps in the world. While previous surveys in Brazil have reported comparable or greater richness, it is notable that these studies typically involved significantly larger sampling efforts. For instance,

Table 1. List of species in the Parque Nacional da Serra do Divisor and their respective collection methods. W = Winkler extractor; M = Manual sampling; P = Pitfall traps. Species marked with "*" represent first records for Acre and "**" represent first records for Brazil.

Taxon	Collection method		
	W	M	P
Amblyoponinae			
Fulakora n. sp.	x		
Prionopelta amabilis Borgmeier, 1949	x		
Prionopelta dubia Ladino & Feitosa, 2020		x	
Dolichoderinae			
Azteca ovaticeps Forel, 1904		x	
Azteca schimperi Emery, 1893*		x	
Azteca sp. 1	x	x	
Azteca sp. 2			x
Dolichoderus bidens (Linnaeus, 1758)			x
Dolichoderus debilis Emery, 1890		x	
Dolichoderus decollatus Smith, 1858		x	x
Dolichoderus ferrugineus Forel, 1903		x	
Dolichoderus imitator Emery, 1894	x		x
Dolichoderus lobicornis (Kempf, 1959)*		x	
Dolichoderus quadridenticulatus (Roger, 1862)		x	
Dolichoderus rugosus (Smith, 1858)		x	x
Dolichoderus schulzi Emery, 1894*		x	
Dolichoderus septemspinosus Emery, 1894		x	x
Linepithema piliferum (Mayr, 1870)**			x
Dorylinae			
Acanthostichus kirbyi Emery, 1895*		x	
Eciton burchellii (Westwood, 1842)		x	x
Eciton drepanophorum Smith, 1858*		x	x
Eciton lucanoides Emery, 1894		x	
Eciton quadriglume (Haliday, 1836)			x
Labidus praedator (Smith, 1858)		x	x
Neivamyrmex sp. 1		x	
Neivamyrmex sp. 2			x
Neivamyrmex n. sp.		x	
Neocerapachys neotropicus (Weber, 1939)*	x		
Nomamyrmex esenbeckii (Westwood, 1842)		x	
Syscia sp. 1	x		

Continue...

...Continuation

Taxon	Collection method		
	W	M	P
Ectatomminae			
Ectatomma brunneum Smith, 1858		x	
Ectatomma edentatum Roger, 1863		x	x
Ectatomma lugens Emery, 1894	x	x	x
Ectatomma tuberculatum (Olivier, 1792)		x	x
Gnamptogenys acuminata (Emery, 1896)	x		x
Gnamptogenys fernandezi Lattke, 1990*	x		
Gnamptogenys kempfi Lenko, 1964*	x		
Gnamptogenys regularis Mayr, 1870		x	x
Gnamptogenys sulcata (Smith, 1858)			x
Gnamptogenys tortuolosa (Smith, 1858)			x
Gnamptogenys n. sp.			x
Holcoponera pleurodon (Emery, 1896)*			x
Holcoponera moelleri Forel, 1912			x
Holcoponera striatula (Mayr, 1884)			x
New genus sp. 1	x		
Formicinae			
Brachymyrmex cavernicola Wheeler, 1938	x		
Brachymyrmex nr. termitophilus			x
Camponotus ager (Smith, 1858)			x
Camponotus atriceps (Smith, 1858)	x	x	x
Camponotus crassus Mayr, 1862		x	
Camponotus femoratus (Fabricius, 1804)		x	x
Camponotus heathi Mann, 1916		x	
Camponotus latangulus Roger, 1863		x	
Camponotus nidulans (Smith, 1860)		x	
Camponotus novogranadensis Mayr, 1870	x	x	x
Camponotus rapax (Fabricius, 1804)*		x	
Camponotus sexguttatus (Fabricius, 1793)		x	
Camponotus senex (Smith, 1858)			x
Camponotus sp. 1		x	x
Camponotus sp. 2			x
Camponotus sp. 3			x

Continue...

...Continuation

Taxon	Collection method		
	W	M	P
Gigantiops destructor (Fabricius, 1804)	x	x	x
Nylanderia caeciliae (Forel, 1899)*	x		x
Nylanderia docilis (Forel, 1908)*	x		
Nylanderia fulva (Mayr, 1862)			x
Nylanderia sp. 1	x		x
Nylanderia sp. 2	x		
Nylanderia sp. 3	x		
Myrmicinae			
Acromyrmex subterraneus (Forel, 1893)			x
Apterostigma gr. *auriculatum* sp. 1	x		
Apterostigma callipygium Lattke, 1997**	x		
Apterostigma ierense Weber, 1937*	x		
Apterostigma pilosum Mayr, 1865*	x		x
Apterostigma urichii Forel, 1893*	x	x	
Atta sexdens (Linnaeus, 1758)		x	
Cephalotes atratus (Linnaeus, 1758)		x	x
Cephalotes grandinosus (Smith, 1860)*		x	
Cephalotes inaequalis (Mann, 1916)*		x	
Cephalotes opacus Santschi, 1920		x	
Cephalotes placidus (Smith, 1860)		x	
Cephalotes spinosus (Mayr, 1862)		x	
Crematogaster brasiliensis Mayr, 1878			x
Crematogaster curvispinosa Mayr, 1862			x
Crematogaster flavomicrops Longino, 2003*	x		
Crematogaster limata Smith, 1858			x
Crematogaster nigropilosa Mayr, 1870			x
Crematogaster stollii Forel, 1885	x		
Crematogaster tenuicula Forel, 1904	x		
Crematogaster sp. 1			x
Cyphomyrmex hamulatus Weber, 1938*	x		x
Cyphomyrmex laevigatus Weber, 1938			x
Cyphomyrmex minutus Mayr, 1862	x		
Cyphomyrmex rimosus (Spinola, 1851)	x		x
Cyphomyrmex n. sp. 1	x		

Continue...

