Checklist of spider species in a urban forest fragment in the Brazilian Amazon with 16 new local records and 3 new records from Brazil

Lista de espécies de aranhas em um fragmento urbano de floresta na Amazônia brasileira com 16 novos registros locais e 3 novos registros para o Brasil

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Abstract: The order Araneae comprises more than 52,000 described species of spiders and despite their high diversity, there is still a lot to study about their taxonomy and biogeography, especially in tropical regions. In this paper, we provide a checklist of spiders from the Research *Campus* of the Museu Paraense Emílio Goeldi, Belém, Pará, Brazil, with new records in different scales. The sampling occurred sporadically between 2011–2018, using different sampling methods. A total of 492 individuals of 172 morphospecies were recorded, distributed in 103 genera and 25 families. It was possible determining 84 species (48.8%), with 16 new records for Belém, including seven for Pará and three for Brazil. The relatively high species can be explained for many factors, such as sampling at different times of the year, use of various collection methods and the fact that the study area is connected to an extensive forest matrix to the northeast, possibly allowing the dispersal of individuals between areas. Finally, the new records, the high species richness and the amount of undetermined species highlights the challenges of having an acceptable level of faunistic knowledge of Amazonia spiders.

Keywords: Amazon. Diversity. Faunistic inventory. Belém. Goeldi Museum.

Resumo: A ordem Araneae reúne mais de 52.000 espécies descritas de aranhas e, apesar da alta diversidade, ainda há muito o que estudar sobre a taxonomia e a biogeografia do grupo, especialmente em regiões tropicais. Neste trabalho, fornecemos uma lista de espécies/morfoespécies de aranhas do *Campus* de Pesquisa do Museu Paraense Emílio Goeldi, Belém, Pará, Brasil, com novos registros em diferentes escalas. As coletas ocorreram de forma esporádica entre 2011–2018, mediante diversos métodos de coleta. Foram amostrados 492 indivíduos de 172 morfoespécies, distribuídas em 103 gêneros e 25 famílias. Foi possível determinar 84 espécies (48,8%), com 16 novos registros para Belém, incluindo sete para o Pará e três para o Brasil. A riqueza de espécies relativamente alta pode ser explicada por diversos fatores, como amostragem em diferentes épocas do ano, uso de vários métodos de coleta e o fato de a área de estudo estar conectada com uma matriz florestal extensa ao nordeste, possivelmente permitindo a dispersão de indivíduos entre as áreas. Por fim, os registros novos, a alta riqueza de espécies e a quantidade de espécies não determinados destacam os desafios de se obter um nível aceitável do conhecimento faunístico de aranhas na Amazônia.

Palavras-chave: Amazônia. Diversidade. Inventário faunístico. Belém. Museu Goeldi.

Pantoja, P., Xavier, C., Serrão, L. F. B., Favacho, C. A. C., Saturnino, R., & Bonaldo, A. B. (2025). Checklist of spider species in a urban forest fragment in the Brazilian Amazon with 16 new local records and 3 new records from Brazil. *Boletim do Museu Paraense Emílio Goeldi. Ciências Naturais*, *20*(1), e2025-1012. http://doi.org/10.46357/bcnaturais.v20i1.1012

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Received on 08/16/2024
Approved on 11/18/2024
Editorial responsibility: Leonardo Sousa Carvalho

INTRODUCTION

Spiders are a group of chelicerates with great evolutionary success, having conquered most of the terrestrial environments (S. C. Dias et al., 2009; Foelix, 2011) and reaching more than 52,800 species described to date (World Spider Catalog, 2025). Currently, thanks to the numerous taxonomists working in highly diverse tropical regions, new spider species are being described at a rapid pace, an average of 834 species annually between 2012 and 2021 (World Spider Catalog, 2025). This accelerated rate of discovery corroborates estimates that the actual global spider richness ranges from 60,000 up to 170,000 species (Coddington & Levi, 1991; Platnick, 1999).

Although spiders are present in great richness and abundance in the tropics (A. Santos et al., 2007; Table 1), there are still several aspects about them that we know very little about. For example, taxonomic knowledge of spiders is quite uneven, with some taxa being much better known than others (Bonaldo et al., 2009a). Likewise, knowledge about the distribution of Neotropical spider species is fragmented (Bonaldo et al., 2009b) and, especially in Brazil, records are concentrated in easily accessible areas, such as the vicinity of large cities, highways, and riverside regions (Bonaldo et al., 2009b; Brescovit et al., 2011; U. Oliveira et al., 2017; Rodrigues et al., 2017). Furthermore, even areas that already have several species records may still be undersampled and present new records when resampled, given that the total species richness in a region is rarely achieved (Coddington et al., 2009).

The knowledge about distribution of spiders is quite incipient in Brazilian Amazon. U. Oliveira et al. (2017), when analyzing the taxonomic literature on spiders and inventories of the Brazilian araneofauna published between 1757 and 2009, recognized 1,036 species of spiders for the Brazilian Amazon, based on 2,516 records of spider species for the biome. However, these records come from samples taken in only 12% of the area occupied by the Amazon biome (U. Oliveira et al., 2017), indicating a strong sampling bias which generates large gaps in knowledge about the distribution of spider species in that region. These gaps are even present in fragments preserved in urban areas, which often harbor an unknown spider fauna. For example, Carvalho & Gasnier (2019) found 94 spider morphospecies in a fragment of Amazon rainforest in the center of Manaus (AM, Brazil; Table 3) and were also able to identify four new records in Central Amazon. This reveals that even small fragments with altered climate and landscape, under the strong influence of the city, maintain a significant diversity of spider communities (Taucare-Ríos et al., 2013).