...Continuation

Taxon	Collection method		
	W	M	P
Cyphomyrmex n. sp. 2			x
Hylomyrma dolichops Kempf, 1973			x
Hylomyrma immanis Kempf, 1973			x
Hylomyrma marielleae Ulysséa, 2021			x
Megalomyrmex incisus Smith, 1947*	x		
Megalomyrmex balzani Emery, 1894			x
Megalomyrmex leoninus Forel, 1885		x	x
Megalomyrmex drifti Kempf, 1961*	x		
Mycetomoellerius farinosus (Emery, 1894)	x		x
Myrmicocrypta sp. 1	x		
Myrmicocrypta sp. 2			x
Nesomyrmex anduzei (Weber, 1943)*		x	
Nesomyrmex sp. 1			x
Ochetomyrmex neopolitus Fernández, 2003			x
Ochetomyrmex sp. 1	x		
Octostruma amrishi (Makhan, 2007)*	x		
Octostruma obtusidens Longino, 2013*	x		
Octostruma betschi Perrault, 1988	x		x
Octostruma iheringi (Emery, 1888)	x		
Octostruma pexidorsum Longino, 2013*	x		
Paratrachymyrmex bugnioni (Forel, 1912)	x		x
Paratrachymyrmex cornetzi (Forel, 1912)	x		x
Paratrachymyrmex diversus (Mann, 1916)*	x		
Paratrachymyrmex mandibularis (Weber, 1938)*	x		x
Paratrachymyrmex sp. 1	x		
Pheidole araneoides Wilson, 2003			x
Pheidole astur Wilson, 2003			x
Pheidole biconstricta Mayr, 1870	x		x
Pheidole nr. *biconstricta*			x
Pheidole cataractae Wheeler, 1916			x
Pheidole cuevasi Wilson, 2003**			x
Pheidole nr. *davidsonae*			x
Pheidole demeter Wilson, 2003**			x
Pheidole fimbriata Roger, 1863			x

Continue...

...Continuation

Taxon	**Collection method**		
	W	**M**	**P**
Pheidole gertrudae Forel, 1886		x	
Pheidole grandinodus Wilson, 2003*	x		x
Pheidole gilva Wilson, 2003**			x
Pheidole horribilis Wilson, 2003			x
Pheidole nr. *leonina*			x
Pheidole microps Wilson, 2003*	x		
Pheidole midas Wilson, 2003*			x
Pheidole oxyops Forel, 1908			x
Pheidole paraensis Wilson, 2003*			x
Pheidole nr. *piceonigra*			x
Pheidole sagax Wilson, 2003**			x
Pheidole stigma Wilson, 2003			x
Pheidole strigosa Wilson, 2003*	x		x
Pheidole subarmata Mayr, 1884			x
Pheidole transversostriata Mayr, 1887*		x	
Pheidole vallifica Forel, 1901*			x
Pheidole vorax (Fabricius, 1804)			x
Pheidole wallacei Mann, 1916*	x		
Pheidole sp. 1			x
Pheidole sp. 2			x
Pheidole sp. 3			x
Pheidole sp. 4	x		x
Pheidole sp. 5			x
Pheidole sp. 6			x
Pheidole sp. 7			x
Pheidole sp. 8			x
Pheidole sp. 9			x
Pheidole sp. 10			x
Pheidole sp. 11			x
Pheidole sp. 12			x
Pheidole sp. 13			x
Pheidole sp. 14	x		x
Pheidole sp. 15			x
Pheidole sp. 16			x

Continue...

https://doi.org/10.1590/1676-0611-BN-2024-1686

...Continuation

Taxon	Collection method		
	W	M	P
Pheidole sp. 17	x		x
Pheidole sp. 18			x
Pheidole sp. 19			x
Pheidole sp. 20	x		x
Pheidole sp. 21			x
Pheidole sp. 22			x
Pheidole sp. 27			x
Pheidole sp. 28			x
Pheidole sp. 30			x
Pheidole sp. 32	x		x
Pheidole sp. 34	x		
Pheidole sp. 36	x		
Pheidole sp. 38	x		
Pheidole sp. 40	x		
Pheidole sp. 41	x		
Rhopalothrix sp. n.	x		
Rogeria lirata Kugler, 1994	x		
Rogeria micromma Kempf, 1961*	x		
Rogeria scobinata Kugler, 1994*	x	x	
Rogeria n. sp. 1	x		
Rogeria n. sp. 2	x		
Sericomyrmex bondari Borgmeier, 1937	x		x
Sericomyrmex opacus Mayr, 1865*			x
Solenopsis saevissima (Smith, 1855)		x	x
Solenopsis virulens (Smith, 1858)	x	x	x
Solenopsis sp. 1	x		
Solenopsis sp. 2	x		x
Solenopsis sp. 3	x	x	x
Solenopsis sp. 4	x	x	x
Solenopsis sp. 5	x	x	
Solenopsis sp. 6	x	x	
Solenopsis sp. 7		x	x
Solenopsis sp. 8			x
Strumigenys alberti Forel, 1893	x		

Continue...

...Continuation

Taxon	**Collection method**		
	W	**M**	**P**
Strumigenys cosmostela Kempf, 1975*	x		
Strumigenys decipula (Bolton, 2000)*	x		
Strumigenys denticulata Mayr, 1887	x		x
Strumigenys elongata Roger, 1863	x		
Strumigenys glenognatha (Bolton, 2000)*	x		
Strumigenys inusitata (Lattke, 1992)*			x
Strumigenys metopia (Brown, 1959) *	x		
Strumigenys perparva Brown, 1958*	x		
Strumigenys precava Brown, 1954*	x		
Strumigenys stenotes (Bolton, 2000)*	x		
Strumigenys subedentata Mayr, 1887	x		
Strumigenys trudifera Kempf & Brown, 1969	x		
Strumigenys n. sp. lanuginosa complex	x		x
Strumigenys n. sp. gr. schulzi	x		
Tranopelta gilva Mayr, 1866			x
Wasmannia auropunctata (Roger, 1863)	x	x	x
Wasmannia rochai Forel, 1908	x		
Wasmannia scrobifera Kempf, 1961*	x		
Paraponerinae			
Paraponera clavata (Fabricius, 1775)		x	
Ponerinae			
Anochetus diegensis Forel, 1912	x		
Anochetus mayri Emery, 1884*	x		
Centromyrmex brachycola (Roger, 1861)			x
Hypoponera distinguenda inexpedita (Forel, 1911)*	x		
Hypoponera trigona cauta (Forel, 1912)*	x		
Hypoponera n. sp. 1	x		
Hypoponera n. sp. 2	x		
Hypoponera n. sp. 3	x	x	
Hypoponera n. sp. 4	x		
Hypoponera n. sp. 5	x		
Hypoponera n. sp. 6	x		
Hypoponera n. sp. 7	x		
Hypoponera n. sp. 8	x		x

Continue...