In the State of Pará, in the Oriental Amazon, there are a few locations that can be considered intensively sampled and with extensive published lists of spider species/morphospecies (Table 1). One of those checklists was provided by Rodrigues et al. (2017), who analyzed records from the Belém Area of Endemism, including portions of eastern Pará and western Maranhão, and obtained 319 species, with 247 records for the municipality of Belém. In the present paper, we provide a checklist of spiders sampled at the Research *Campus* of the Museu Paraense Emílio Goeldi (RC-MPEG), Belém, Pará, an area composed by buildings, herbaceous vegetations and forest fragments, highlighting new local (Belém) or regional (Pará/Brazil) records.

MATERIAL AND METHODS

STUDY AREA

The Research *Campus* of the Museu Paraense Emílio Goeldi (01° 27' 04.44" S, 48° 26' 39.32" W; RC-MPEG) has approximately 0.11 km^2 and is located in the municipality of Belém, Pará, in an area that has been intensely anthropized, bordered to the west by an extensive urban matrix and to the east by cultivated areas and fragments of rainforest (Figure 1). The internal area of the RC-MPEG consists of buildings surrounded by areas of herbaceous and/or shrub vegetation, in addition to small fragments of secondary forest in its northwest and southeast portions (Figures 1–2), partially isolated from the biggest forest fragment by a brick wall of approximately 2 meter high. The study

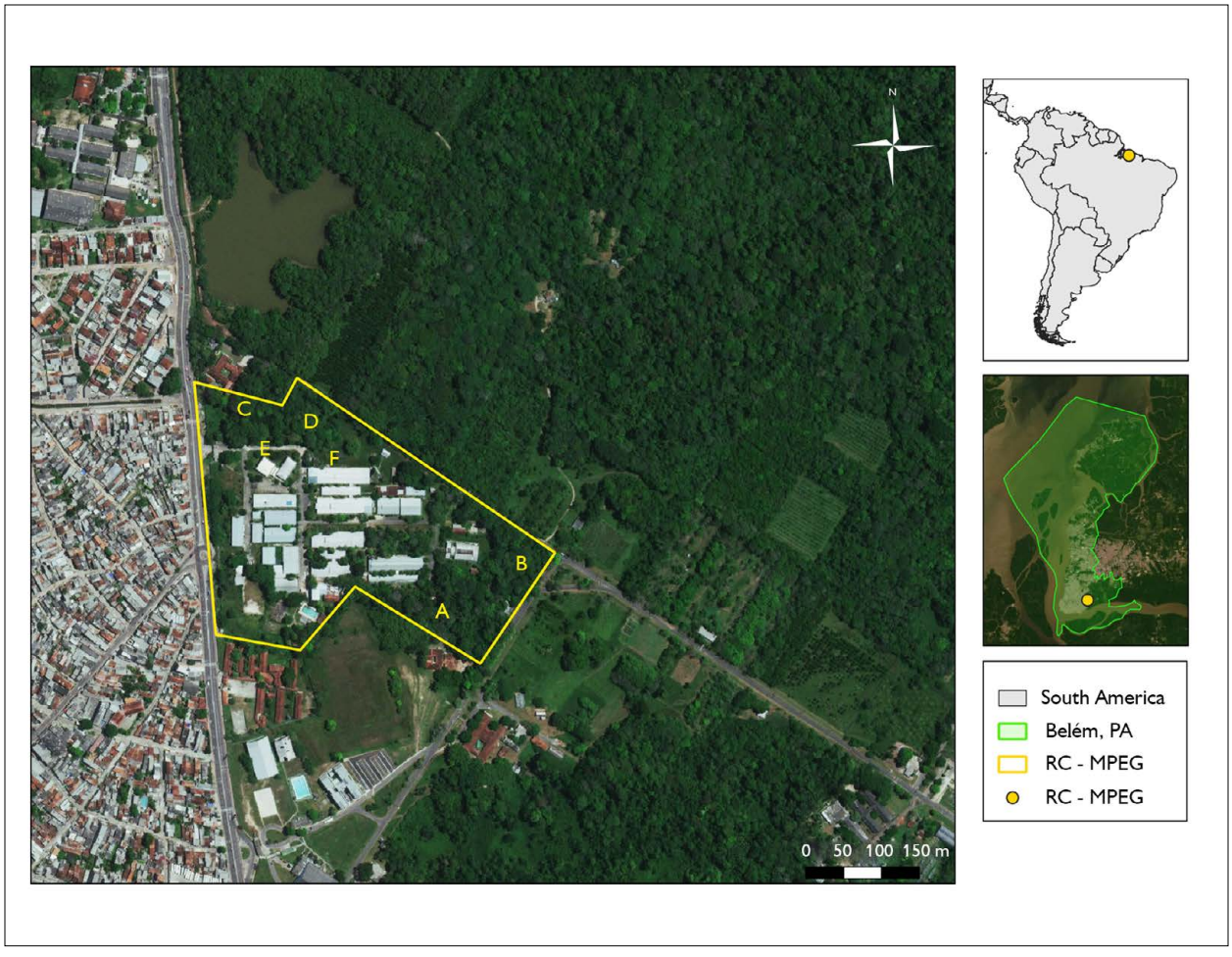

Figure 1. Map of the study area, Research *Campus* of the Museu Paraense Emílio Goeldi (in yellow), located in the city of Belém (in green), Pará, Brazil. The yellow letters (A–F) represent the images in Figure 2. Map: Paulo Pantoja (2017).

Table 1. Summary of inventories of spiders in regions of the State of Pará.

Reference	Locality	Species richness / Percentage of determined species
Ricetti and Bonaldo (2008)	Serra do Cachimbo, Novo Progresso	427 / 21%
Bonaldo et al. (2009b)	Caxiuanã National Forest, Melgaço	591 / 28%
Cafofo et al. (2013)	Caxiuanã National Forest, Melgaço	496 / 30%
Bonaldo et al. (2015)	Sustainable Industrial District of BR-163, Santarém – Castelo dos Sonhos	577 / 13%
Rodrigues et al. (2017)	Belém Area of Endemism, many municipalities	318 / 100%
Silva Junior and Saturnino (2016)	Reserva Extrativista Marinha de Soure, Soure	121 / 29%
Saturnino et al. (2017)	Bagre and Portel	493 / not provided

area is in the Afi climate zone, according to the Koppen classification, with a permanently humid climate and no cold season; the average annual precipitation reaches 2,834 mm (Belém, 2012).

DATA COLLECTION, IDENTIFICATION AND REGISTRATION

The sampling were conducted in several environments within the RC-MPEG, including the internal and external

Figure 2. Environments sampled at the RC-MPEG: A) forest area located to the southeast on the map; B) border area located to the southeast on the map; C-D) forest areas located to the northwest on the map; E-F) border areas at the entrance of the RC-MPEG, located to the northwest on the map. Photos: Paulo Pantoja (2016).

areas of the buildings, open areas dominated by grasses, and small forest fragments (Figure 2). Since the fragments were small and the sampling were intended to be qualitative, there was no demarcation of plots or control of the time spent on each method employed. Instead, sampling occurred across all possible environments within the *campus*, in sporadic periods between 2011 and 2018, with a considerably greater effort between 2014 and 2015, encompassing both rainy and dry seasons. During collections, at least one of the following methods were used: diurnal and nocturnal manual collections, beating tray, pitfall traps and Winkler extractors. All these methods were described by Bonaldo et al. (2009b).

The spiders were sorted and adult individuals were determined to the lowest possible taxonomic level based on literature available in the World Spider Catalog (2025). All adult individuals identified at the genus level were included, and when it was not possible to identify the species, the individuals were grouped into morphospecies based on genitalia characters. Adult individuals were fixed in 80% alcohol and deposited in the Arachnology Collection of the Museu Paraense Emílio Goeldi (MPEG; curator Alexandre B. Bonaldo). Some individuals were photographed in the field with a Canon 70D camera, Canon 100 mm 2.8 macro lens, external flash with homemade diffuser and collected for later identification. The map of the study area was created in the QGIS software v. 3.10 (QGIS Development Team, 2024), using the QuickMapServices plugin, v. 0.19, ESRI Satellite layer.

RESULTS

A total of 492 adult individuals belonging to 172 species/morphospecies, distributed in 113 genera and 25 families (Table 2; Figures 3–13) were obtained. Of this total, it was possible to identify 84 species (48.8%; Table 2), of which 16 species are new records from Belém, seven from Pará and three from Brazil. The most abundant species were *Micrathena aureola* (C. L. Koch, 1836) (n = 28; Figures 4A–4B), *Micrathena plana* (C. L. Koch, 1836) (n = 21; Figure 4E), Lycosidae sp. 1 (n = 16), *Scopocira tenella* Simon, 1900 (n = 15; Figure 9F), *Architis tenuis* Simon, 1898 (n = 13; Figure 7D), Oonopidae sp. 1 (n = 13), *Cotinusa dimidiata* Simon, 1900 (n = 12), *Philoponella opelli* Faleiro & Santos, 2014 (n = 11), *Eustala* sp. 1 (n = 11) and *Noegus coccineus* Simon, 1900 (n = 11), accounting for 22.8% of the total individuals collected. The remaining species/morphospecies were represented by 10 or fewer individuals, with 87 taxa represented by a single individual each (Table 2). Araneidae (38 spp.; n = 136) was the richest and most abundant family, followed by Salticidae (40 spp.; n = 101), which represented 45.3% of the species and 48.2% of the individuals collected. Eight families were represented by only one species/morphospecies (Table 2), namely: Gnaphosidae, Hahnnidae, Mimetidae, Ochyrocerathidae, Oecobiidae, Philodromidae, Sparassidae and Selenopidae.

Of the 84 species recorded for RC-MPEG, 56 species (67.4%) are widely distributed, among them: *Hasarius adansoni* (Audouin, 1826) is cosmopolitan, being found in several continents (World Spider Catalog, 2025); *Scytodes fusca* (Walckenaer, 1837) (Figure 12F) and *Zosis geniculata* (Olivier, 1789) (Figure 12F) have a pantropical distribution (World Spider Catalog, 2025); seven species are distributed throughout the Americas and another 46 species are distributed in the Neotropical region. On the other hand, 28 species have been recorded so far exclusively in the Amazon biome, among which *Capidava biuncata* Simon, 1902, *Lyssomanes tenuis* Peckham, Peckham & Wheeler, 1889 (Figure 9B), *Martella utingae* (Galiano, 1967), *Mesabolivar cambridgei* (Mello-Leitão, 1947), *Metazygia goeldii* Levi, 1995, *Myrmapana mocamboensis* (Galiano, 1974), *Rhyphelia muiratinga* (Ruiz, 2013) and *Tupirinna goeldi* Xavier & Bonaldo, 2021 are known only from the State of Pará, Brazil. Additionally, *Senoculus robustus* Chickering, 1941 (Figure 12C), *Eriophora nephiloides* (O. Pickard-Cambridge, 1889) and *Misumenoides rubrithorax* Caporiacco, 1947 (Figure 12B) are being recorded for the first time in Brazil and other 13 species are being recorded for the first time in the municipality of Belém, of which seven are new records for the State of Pará, totaling 16 new records (Table 2).