...Continuation

Taxon	Collection method		
	W	M	P
Hypoponera n. sp. 9	x		
Hypoponera n. sp. 10	x	x	
Hypoponera n. sp. 11	x		
Hypoponera n. sp. 12	x	x	
Hypoponera n. sp. 13	x	x	x
Mayaponera arhuaca (Forel, 1901)	x		
Mayaponera constricta (Mayr, 1884)	x		x
Neoponera apicalis (Latreille, 1802)			x
Neoponera carinulata (Roger, 1861)		x	
Neoponera laevigata (Smith, 1858)			x
Neoponera oberthueri (Emery, 1890)*	x	x	
Neoponera unidentata (Mayr, 1862)	x	x	
Neoponera verenae Forel, 1922			x
Odontomachus bauri Emery, 1892		x	
Odontomachus chicomendesi França, Fernandes & Lattke, 2024	x		x
Odontomachus haematodus (Linnaeus, 1758)		x	x
Odontomachus meinerti Forel, 1905	x		
Odontomachus yucatecus Brown, 1976*			x
Pachycondyla crassinoda (Latreille, 1802)			x
Pachycondyla harpax (Fabricius, 1804)			x
Platythyrea angusta Forel, 1901		x	
Pseudoponera gilberti (Kempf, 1960)*	x		
Thaumatomyrmex atrox Weber, 1939*			x
Proceratiinae			
Discothyrea humilis Weber, 1939*	x		
Discothyrea sexarticulata complex*		x	
Discothyrea sp. 1	x		
Probolomyrmex boliviensis Mann, 1923	x		
Pseudomyrmecinae			
Pseudomyrmex ethicus (Forel, 1911)*		x	
Pseudomyrmex beccarii (Menozzi, 1935)*		x	
Pseudomyrmex penetrator (Smith, 1877)*		x	
Pseudomyrmex tenuis (Fabricius, 1804)	x	x	x
Pseudomyrmex sp. 1		x	
Pseudomyrmex sp. 2		x	

Solar et al. (2016) documented 285 ant species across 18 areas within a territory spanning 2 million hectares in the eastern Amazon. Camacho & Vasconcelos (2015) registered 277 species in a single reserve in the Brazilian Cerrado, but the records are based in 10 years of samplings. Specifically for the state of Acre, western Amazon, a survey carried out by Oliveira et al. (2009) over three and a half years of collections recorded 276 ant species. Finally, an inventory carried out in Xapuri, also in Acre, by Miranda et al. (2017) recorded only two more species than our study (263 in their study, compared to 261 in ours), despite involving three collection events divided between three years using epigaeic pitfalls and vegetation beating method. The fact that two of the surveys with the highest species diversity were conducted in Acre suggests that this portion of the Brazilian Amazon may host one of the greatest ant diversities in the country.

The findings from the present study also stand out in a global context. Among the 775 studies analyzed, only two revealed a similar ant richness, albeit with considerably greater sampling efforts. In a study conducted in a protected area in Panama, Leponce et al. (2021) reported results from a year-long sampling effort combining 11 collection methods, which resulted in 405 species. Another study in Cameroon

Figure 2. Ants recorded in Brazil for the first time in the literature. A: *Apterostigma callipygium*; B: *Linepithema piliferum*; C: *Pheidole cuevasi*; D: *Pheidole demeter*; E: *Pheidole gilva*; F: *Pheidole sanax*. Images by the authors.

documented 306 species over a year and a half, using four collection methods: hand collecting, bait trap, Berlese extraction and pitfall traps (Tchoudjin et al. 2020). In light of this context, it is possible to place the PNSD in the global biodiversity spotlight, since the number of species recorded in the park over just four days distinguishes it as one of the surveys with the highest ant species richness documented ever.

More than 75% of species were exclusively captured by a single method, indicating that the combination of collection methods is the better approach to cover the highest ant diversity possible, as demonstrated by Delabie et al. (2021). The use of epigaeic pitfalls allows the capture of ants that walk on the soil surface, whereas the Winkler extractor is efficient for collecting ants that nest and forage in the interstices of the leaf-litter (Fisher 1999, Delabie et al. 2021). Since no traps were installed in the vegetation, manual collections were crucial for sampling some arboreal genera, such as *Pseudomyrmex* and *Cephalotes*, of which all species were collected manually.

The high diversity of *Pheidole* observed in this study is an expected result, as demonstrated by Feitosa et al. (2022), which showed that this is the most frequent genus recorded in ant diversity studies in Brazil. In fact, *Pheidole* stands as the most diverse ant genus in the world, boasting 1160 species and 124 subspecies described, with approximately 200 recorded in Brazil (Bolton 2024, AntWeb 2024). The large number of *Strumigenys* and *Camponotus* species recorded in the PNSD also corroborates Feitosa et al. (2022), who found these two genera (albeit with *Camponotus* preceding *Strumigenys*), to be the most specious after *Pheidole*. *Camponotus* ranks as the second most diverse genus worldwide, with 1086 species and 411 subspecies described, including approximately 170 occurring in Brazil (Bolton 2024, AntWeb 2024). Meanwhile, the richness of *Strumigenys* can be attributed to two factors: the high diversity of species (879, of which approximately 90 are recorded in Brazil) combined with the collection technique (Bolton 2024, AntWeb 2024). Among the 15 *Strumigenys* species found, 13 were captured exclusively using the Winkler extractor, underscoring the significance of this technique for collecting ants that nest and forage in leaf litter.

Hypoponera also stood out in our study by its great richness in the PNSD (15 species), which may be attributed to the use of the Winkler extractor, as these ants are among the most commonly found in the leaf-litter (Bolton & Fisher 2011). As demonstrated by Feitosa et al. (2022), *Hypoponera* is generally represented in studies by morphospecies, lacking specific-level identification, which is also the case in this study, with 13 out of the 15 species remaining unidentified. This issue stems from the dearth of taxonomic studies on the genus in Neotropical region, but an ongoing taxonomic revision by the authors of the present study has revealed that all 13 morphospecies listed here represent new species. Furthermore, new species were also recognized for six other genera (Table 1). This underscores the significance of the PNSD in advancing our understanding of ant diversity in Brazil.

Although our results are relevant from the point of view of the high richness of species recorded in a single conservation unit, the absence of frequently collected genera that have records in the state of Acre may indicate an artifact caused by the collection methods employed. Genera such as *Myrmelachista* and *Tapinoma*, usually found in vegetation, may not have been collected due to the lack of specific methods for this stratum in our inventory. Therefore, although we have added many new records for the state, many more may still be made as collections are carried out targeting other strata.

The new records of the species *Linepithema piliferum*, *Pheidole cuevasi*, *Pheidole demeter*, and *Pheidole gilva* in Brazil are expected, since they all have records in Peru, country that borders the PNSD. Although the records of species *Apterostigma callipygium*, and *Pheidole sagax* are not unexpected, the new findings presented in this study represent a significant extension of their distribution range, which was previously more closely documented in Ecuador and Colombia.

The area of PNSD was strongly influenced by the Andes during its geological and floristic formation (SEMA 2010). Its location in a transitional zone between the Andes and the Amazon likely contributes to the high biodiversity observed in the extreme west of Acre, as suggested by Ruaro & Laurance (2021). Additionally, the relatively low rate of accumulated deforestation (28.43 km² between 2008 and 2023) and low human density in the park contribute to the protection of PNSD's fauna from direct anthropogenic effects (Bardales et al. 2023, TerraBrasilis Portal – INPE 2024).

Finally, the results found in the present study emphasize the park's strategic significance for the conservation. In fact, the number of ant species newly recorded for the state of Acre (66), for Brazil (6), and the number of species potentially identified as new for science (22) is the most significant considering all recent surveys conducted in under-sampled regions of the western Amazon (Feitosa et al. 2022). These numbers are a strong indication that the PNSD is among the areas with the highest diversity of ants on the planet, even when compared to other conservation units with much greater sampling efforts. This finding underscores the importance of maintaining the PNSD as a National Park, ensuring the highest level of legal protection for the area.

Supplementary Material

The following online material is available for this article:

Table S1 – Supporting information: Frontier Ants Unveiled: Exploring the Remarkable Diversity of the Brazilian far west.

Acknowledgments

We thank Alexandre Casadei-Ferreira and Thiago Silva for their assistance in collecting the ants. We also express our gratitude to Eder França, Frederico Marcineiro, Paloma Andrade, Jaqueline Paes, Lívia Prado, Otávio Silva, and Alexandre Casadei-Ferreira for their support with species identifications. Ant collection was conducted under research permit SisBio 38818-6, issued by the Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio). We acknowledge the financial support provided by the National Council of Research and Scientific Development – CNPq (grants 301495/2019–0 and 140811/2019-2). This paper was also partially funded by the Partnerships for Enhanced Engagement in Research (PEER) Science Program (NAS/USAID – award number AID-OAAA-11-00012 – project 3-188).

Author Contributions

Amanda Martins Dias: conceptualization; methodology; investigation; visualization; writing – original draft; writing – review & editing. Rodrigo Machado Feitosa: conceptualization; funding acquisition; resources; methodology; investigation; visualization; writing – original draft; writing – review & editing.

Conflicts of Interest

The author(s) declare(s) that they have no conflict of interest related to the publication of this manuscript

Ethics

This study did not involve human beings and/or clinical trials that should be approved by one Institutional Committee.

Data Availability

Supporting data are available at: 10.5281/zenodo.12709586

References

Alvares, C. A., Stape, J. L., Sentelhas, P. C., de Moraes Gonçalves, J. L., & Sparovek, G. (2013). Köppen's climate classification map for Brazil. *Meteorologische Zeitschrift, 22*(6), 711–728. https://doi.org/10.1127/0941-2948/2013/0507

ANA – Agência Nacional de Águas. (2010). *Catálogo de Metadados da ANA*. https://metadados.snirh.gov.br/geonetwork/srv/api/records/7cfd53c4-b4e1-4aba-a79b-857a19649df6.

AntWeb. (2024). *Country: Brazil*. https://www.antweb.org/taxonomicPage.do?rank=genus&countryName=Brazil

Arias-Penna, T. M. (2008). Subfamilia Ectatomminae. In E. Jiménez, F. Fernández, T. M. Arias, & F. H. Lozano-Zambrano, (Eds.) *Sistemática, biogeografía y conservación de las hormigas cazadoras de Colombia* (pp. 53–107). Instituto de Investigación de Recursos Biológicos Alexander von Humboldt.

Azevedo, C. O., & Batista, M. L. (2002). New species of *Apenesia* (Hymenoptera, Bethylidae) from the Parque Nacional da Serra do Divisor, Acre, Brazil. *Revista Brasileira de Entomologia., 46*(1), 25–32. https://doi.org/10.1590/S0085-56262002000100005

Baccaro, F. B., Feitosa, R. M., Fernández, F., Fernandes, I. O., Izzo, T. J., Souza, J. L. P., & Solar, R. (2015). *Guia para os gêneros de formigas do Brasil*. INPA.

Bardales, R., Hyde, M., Gallo. J., & Boron, V. (2023). National parks and conservation concessions: a comparison between mammal populations in two types of tropical protected areas in Ucayali, Peru. *Journal of Tropical Ecology, 39*, 1–7. https://doi.org/10.1017/S0266467422000414

Barrera, C. A., Sosa-Calvo, J., Schultz, T. R., Rabeling, C., & Bacci, M. (2022). Phylogenomic reconstruction reveals new insights into the evolution and biogeography of *Atta* leaf-cutting ants (Hymenoptera: Formicidae). *Systematic Entomology*, *47*, 13–35. https://doi.org/https://doi.org/10.1111/syen.12513

Bolton, B. (2000). The ant tribe Dacetini. *Memoirs of the American Entomological Institute, 65*, 1–1028

Bolton, B. (2024, September 14). *An online catalog of the ants of the world*. Antcat. https://antcat.org.