Table 2. List of spider species/morphospecies by family and number of individuals collected (N). Known distribution, type of new record (when applicable), and consulted bibliography in determining the species are provided by determined species. Synanthropic species are accompanied by '(S)'. (Continue)

Family / Species	N	Distribution	New record	Consulted bibliography
Anyphaenidae	5			
Anyphaenidae sp. 1	3			
Anyphaenidae sp. 2	1			
Anyphaenidae sp. 3	1			
Araneidae	136			
Alpaida truncata (Keyserling, 1865) (Figure 3A)	5	Neotropical		Levi (1988)
Alpaida veniliae (Keyserling, 1865)	2	Neotropical		Levi (1988)
Araneus guttatus (Keyserling, 1865)	1	Neotropical		Levi (1991a)
Argiope argentata (Fabricius, 1775) (S)	1	America		Levi (2004)
Bertrana striolata Keyserling, 1884	1	Neotropical		Levi (1989)
Cyclosa bifurcata (Walckenaer, 1841)	1	Neotropical		Levi (1999)
Cyclosa fililineata Hingston, 1932	2	Neotropical		Levi (1999)
Cyclosa tapetifaciens Hingston, 1932	1	Neotropical		Levi (1999)
Eriophora nephiloides (O. Pickard-Cambridge, 1889) (Figures 13A, 13B)	1	Neotropical	Brazil	Levi (1971)
Eustala sp. 1	11			
Eustala sp. 2	2			
Eustala sp. 3	4			
Eustala sp. 4	1			
Eustala sp. 5	3			
Eustala sp. 6	1			
Eustala sp. 7	1			
Eustala sp. 8	1			
Gasteracantha cancriformis (Linnaeus, 1758) (Figure 3E)	3	America		Levi (1996)
Mangora insperata Soares & Camargo, 1948	1	Amazon	Pará	Levi (2007)
Mangora melanocephala (Taczanowski, 1874)	2	Neotropical		Levi (2007)
Melychiopharis sp. 1	1			
Metazygia goeldii Levi, 1995	1	Amazon		Levi (1995a)
Metazygia yobena Levi, 1995	1	Amazon		Levi (1985)
Micrathena aureola (C. L. Koch, 1836) (Figures 4A-4B)	28	Neotropical		Levi (1985)
Micrathena evansi Chickering, 1960	7	Neotropical		Levi (1985)
Micrathena excavata (C. L. Koch, 1836)	1	Neotropical		Levi (1985)
Micrathena horrida (Taczanowski, 1873) (Figure 4D)	2	Neotropical		Levi (1985)
Micrathena patruelis (C. L. Koch, 1839)	3	Neotropical	Belém	Levi (1985)
Micrathena plana (C. L. Koch, 1836)	21	Neotropical		Levi (1985)
Micrathena schreibersi (Perty, 1833) (Figure 4C)	1	Neotropical		Levi (1985)
Micrathena spinosa (Linnaeus, 1758) (Figure 4E)	10	Amazon		Levi (1985)
Micrepeira hoeferi Levi, 1995	2	Neotropical	Pará	Levi (1995b)

Table 2. (Continue)

Family / Species	N	Distribution	New record	Consulted bibliography
Neoscona nautica (L. Koch, 1875)	2	Neotropical		Levi (1993)
Parawixia kochi (Taczanowski, 1873)	2	Neotropical		Levi (1992)
Scoloderus cf. *giber* (Figure 3D)	2			
Verrucosa sp. 1 (Figure 3F)	5			
Wagneriana neblina Levi, 1991 (Figure 4F)	1	Amazon	Belém	Levi (1991b)
Wagneriana transitoria (C. L. Koch, 1839)	1	Neotropical		Levi (1991b)
Corinnidae	13			
Corinna gr. *kochi* sp. n. 1	4			
Corinna gr. *kochi* sp. n. 2	2			
Corinna gr. *kochi* sp. n. 3	1			
Creugas sp. n. 1	3			
Falconina gracilis (Keyserling, 1891) (S)	1	America		Bonaldo (2000)
Myrmecotypus olympus Reiskind, 1969 (Figure 6D)	1	Neotropical		Reiskind (1969)
Simonestus sp. n. 1	1			
Tupirinna goeldi Xavier & Bonaldo, 2021	1	Amazon		Xavier and Bonaldo (2021)
Ctenidae	12			
Ancylometes rufus (Walckenaer, 1837) (S) (Figure 5A)	1	Neotropical		Höfer and Brescovit (2000)
Centroctenus ocelliventer (Strand, 1909) (Figure 5C)	1	Neotropical		Brescovit (1996)
Ctenus maculisternis Strand, 1909	5	Amazon		Höfer and Brescovit (1997)
Ctenus sp. 1	1			
Phoneutria reidyi (F. O. Pickard-Cambridge, 1897) (Figures 5E-5F)	1	Amazon		Eickstedt (1983)
Gnaphosidae	2			
Zimiromus aff. *tropicalis*	2			
Hahniidae	2			
Hahniidae sp.1	2			
Idiopidae	2			
Idiopis sp. 1 (Figure 6B)	1			
Idiopis sp. 2	1			
Ischnothelidae	4			
Ischnothele guianensis (Walckenaer, 1837) (S) (Figure 6A)	2	Amazon		Coyle (1995)
Ischnothele sp. 1	2			
Lycosidae	21			
Lycosidae sp. 1	16			
Lycosidae sp. 2	1			
Lycosa sp. 1	4			
Mimetidae	2			
Gelanor sp. 1 (Figure 6E)	2			
Ochyrocerathidae	5			
Ochyrocera hamadryas Brignoli, 1978	5	Amazon		Brignoli (1978)

Table 2. (Continue)