Bolton, B., & Fisher, B. L. (2011). Taxonomy of Afrotropical and West Palaearctic ants of the ponerine genus *Hypoponera* Santschi (Hymenoptera: Formicidae). *Zootaxa, 2843*, 1–118. https://doi.org/10.11646/zootaxa.2843.1.1

Calouro, A. M. (1999). Riqueza de mamíferos de grande e médio porte do Parque Nacional da Serra do Divisor (Acre, Brasil). *Revista Brasileira de Zoologia, 16*, 195–213. https://doi.org/10.1590/S0101-81751999000600020

Camacho, G. P., Franco, W., & Feitosa, R. M. (2020). Additions to the taxonomy of *Gnamptogenys* Roger (Hymenoptera: Formicidae: Ectatomminae) with an updated key to the New World species. *Zootaxa, 4747*(3), 450–476. https://doi.org/10.11646/zootaxa.4747.3.2

Camacho, G. P., & Vasconcelos, H. L. (2015). Ants of the Panga Ecological Station, a Cerrado Reserve in Central Brazil. *Sociobiology, 62*(2), 281–295. https://doi.org/10.13102/sociobiology.v62i2.281-295

Chaul, J. (2020). A new species of *Discothyrea* Roger (Hymenoptera: Formicidae) from the Brazilian Atlantic Rainforest. *Boletim do Museu Paraense Emílio Goeldi – Ciências Naturais, 15*, 199–217. https://doi.org/10.46357/bcnaturais.v15i1.266

Delabie, J., Koch, E., Dodonov, P., Caitano, B., DaRocha, W., Jahyny, B., Leponce, M., Majer, J., & Mariano, C. (2021). Sampling and Analysis Methods for Ant Diversity Assessment. In J.C. Santos, & G.W. Fernandes (Eds), *Measuring Arthropod Biodiversity* (pp. 13–54). Springer. https://doi.org/10.1007/978-3-030-53226-0_2

Divieso, R., Rorato, A., Feitosa, R. M., Meyer, A. L. S., & Pie, M. R. (2020). How to prioritize areas for new ant surveys? Integrating historical data on species occurrence records and habitat loss. *Journal of Insect Conservation 24*, 901-911. https://doi.org/10.1007/s10841-020-00262-y

Dolibaina, D. R., Dias, F. M., Mielke, O. H., & Casagrande, M. M. (2015). *Argyrogrammana* Strand (Lepidoptera: Riodinidae) from Parque Nacional da Serra do Divisor, Acre, Brazil, with the description of four new species. *Zootaxa, 4028*(2), 227–45. http://dx.doi.org/10.11646/zootaxa.4028.2.4

Elizalde, L., Arbetman, M., Arnan, X., Eggleton, P., Leal, I. R., Lescano, M. N., Saez, A., Werenkraut, V., & Pirk, G. I. (2020). The ecosystem services provided by social insects: traits, management tools and knowledge gaps. *Biological Reviews*, *95*, 1418–1441. https://doi.org/10.1111/brv.12616

Fearnside, P. M. (2012). Brazil's Amazon forest in mitigating global warming: unresolved controversies. *Climate Policy, 12*, 70–81. https://doi.org/10.1080/14693062.2011.581571

Fearnside, P. M. (2021). The intrinsic value of Amazon biodiversity. *Biodiversity and Conservation, 30*, 1199–1202. https://doi.org/10.1007/s10531-021-02133-7

Federal Decree Nº 97.839 (1989). *Cria o Parque Nacional da Serra do Divisor*. https://www.planalto.gov.br/ccivil_03/decreto/Antigos/D97839.htm#:~:text=DECRETO%20N%C2%BA%2097.839%2C%20DE%2016,de%20acordo%20com%20o%20art.

Feitosa, R. M., Camacho, G. P., Silva, T. S. R., Ulysséa, M. A., Ladino, N., Oliveira, A. M., Albuquerque, E. Z., Schmidt, F. A., Ribas, C. R., Nogueira, A., Baccaro, F. B., Queiroz, A. C. M., Dáttilo, W., Silva, R. R., Santos, J. C., Rabello, A. M., Morini, M. S. de C., Quinet, Y. P., Del-Claro, K., Harada, A. Y., Carvalho, K. S., Sobrinho, T. G., Moraes, A. B., Vargas, A. B., Mauratorezan-Silingardi, H., Souza, J. L. P., Marques, T., Izzo, T., Lange, D., Santos, I. A., Nahas, L., Paolucci, L., Soares, S. A., Costa-Milanez, C. B., Diehl-Fleig, E., Campos, R. B. F., Solar, R., Frizzo, T., & Darocha, W. (2022). Ants of Brazil: an overview based on 50 years of diversity studies. *Systematics and Biodiversity, 20*, 1–27. https://doi.org/10.1080/14772000.2022.2089268

Feng, X., Merow, C., Liu, Z., Park, D. S., Roehrdanz, P. R., Maitner, B., Newman, E. A., Boyle, B. L., Lien, A., Burger, J. R., Pires, M. M., Brando, P. M., Bush, M. B., McMichael, C. N. H., Neves, D. M., Nikolopoulos, E. I., Saleska, S. R., Hannah, L., Breshears, D. D., Evans, T. P., Soto, J. R., Ernst, K. C., & Enquist, B. J. (2021). How deregulation, drought and increasing fire impact Amazonian biodiversity. *Nature, 597*, 516–521. https://doi.org/10.1038/s41586-021-03876-7

Fernandes, I. O., Larabee, F. J., Oliveira, M. L., Delabie, J. H. C., & Schultz, T. R. (2021). A global phylogenetic analysis of trap-jaw ants, *Anochetus* Mayr and *Odontomachus* Latreille (Hymenoptera: Formicidae: Ponerinae). *Systematic Entomology, 46*, 685–703. https://doi.org/10.1111/syen.12483

Fernández, F. (2003). Myrmicine ants of the genera *Ochetomyrmex* and *Tranopelta* (Hymenoptera: Formicidae). *Sociobiology, 41*, 633–661.

Fernández, F. (2008). Subfamilia Ponerinae s. str. In E. Jiménez, F. Fernández, T. M. Arias, F. H. Lozano-Zambrano (Eds.), *Sistemática, biogeografía y conservación de las hormigas cazadoras de Colombia* (pp. 123–218). Instituto de Investigación de Recursos Biológicos Alexander von Humboldt.

Fernández, F., & Guerrero, R. J. (2019). Subfamilia Ponerinae. Capítulo 17. In F. Fernández, R. J. Guerrero, & T. Delsinne (Eds.) *Hormigas de Colombia* (pp. 123–218). Universidad Nacional de Colombia.

Fernández, F., & Serna, F. J. (2019). Subfamilia Myrmicinae. Capítulo 27. In F. Fernández, R. J. Guerrero, & T. Delsinne (Eds.) *Hormigas de Colombia* (pp. 791–888). Universidad Nacional de Colombia.

Fisher, B. L. (1999). Improving inventory efficiency: a case study of leaf-litter ant diversity in Madagascar. *Ecological Applications, 9*, 714–731. https://doi.org/https://doi.org/10.1890/1051-0761(1999)009[0714:IIEACS]2.0.CO;2

Forister, M. L., Pelton, E. M., & Black, S. H. (2019). Declines in insect abundance and diversity: We know enough to act now. *Conservation Science and Practice, 1*, e80. https://doi.org/10.1111/csp2.80

Franco, A. L. C., Sobral, B. W., Silva, A. L. C., & Wall, D. H. (2019). Amazonian deforestation and soil biodiversity. *Conservation Biology, 33*, 590–600. https://doi.org/10.1111/cobi.13234

Gonçalves, C. R. (1961). O gênero *Acromyrmex* no Brasil (Hym. Formicidae). *Studia Entomologica, 4*, 113–180.

Guénard, B., Weiser, M., Gomez, K., Narula, N., & Economo, E. P. (2017). The Global Ant Biodiversity Informatics (GABI) database: a synthesis of ant species geographic distributions. *Myrmecological News, 24*, 83–89.

Habel, J. C., Samways, M. J., & Schmitt, T. (2019). Mitigating the precipitous decline of terrestrial European insects: Requirements for a new strategy. *Biodiversity and Conservation, 28*, 1343–1360. https://doi.org/10.1007/s10531-019-01741-8

IBGE – Instituto Brasileiro de Geografia e Estatística (2022). *Malha Municipal*. https://www.ibge.gov.br/geociencias/organizacao-do-territorio/malhas-territoriais/15774-malhas.html

ICMBio – Instituto Chico Mendes de Conservação da Biodiversidade (2024). *Parna da Serra do Divisor*. https://www.gov.br/icmbio/pt-br/assuntos/biodiversidade/unidade-de-conservacao/unidades-de-biomas/amazonia/lista-de-ucs/parna-da-serra-do-divisor

ICMBio – Instituto Chico Mendes de Conservação da Biodiversidade (2018). *Livro Vermelho da Fauna Brasileira Ameaçada de Extinção*. ICMBio.

Janicki, J., Narula, N., Ziegler, M., Guénard, B., & Economo, E. P. (2016). Visualizing and interacting with large-volume biodiversity data using client–server web-mapping applications: The design and implementation of antmaps.org. *Ecological Informatics, 32*, 185–193. https://doi.org/10.1016/j.ecoinf.2016.02.006

Ješovnik, A., & Schultz, T. R. (2017). Revision of the fungus-farming ant genus *Sericomyrmex* Mayr (Hymenoptera, Formicidae, Myrmicinae). *Zookeys, 670*, 1–109. https://doi.org/10.3897/zookeys.670.11839

Kempf, W. W. (1966). A revision of the Neotropical fungus-growing ants of the genus *Cyphomyrmex* Mayr. Part II: Group of *rimosus* (Spinola) (Hym., Formicidae). *Studia Entomologica, 8*, 161–200.

Koga, D. M., Brown, I. F., Fearnside, P. M., Salisbury, D. S., & Silva, S. S. (2022). Serra do Divisor National Park: a protected area under threat in the south-western Brazilian Amazon. *Environmental Conservation, 49*(2), 74–82. https://doi.org/10.1017/S0376892922000091

Ladino, N., & Feitosa, R. M. (2020). Taxonomic revision of the genus *Prionopelta* Mayr, 1866 (Formicidae: Amblyoponinae) for the Neotropical region. *Zootaxa, 4821*(2), 201–249. https://doi.org/10.11646/zootaxa.4821.2.1

Lattke, J. E. (1997). Revisión del género *Apterostigma* Mayr (Hymenoptera: Formicidae). *Arquivos do Instituto Biológico (São Paulo), 34*, 121-221. https://doi.org/10.11606/issn.2176-7793.v34i5p121–221

Leponce, M., Corbara, B., Delabie, J. H. C., Orivel, J., Aberlenc, H. P., Bail, J., Barrios, H., Campos, R. I., Nascimento, I. C. do, Compin, A., Didham, R. K., Floren, A., Medianero, E., Ribeiro, S. P., Roisin, Y., Schmidl, J., Tishechkin, A. K., Winchester, N. N., Basset, Y., & Dejean, A. (2021). Spatial and functional structure of an entire ant assemblage in a lowland Panamanian rainforest. *Basic and Applied Ecology, 56*, 32–44. https://doi.org/10.1016/j.baae.2021.06.007

Longino, J. T. (2003). The *Crematogaster* (Hymenoptera, Formicidae, Myrmicinae) of Costa Rica. *Zootaxa, 151*, 1–150. https://doi.org/10.11646/zootaxa.151.1.1

Longino, J. T., & Branstetter, M. G. (2020). Phylogenomic Species Delimitation, Taxonomy, and 'Bird Guide' Identification for the Neotropical Ant Genus *Rasopone* (Hymenoptera: Formicidae). *Insect Systematics and Diversity, 4*(2), 1–33. https://doi.org/10.1093/isd/ixaa004

Longino, J. T., & Fernández, F. (2007). Taxonomic review of the genus *Wasmannia*. In R. R. Snelling, B. L. Fisher,, & P. S. Ward (Eds.) *Advances in ant systematics (Hymenoptera: Formicidae): homage to E.O. Wilson – 50 years of contributions* (pp. 271–289). Memoirs of the American Entomological Institute.

Mackay, W. P. (1996). A revision of the ant genus *Acanthostichus* (Hymenoptera: Formicidae). *Sociobiology, 27*, 129–179.

Mackay, W. P., & Mackay, E. (2010). *The systematics and biology of the New World ants of the genus Pachycondyla (Hymenoptera: Formicidae)*. New York: Edwin Mellen Press.