Family / Species	N	Distribution	New record	Consulted bibliography
Oecobiidae	7			
Oecobius concinnus Simon, 1893 (S)	7	America		A. Santos and Gonzaga (2003)
Oonopidae	26			
Amazonops sp. 1	2			
Aschnaoonops sp. 1	1			
Neoxyphinus barreirosi Abrahim & Bonaldo, 2012	3	Amazon	Belém	Abrahim et al. (2012)
Neoxyphinus termitophilus (Bristowe, 1938)	1	Neotropical		Abrahim et al. (2012)
Oonopidae sp. 1	13			
Oonopidae sp. 2	3			
Oonopidae sp. 3	1			
Oonopidae sp. 4	1			
Oonopidae sp. 5	1			
Oxyopidae	7			
Oxyopes sp. 1 (Figure 7C)	1			
Schaenicoscelis sp. 1 (Figure 7A)	4			
Tapinillus longipes (Taczanowski, 1872) (Figure 7B)	2	Neotropical	Belém	A. Santos (2004)
Philodromidae	3			
Cleocnemis querencia (Lise & Silva, 2011)	3	Amazon		Lise and Silva (2011)
Pholcidae	7			
Carapoia cambridgei (Mello-Leitão, 1947)	4	Amazon		Huber (2000)
Mesabolivar sp. 1 (Figure 6F)	3			
Pisauridae	20			
Architis tenuis Simon, 1898 (Figure 7D)	13	Neotropical		A. Santos (2007)
Thaumasia argenteonotata (Simon, 1898)	7	Neotropical		Silva and Carico (2012)
Salticidae	101			
Acragas aff. *falax*	1			
Acragas cf. *peckhami*	1			
Acragas sp. 1	1			
Acragas sp. 2	1			
aff. *Aphirape* sp. 1	1			
Bryantella sp. 1 (Figure 7F)	1			
Bryantella sp. 2	1			
Capidava biuncata Simon, 1902	4	Amazon		Edwards (2015)
cf. *llargus* sp. 1	1			
Chira trivittata (Taczanowski, 1871)	1	Neotropical		Galiano (1968)
Cotinusa dimidiata Simon, 1900	12	Amazon		Galiano (1968)
Freya decorata (C. L. Koch, 1846)	3	Amazon		Galiano (2001)
Frigga cf. *kessleri*	3			
Fritzia muelleri O. Pickard-Cambridge, 1879	2	Neotropical	Pará	Galiano (2001)
Gastromichans sp. 1	1			
Hasarius adansoni (Audouin, 1826) (S)	1	Cosmopolitan		Prószynski (2018)

Table 2. (Continue)

Family / Species	N	Distribution	New record	Consulted bibliography
Itata sp. 1	3			
Leptofreya aff. *ambigua*	4			
Lyssomanes aff. *robustus*	1			
Lyssomanes cf. *unicolor*	1			
Lyssomanes sp. 1	1			
Lyssomanes tenuis Peckham, Peckham & Wheeler, 1889	2	Amazon		Galiano (1962)
Maeota sp. 1	3			
Marma nigritarsis (Simon, 1900)	1	Neotropical		Zhang and Maddison (2015)
Martella utingae (Galiano, 1967)	1	Amazon		Galiano (1967)
Myrmapana mocamboensis (Galiano, 1974)	2	Amazon		Galiano (1974)
Noegus arator Simon, 1900	1	Amazon	Belém	J. Santos (2003)
Noegus cf. *franganilloi*	1			
Noegus coccineus Simon, 1900	10	Amazon	Pará	J. Santos (2003)
Nycerella cf. *neglecta*	2			
Parafluda banksi Chickering, 1946	2	Neotropical		Galiano (1971)
Philira sp. 1	4			
Rhyphaelia aff. *paxiuba*	1			
Rhyphelia muiratinga (Ruiz, 2013)	1	Amazon	Belém	Ruiz (2013)
Sarinda nigra Peckham & Peckham, 1892 (Figure 7A)	1	Neotropical		Galiano (1965)
Scopocira histrio Simon, 1900	2	Neotropical		Costa and Ruiz (2014)
Scopocira tenella Simon, 1900	15	Neotropical		Costa and Ruiz (2014)
Scopocira sp. 1	1			
Salticidae sp. 1	7			
Salticidae sp. 2	1			
Scytodidae	6			
Scytodes fusca Walckenaer, 1837 (S) (Figure 10B)	2	Pantropical		Šestáková et al. (2014)
Scytodes sp. 1	2			
Scytodes sp. 2	1			
Scytodes sp. 3	1			
Selenopidae	3			
Selenops maranhensis Mello-Leitão, 1918 (S) (Figure 10A)	3	Neotropical		Corronca (1995)
Senoculidae	3			
Senoculus robustus Chickering, 1941 (Figures 10C, 13E, 13F)	1	Neotropical	Brazil	Chickering (1941)
Senoculus sp. 1 (Figure 10D)	2			
Sparassidae	1			
Sparassidae sp. 1	1			
Tetragnathidae	5			
Azilia sp. 1 (Figure 10E)	3			
Leucauge sp. 1 (Figure 10F)	1			
Leucauge sp. 2	1			
Theraphosidae	4			
Acanthoscurria geniculata (C. L. Koch, 1841)	1	Amazon		Paula et al. (2014)

Table 2. (Continue)

Family / Species	N	Distribution	New record	Consulted bibliography
Avicularia avicularia (Linnaeus, 1758) (S) (Figures 11A, 11B)	3	Neotropical		Fukushima and Bertani (2017)
Theridiidae	41			
Achaearanea sp. 1	1			
Achaearanea sp. 2	1			
Achaearanea trapezoidalis (Taczanowski, 1873)	3	Neotropical		Levi (1955)
Anelosimus eximius (Keyserling, 1884)	10	America		Agnarsson (2006)
Ariamnes attenuatus O. Pickard-Cambridge, 1881	1	Neotropical		Exline and Levi (1962)
Dipoena cf. *hortoni*	2			
Janula salobrensis (Simon, 1895)	5	Neotropical		Levi (1964)
Spintharus flavidus Hentz, 1850	4	America		Levi (1963b)
Steatoda sp. 1	5			
Theridion cf. *archeri*	2			
Theridion soaresi Levi, 1963	1	Amazon		Levi (1963a)
Theridion sp. 1	2			
Thwaitesia bracteata (Exline, 1950)	2	Amazon		Levi (1963b)
Thymoites cf. *prolatus*	1			
Tidarren sisyphoides (Walckenaer, 1841) (S)	1	America		Levi (1957)
Thomisidae	28			
Bucranium taurifrons (O. Pickard-Cambridge, 1881)	1	Neotropical		Teixeira et al. (2014)
Epicadinus biocellatus Mello-Leitão, 1929 (Figure 11E)	2	Amazon		Prado et al. (2018)
Epicadus taczanowskii Roewer, 1951 (Figures 11C, 11D)	5	Neotropical		Machado et al. (2018)
Misumenoides rubrithorax Caporiacco, 1947 (Figures 12B, 13C, 13D)	2	Neotropical	Brazil	Lise et al. (in prep.)
Misumenops sp. 1	5			
Onocolus echinatus (Taczanowski, 1872)	1	Neotropical		Lise (1981)
Strophius cf. *albofasciatus*	1			
Strophius nigricans Keyserling, 1880 (Figure 12A)	2	Neotropical		Teixeira et al. (2014)
Synema sp. 1 (Figure 12C)	4			
Synema sp. 2 (Figure 12D)	1			
Tmarus sp. 1	1			
Tmarus sp. 2	1			
Tmarus sp. 3	1			
Tmarus sp. 4	1			
Tmarus sp. 5	1			
Trechaleidae	15			
Dossenus cf. *longipes* (Figure 12E)	7			
Neoctenus comosus Simon, 1897	7	Neotropical	Pará	Dávila (2003)
Syntrechalea adis Carico, 2008	1	Amazon	Pará	Carico (2008)
Uloboridae	12			

Table 2. (Conclusion)

Family / Species	N	Distribution	New record	Consulted bibliography
Philoponella opelli Faleiro & Santos, 2014	11	Neotropical	Pará	Faleiro and A. Santos (2014)
Zosis geniculata (Olivier, 1789) (S) (Figure 12F)	1	Pantropical		Opell (1979)
Individuals total	492			

Figure 3. Diversity of Araneidae at the RC-MPEG: A) *Alpaida truncata*, male; B) *Cyclosa* sp., female; C) *Eustala* sp., male; D) *Scoloderus* sp., female; E) *Gasteracantha cancriformes*, female; F) *Verrucosa* sp., female. Photos: César Favacho (2016).

Figure 4. Diversity of Araneidae at the RC-MPEG, genera *Micrathena* and *Wagneriana*: A-B) *Micrathena aureola*; A) female; B) male; C) *Micrathena schreibersi*, female; D) *Micrathena horrida*, subadult male; E) *Micrathena plana*, female; F) *Wagneriana neblina*, female. Photos: César Favacho (2016).

Figure 5. Diversity of Ctenidae at the RC-MPEG: A) *Ancylometes rufus*, male; B) *Ctenus* sp., female; C) *Centroctenus ocelliventer*, female; D) *Ctenus* sp., female; E-F) *Phoneutria reidyi*, male; E) dorsolateral view; F) frontal view. Photos: César Favacho (2016).

Figure 6. Diversity of spiders at the RC-MPEG: A) *Ischnothele guianensis*, Ischnothelidae, female; B) *Idiops* sp., Idiopidae, male; C) *Corinna* sp., Corinnidae, male; D) *Myrmecotypus niger*, Corinnidae, male; E) *Gelanor* sp., Mimetidae, female; F) *Carapoia fowleri*, Pholcidae, female. Photos: César Favacho (2016).

Figure 7. Diversity of Oxyopidae (A-D) and Salticidae (E-F) at the RC-MPEG: A) *Schaenicosceles* sp., subadult male; B) *Tapinillus longipes*, female; C) *Oxyopes* sp., female with egg sac; D) *Architis tenuis*, Pisauridae, female; E) *Sarinda* sp., female; F) *Bryantella* sp., female. Photos: César Favacho (2016).

Figure 8. Diversity of Salticidae at the RC-MPEG: A) *Acragas* sp., female; B) *Nycerella* sp., female; C) *Freya decorata*, female; D) *Philira* sp., female; E) *Freya rubiginosa*, male, preying on a dipteran; F) *Philira* sp., male. Photos: César Favacho (2016).

Figure 9. Diversity of Salticidae at the RC-MPEG: A) *Chira trivittata*, female; B) *Lyssomanes tenuis*, female; C) *Maeota* sp., male; D) *Noegus arator*, male; E) *Noegus* sp., female; F) *Scopocira tenella*, female. Photos: César Favacho (2016).

Figure 10. Diversity of spiders at the RC-MPEG: A) *Selenops maranhensis*, Selenopidae, female; B) *Scytodes fusca*, Scytodidae, female; C-D) Senoculidae – *Senoculus robustus*, female (C) and *Senolus* sp., male (D) –; E-F) Tetragnathidae – *Azilia* sp., female (E) and *Leucauge* sp., female (F). Photos: César Favacho (2016).

Figure 11. Diversity of Theraphosidae (A-B) and Thomisidae (C-F) at the RC-MPEG: A-B) *Avicularia avicularia*, Theraphosidae – female, dorsal view (A) and juvenile, dorsal view (B) –; C-D) *Epicadus taczanowskii*, Thomisidae – female, dorsanterior view (C) and male (smaller, brown spider) on the abdomen of the female (larger, yellow spider) (D) –; E) *Epicadinus biocelatus*, Thomisidae, female; F) *Tmarus* sp., Thomisidae, male. Photos: César Favacho (2016).

Figure 12. Diversity of spiders at the RC-MPEG: A-D) Thomisidae – *Strophius nigricans*, female preying on an ant (A); *Misumenoides rubrithorax*, female (B); *Synema* sp., female (C); *Synema* sp., male (D) –; E) *Dossenus* sp., Trechaleidae, male; F) *Zosis geniculata*, Uloboridae, female. Photos: César Favacho (2016).

Figure 13. New records for Brazil: A-B) *Eriophora nephiloides*, Araneidae, male – habitus dorsal (A) and palp, mesal view (B) –; C-D) *Misumenoides rubrithorax*, Thomisidae, female – habitus dorsal (C) and epigynum (D); E-F) *Senoculus robustus*, Senoculidae, female – habitus dorsal (E) and epigynum (F). Scale bars (mm): A: 2; B, D, F: 0.2; C: 1; E: 3. Photos: Paulo Pantoja (2024).