Marin, F. R., Zanon, A. J., Monzon, J. P., Andrade, J. F., Silva, E. H. F. M., Richter, G. L., Antolin, L. A. S., Ribeiro, B. S. M. R., Ribas, G. G., Battisti, R., Heinemann, A. B., & Grassini, P. (2022). Protecting the Amazon forest and reducing global warming via agricultural intensification. *Nature Sustainability, 5*, 1018–1026. https://doi.org/10.1038/s41893-022-00968-8

Miranda, P. N., Baccaro, F. B., Morato, E. F., Oliveira, M. A., & Delabie, J. H. C. (2017). Limited effects of low-intensity forest management on ant assemblages in southwestern Amazonian forests. *Biodiversity and Conservation, 26*, 2435–2451. https://doi.org/10.1007/s10531-017-1368-y

Miranda, P. N., Oliveira, M. A., Baccaro, F. B., Morato, E. F., & Delabie, J. H. C. (2012). Check list of ground-dwelling ants (Hymenoptera: Formicidae) of the eastern Acre, Amazon, Brazil. *Check List, 8*(4), 722–730. https://doi.org/10.15560/8.4.722

MMA – Ministério do Meio Ambiente do Brasil (1998). *Plano de Manejo fase 2 – Parque Nacional da Serra do Divisor*. https://www.gov.br/icmbio/pt-br/assuntos/biodiversidade/unidade-de-conservacao/unidades-de-biomas/amazonia/lista-de-ucs/parna-da-serra-do-divisor.

MMA – Ministério do Meio Ambiente do Brasil (2023). *Painel Unidades de Conservação Brasileiras*. https://app.powerbi.com/view?r=eyJrIjoiMGNmMGY3NGMtNWZlOC00ZmRmLWExZWItNTNiNDhkZDg0MmY4IiwidCI6IjM5NTdhMzY3LTZkMzgtNGMx Zi1hNGJhLTMzZThmM2M1NTBlNyJ9&pageName=ReportSectione0a112a2a9e0cf52a827.

MMA – Ministério do Meio Ambiente e Mudança do Clima. (2024, September 14). *Plano de Ação para Prevenção e Controle do Desmatamento na Amazônia Legal Brasil - Ministério do Meio Ambiente e Mudança do Clima: 5ª fase (2023 a 2027)*. Brazilian Government. https://www.gov.br/mma/pt-br/assuntos/combate-ao-desmatamento/amazonia-ppcdam-1

Morato, E. F., Amarante, S. T., & Silveira, O. T. (2008). Avaliação ecológica rápida da fauna de vespas (Hymenoptera: Aculeata) do Parque Nacional da Serra do Divisor, Acre, Brasil. *Acta Amazonica*, *38*(4). https://doi.org/10.1590/S0044-59672008000400025

Noriega, J. A., Hortal, J., Azcárate, F. M., Berg, M. P., Bonada, N., Briones, M. J. I., Del Toro, I., Goulson, D., Ibanez, S., Landis, D. A., Moretti, M., Potts, S. G., Slade, E. M., Stout, J. C., Ulyshen, M. D., Wackers, F. L., Woodcock, B. A., & Santos, A. M. C. (2018). Research trends in ecosystem services provided by insects. *Basic and Applied Ecology, 26*, 8–23. https://doi.org/10.1016/j.baae.2017.09.006

Oliveira, A. M., & Feitosa, R. M. (2019). Taxonomic revision of the genus *Probolomyrmex* Mayr, 1901 (Hymenoptera: Formicidae: Proceratiinae) for the Neotropical Region. *Zootaxa, 4614*, 61–94. https://doi.org/10.11646/zootaxa.4614.1.3

Oliveira, A. M., Powell, S., & Feitosa, R. M. (2021a). A taxonomic study of the Brazilian turtle ants (Formicidae: Myrmicinae: *Cephalotes*). *Revista Brasileira de Entomologia, 65*(3), 1–52. https://doi.org/10.1590/1806-9665-rbent-2021-0028

Oliveira, G. C. de S., Henriques, N. R., Clemente, M. A., & Souza, M. M. (2021b). Conservation Units as a protection tool for social wasps in Minas Gerais state, Brazil. *Papéis Avulsos de Zoologia (São Paulo), 61*, e20216125. https://doi.org/10.11606/1807-0205/2021.61.25

Oliveira, M. A., Lucia, T. D., Marinho, C., Delabie, J. H. C., & Morato, E. F. (2009). Ant diversity in an area of the Amazon Forest in Acre, Brazil. *Sociobiology, 54*(1), 243–268.

Ortiz-Sepulveda, C. M., Van Bocxlaer, B., Meneses, A. D. & Fernández, F. (2019). Molecular and morphological recognition of species boundaries in the neglected ant genus *Brachymyrmex* (Hymenoptera: Formicidae): toward a taxonomic revision. *Organisms Diversity & Evolution, 19*, 447–542. https://doi.org/10.1007/s13127-019-00406-2

Pacheco, J. A., & Mackay, W. P. (2013). *The systematics and biology of the New World thief ants of the genus Solenopsis (Hymenoptera: Formicidae)*. Lewiston, New York: Edwin Mellen Press.

PL 6024/2019 (2019). *Projeto de Lei*. Brazilian Government. https://www.camara.leg.br/proposicoesWeb/fichadetramitacao?idProposicao=2229754.

Portal TerraBrasilis (INPE) (2024). *Access to interactive services*. http://terrabrasilis.dpi.inpe.br/app/dashboard/deforestation/biomes/legal_amazon/increments.

Ruaro, R., & Laurance, W. F. (2021). Pending bill could devastate Brazil's Serra do Divisor National Park. *Nature Ecology & Evolution*, *6*, 120–121. https://doi.org/10.1038/s41559-021-01632-8

Samways, M. J., Barton, P. S., Birkhofer, K., Chichorro, F., Deacon, C., Fartmann, T., Fukushima, C. S., Gaigher, R., Habel, J. C., Hallmann, C. A., Hill, M. J., Hochkirch, A., Kaila, L., Kwak, M. L., Maes, D., Mammola, S., Noriega, J. A., Orfinger, A. B., Pedraza, F., Pryke, J. S., & Cardoso, P. (2020). Solutions for humanity on how to conserve insects. *Biological Conservation, 242*, 108427. https://doi.org/10.1016/j.biocon.2020.108427

Schmidt, F. A., Costa, M. M. S., Martello, F., Oliveira, A. B., Menezes, A. S., Fontenele, L. K., Morato, E. F. & Oliveira, M. A. (2020). Ant diversity studies in Acre: what we know and what we could do to know more? *Boletim do Museu Paraense Emílio Goeldi Ciências Naturais, 15*(1), 113–134. http://doi.org/10.46357/bcnaturais.v15i1.235

Schmidt, F. A., Ribas, C. R., Feitosa, R. M., Baccaro, F. B., Queiroz, A. C. M. de, Sobrinho, T. G., Quinet, Y., Carvalho, K. S., Izzo, T., Morini, M. S. de C., Nogueira, A., Torezan-Silingardi, H. M., Souza, J. L. P., Ulysséa, M. A., Vargas, A. B., Dáttilo, W., Del-Claro, K., Marques, T., Moraes, A. B., Paolucci, L., Rabello, A. M., Santos, J. C., Solar, R., Albuquerque, E. Z. de, Esteves, F., Campos, R. B. F., Lange, D., Nahas, L., Santos, I. A. dos, Silva, R. R., Soares, S. A., Camacho, G. P., Costa-Milanez, C. B. da, DaRocha, W., Diehl-Fleig, E., Frizzo, T., Harada, A. Y., & Martello, F. (2022). Ant diversity studies in Brazil: an overview of the myrmecological research in a megadiverse country. *Insectes Sociaux, 69*, 105–121. https://doi.org/10.1007/s00040-022-00848-6

Schultheiss, P., Nooten, S. S., Wang, R., Wong, M. K. L., Brassard, F., & Guénard, B. (2022). The abundance, biomass, and distribution of ants on Earth. *Proceedings of the National Academy of Sciences U.S.A., 119*(40), e2201550119. https://doi.org/10.1073/pnas.2201550119

SEMA - Secretaria de Estado de Meio Ambiente do Acre (2010). *Livro Temático vol. 3/Recursos naturais: Biodiversidade e ambientes do Acre*. SEMA Acre.

Silva Junior, C. H. L., Pessôa, A. C. M., Carvalho, N. S., Reis, J. B. C., Anderson, L. O., & Aragão, L. E. O. C. (2021). The Brazilian Amazon deforestation rate in 2020 is the greatest of the decade. *Nature Ecology & Evolution, 5*, 144–145. https://doi.org/10.1038/s41559-020-01368-x

Solar, R. R. C., Chaul, J. C. M., Maués, M. & Schoereder, J. H. (2016). A Quantitative Baseline of Ants and Orchid Bees in Human-Modified Amazonian Landscapes in Paragominas, PA, Brazil. *Sociobiology, 63*, 925. https://doi.org/10.13102/sociobiology.v63i3.1052

Solomon, S. E., Rabeling, C., Sosa-Calvo, J., Lopes, C. T., Rodrigues, A., Vasconcelos, H. L., Bacci Jr, M., Mueller, U. G., & Schultz, T. R. (2019). The molecular phylogenetics of *Trachymyrmex* Forel ants and their fungal cultivars provide insights into the origin and coevolutionary history of 'higher-attine' ant agriculture. *Systematic Entomology, 44*, 939–956. https://doi.org/10.1111/syen.12370

Stork, N. E. (2018). How many species of insects and other terrestrial arthropods are there on earth? *Annual Review of Entomology, 63*, 31–45. https://doi.org/10.1146/annurev-ento-020117-043348

Tchoudjin, G.L., Zephirin, T., Fomekong-Lontchi, J., Kakam, S., Aymélé-Choungmo, S. R., Kenfack-Fogang, P., Massussi, J. A., Niba, A. S., & Djiéto-Lordon, C. (2020). Influence of season on leaf litter ant (Hymenoptera: Formicidae) diversity in the locality of Minko'o (Southern, Cameroon). *African Journal of Ecology*, *58*, 796–814. https://doi.org/10.1111/aje.12775

Ulysséa, M. A., & Brandão, C. R. F. (2021). Taxonomic revision of the Neotropical ant genus *Hylomyrma* Forel, 1912 (Hymenoptera: Formicidae: Myrmicinae), with the description of fourteen new species. *Zootaxa, 5055*, 1–137. https://doi.org/10.11646/zootaxa.5055.1.1

Wagner, D. L. (2020). Insect Declines in the Anthropocene. *Annual Review of Entomology, 65*, 457–480. https://doi.org/10.1146/annurev-ento-011019-025151

Ward, P. S. (2019). Subfamilia Pseudomyrmecinae. Capítulo 33. In F. Fernández, R. J. Guerrero, & T. Delsinne (Eds.) *Hormigas de Colombia* (pp. 1089–1113) Universidad Nacional de Colombia.

Watkins, J. F. (1976). *The identification and distribution of New World army ants (Dorylinae: Formicidae).* Waco, Texas: Baylor University Press.

Whitney, B. M., Oren, D. C.; & Brumfield, R. T. (2004). A New Species of *Thamnophilus* Antshrike (Aves: Thamnophilidae) from the Serra Do Divisor, Acre, Brazil. *The Auk, 121*(4), 1031–1039. https://doi.org/10.2307/4090473

Wild, A. L. (2007). Taxonomic revision of the ant genus *Linepithema* (Hymenoptera: Formicidae). *University of California Publications in Entomology, 126*, 1–151.

Williams, J. L., Zhang, Y. M., LaPolla, J. S., Schultz, T. R., & Lucky, A. (2022). Phylogenomic Delimitation of Morphologically Cryptic Species in Globetrotting *Nylanderia* (Hymenoptera: Formicidae) Species Complexes. *Insect Systematics and Diversity, 6*, 1–15. https://doi.org/10.1093/isd/ixab027

Wills, B. D., & Landis, D. A. (2018). The role of ants in north temperate grasslands: a review. *Oecologia, 186*, 323–338. https://doi.org/10.1007/s00442-017-4007-0

Wilson, E. O. (2003). *Pheidole in the New World. A dominant, hyperdiverse ant genus*. Cambridge, Mass.: Harvard University Press.

Received: 13/07/2024

Accepted: 28/10/2024

Published online: 02/12/2024