DISCUSSION

The number of determined species in this study represents almost half of the total of taxa sampled (48.8%), which can be considered high when we compare with other studies on spiders (Table 1) but demonstrate the challenges of having an acceptable level of faunistic knowledge of Amazonian spiders. Obtaining success in determining species depends, among several factors, on the availability of modern taxonomic revisions (Bonaldo et al., 2009a). In the case of spiders, the existence of an online worldwide taxonomic catalog (World Spider Catalog, 2025), which provides primary taxonomic data on the more than 52,800 described species, greatly facilitates the process of assigning a scientific name to the examined specimens. However, several groups still lack recent papers with informative illustrations and descriptions that allow a confident determination, resulting in lists of species with a taxonomic resolution below 50% (Table 1), with some families in which all individuals are grouped only into morphospecies. For example, S. C. Dias & Bonaldo (2012) provided the largest list of spider species/morphospecies for the Brazilian Amazon: 623 spp. in forest gaps and forest matrix in the Urucu River basin, Coari, Amazonas; however, only 23% of the taxa (144 spp.) were determined at the species level (Table 3). In this context, there is a scarcity of biogeographic knowledge of spiders due not only to sampling bias (U. Oliveira et al., 2017), but also to the difficulty in determining taxa at the specific level, which would provide reliably standards for the comparison of community structure across environments and biomes.

The species richness recorded for RC-MPEG is quite representative considering the small area of the *campus* and the obtained abundance. Additionally, the percentage of morphospecies represented by a single individual (49.7%) suggests that species richness is greater, since undersampling is the most likely reason to explain the record of a single individual for several species in a given area (Coddington et al., 2009). Increasing sampling effort would allow recording species abundance patterns more clearly and access new rare species (Coddington et al., 2009), increasing the number of local species.

Our study obtained a great species richness of spiders comparated to other studies carried out in forest fragments in the middle of the urban matrix (Table 3). However, that comparation must be made with reservations, since the sampling methods and periods largely vary between those studies (Table 3). For RC-MPEG, as mentioned previously, the spiders were collected over a long period (eight years) using various methods that allowed to explore different microhabitats (leaf litter, shrubs, tree trunks, grasses, and the interior of buildings) with the goal to obtain as many species as possible. Certainly, sampling in different times of the year and the diversity of sampling methods allowed such expressive richness to be achieved, especially of synanthropic spiders, reinforcing the importance of using different sampling methods in a faunistic inventory.

Another factor that may explain the great richness of spiders in RC-MPEG, is the fact that this site is connected to an extensive forest matrix to the northeast (Figure 1), encompassing the Mocambo Reserve and the Utinga State Park. Spiders have a great dispersal capacity (A. Santos et al., 2007) and it is likely that the spider assemblage disperses throughout this vegetation matrix, resulting in a constant influx of individuals from different species into the RC-MPEG area. Thus, we cannot consider RC-MPEG as an isolated fragment, as is the case of MB (S. C. Dias et al., 2006), BG (S. R. Dias et al., 2024) and UFAM (Carvalho & Gasnier, 2019), but rather as part of a set of forest patches, which are interconnected and contain significant spider diversity.

Regarding families, the greater number of individuals and species of Araneidae (Figures 3–4) can be explained by some reasons. Firstly, thanks to the tireless work of Herbert Levi, who reviewed several genera of Araneidae from Neotropics (see bibliography of Araneidae in Table 2), it was possible to determine at a specific level most of the collected individuals of that family. Furthermore, araneids can be easily sampled, since these spiders build conspicuous orb webs, and are easily seen in both nocturnal and diurnal

Table 3. Summary of some studies on spiders in urban fragments in Brazil.

Locality	Estação Ecológica da Universidade Federal de Minas Gerais, Belo Horizonte – MG	Mata do Buraquinho, João Pessoa – PB	*Campus* of the Federal University of Amazonas, Manaus – AM	Botanical Garden of Diadema City, Diadema – SP	Research *Campus* – Museu Paraense Emílio Goeldi, Belém – PA
Biome	Atlantic Forest	Atlantic Forest	Amazon	Atlantic Forest	Amazon
Reference	Álvares et al. (2004)	S. C. Dias et al. (2006)	Carvalho and Gasnier (2019)	S. R. Dias et al. (2024)	This study
Species richness	223	166	94	37	172
Abundance (only adults)	2,310	1,681	1,080	118	492
Sampling methods	Beating tray and pitfall trap	Nocturnal manual collection, beating tray and pitfall trap	Beating tray	Nocturnal manual collection and pitfall trap	Diurnal and nocturnal manual collections, beating tray, pitfall trap and Winkler extractor
Sampling period	2000-2001	2003-2004	2011-2012	2024	2011-2018
Study site area (in km^2)	1	5	7	0.026	0.11

collections. Additionally, many species build webs in easily accessible places, such as open environments and at the edges of forests (P. Pantoja, personal observation). Likewise, the high representation of Salticidae (Figures 7–9) in this study is largely because it is the most diverse family of spiders, with more than 6,800 described species, in addition to being very abundant in Neotropical region. Also, Neotropical salticids have been receiving attention from taxonomists for many years, with several species being described and redescribed with sufficient information to allow their determination (see bibliography of Salticidae in Table 2).

The 16 new records for the municipality of Belém, an addition to the 247 species already recorded (U. Oliveira et al., 2017) corroborate the idea that even areas in large cities, with easy access and close to research centers, may have previously unrecorded arachnid fauna, a reality also recognized for Manaus by Tourinho et al. (2011). Some factors related to sampling can explain that situation. At first, spiders occupy a multitude of microhabitats in tropical regions, from the litter to the canopy, and some species are found in cryptic environments, such as cracks between tree trunks and rocks. For this reason, it is necessary to use different collection methods when sampling an area to access the arachnid fauna of different vegetation strata (Coddington et al., 1991; Bonaldo et al., 2009b). In addition, the richness and abundance of spider species can vary according to seasonality (Mineo et al., 2010; Campuzano et al., 2019), and for this reason, some species are more easily collected at certain periods of the year. In this context, since the municipality of Belém does not have any published spider inventory, it is expected that new sampling using different methods and over several years will access a previously unknown fauna. Additionally, recent taxonomic publications have strong impact in the taxonomic resolution of the checklists and increase the number of new records. Therefore, even specimens collected a long time ago may represent new records in recent papers, since only after the publication of a recent taxonomic paper on that group it was possible to assign a scientific name to those specimens.

Some of the 83 records that were identified down to species in this paper deserve to be highlighted, due to their synanthropy, medical relevance and noteworthy aspects on

natural history. Eleven species are considered synanthropic (Table 2), since they were collected inside buildings or have been recorded as such in other inventories (Rodrigues et al., 2017). All of them are harmless to humans. *Avicularia avicularia* (Linnaeus, 1758) (Theraphosidae; Figures 11A–11B) is a large synanthropic spider, a species of tarantula that was collected inside several buildings at RC-MPEG. Despite its large size, this species is not aggressive, and a curious fact is that juveniles have a color pattern that is distinct from adults: pink legs and red abdomen (Figure 11B). *Ancylometes rufus* (Walckenaer, 1837) (Ctenidae; Figure 5A) is common in homes, mainly in humid places such as bathrooms and backyards. *Selenops maranhensis* Mello-Leitão, 1918 (Selenopidae; Figure 10A) is also synanthropic, very common to be seen on residential walls, and has a wide and flat body; despite being adapted to the residential environment, specimens of *S. maranhensis* were collected on tree trunks at RC-MPEG. *Phoneutria reidyi* (F. O. Pickard-Cambridge, 1897) (Ctenidae; Figures 5E-5F), commonly known as the "aranha-armadeira" in Brazil, is the only species of medical importance recorded here for RC-MPEG. There are no reports in the literature of severe symptoms resulting from a bite by that species, the most common symptoms are local pain, erythema, edema and paresthesia (Bucaretchi et al., 2018; Salvatierra & Ramos, 2018). The specimen of *P. reidyi* was collected in one of the forest areas. *Anelosimus eximius* (Keyserling, 1884) (Theridiidae) is a social spider that can build community webs among vegetation (Agnarsson, 2006). A community web approximately 1.5 m high was sampled at RC-MPEG, where *Anelosimus* spiders coexisted with others of the species *Philoponella opelli* Faleiro & Santos, 2014 (Uloboridae). *Epicadus taczanowskii* Roewer, 1951 (Thomisidae; Figures 11C–11D) and *Misumenoides rubrithorax* are between the spiders with great sexual dimorphism; in the case of these species, males are distinctly smaller and darker than females. Finally, another Thomisidae that deserves to be highlighted is *Strophius nigricans* Keyserling, 1880 (Figure 12A), a species that feeds preferentially on ants (P. S. Oliveira & Sazima, 1985), in contrast to the generalist diet of most spiders (Foelix, 2011).

Although Belém has a relatively high number of records of spider species (U. Oliveira et al., 2017; Rodrigues et al., 2017), this number could be much higher, given the large extent of areas that remain unsampled (Rodrigues et al., 2017) and the number of taxa that remain unidentified at the species level. If the sampling of a small area, such as RC-MPEG, yielded 16 new records for Belém, we can expect that the sampling of larger and more continuous areas, will increase the list of species for the municipality. Finally, the 172 species recorded for RC-MPEG reinforce the importance of the study area in maintaining regional spider diversity.

AKNOWLEDGEMENTS

We would like to thank Carlos Alves, Marcos Drago, Sávio Bendelak and Vanessa Vidal for their help in the collections made between 2015 and 2016. We would like to thank Abel Bustamante, Gustavo Ruiz and Érika Costa for their help in identifying Salticidae and Níthomas Feitosa for identifying Oonopidae. We are also grateful to Maiara de Alcântara for cataloging the specimens in the MPEG collection. During the first stage of preparation of this paper, PP, CX, ABB and RS received financial support from Conselho Nacional de Pesquisa e Desenvolvimento Tecnológico (CNPq) (PP: Programa Institucional de Bolsas de Iniciação Científica – PIBIC/MPEG #148449/2016-6; CX: PIBIC/MPEG #148195/2016-4; ABB: PQ #307165.2022-1; RS: Programa de Capacitação Institucional – PCI-DA/MPEG #312859/2015-5). ABB and RS received support from project #3362 – CELPA/FADESP Monitoring (REF.: 061/2013; coded at ANEEL as PD-0371-0017/2013) entitled "Monitoring of the possible impacts of the Marajó transmission line on fauna." The final version of this paper was written while PP and CX received financial support from Coordenação de Aperfeiçoamento de Pessoal do Nível Superior (CAPES) and CNPq, respectively, through the Programa de Pós-Graduação em Zoologia, Universidade Federal do Pará/Museu Paraense Emílio Goeldi (PP: #88887.605987/2021-00; CX: #140056/2021-1) and RS through Project #1199/FSADU (Sousândrade Foundation for Development Support at UFMA), entitled

"Experimental development of a methodology for the detection and reduction of vegetation vulnerability factors that cause interruptions in the energy supply," funded by Equatorial Maranhão (579/2017); RS was also supported by a research productivity scholarship from UEMASUL. Finally, we are grateful to the editor, Leonardo Carvalho, and the two anonymous reviewers for their valuable suggestions to improve the manuscript; we are also thankful to the editorial board for their work and assistance with formatting the final versions of the paper.

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AUTHORS' CONTRIBUTION

P. Pantoja contributed to project administration, formal analysis, conceptualization, data curation, writing (original draft, review and editing), investigation, methodology, software, supervision, validation, visualization; C. Xavier contributed to conceptualization, writing (review and editing), investigation, methodology; L. Serrão contributed to conceptualization, investigation, methodology; C. Favacho contributed to conceptualization, investigation, methodology; R. Saturnino contributed to project administration, conceptualization, data curation, writing (review and editing), investigation, supervision, validation; and A. Bonaldo contributed to conceptualization, writing (review and editing), supervision.