Ferns of the Parque Nacional das Nascentes do Rio Parnaíba, Brazilian *Cerrado*

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Key words:
- Floristics
- New records
- Taxonomy
- Thelypteridaceae
- *Veredas*

Abstract

The floristic and taxonomic treatment of ferns from the Parque Nacional das Nascentes do Rio Parnaíba (PNNRP), a protected area in the northern portion of the Brazilian *Cerrado*, within the boundaries of the states of Maranhão, Tocantins, Piauí and Bahia, is presented. Considered the largest full protection area of the *Cerrado*, the PNNRP is in a region rapidly losing its native coverage due to the expansion of agribusiness. This treatment includes identification keys for genera and species, descriptions, comments on diagnostic and ecological characteristics, species distribution, and illustrations. Twenty-five species were recorded in the study area, distributed in 11 families. *Blechnum areolatum* and *B. asplenioides* were recorded for the first time in the state of Maranhão, while *Pteridium esculentum* var. *harpianum*, *Dicranopteris flexuosa*, *Trichomanes pilosum* and *Meniscium serratum* are new records for the state of Piauí.

Palavras-chave:
- Florística
- Novos registros
- Taxonomia
- Thelypteridaceae
- Veredas

Resumo

É apresentado o tratamento florístico-taxonômico das samambaias do Parque Nacional Nascentes do Rio Parnaíba, uma Unidade de Conservação (UC) situada na porção norte do Cerrado brasileiro, nos limites dos estados do Maranhão, Tocantins, Piauí e Bahia. O Parque é considerado a maior área de proteção integral do Cerrado e está localizado em uma região que está perdendo rapidamente sua cobertura nativa devido à expansão do agronegócio na área. Este tratamento inclui chaves para a identificação para famílias, gêneros e espécies, ilustrações, descrições, comentários sobre características diagnósticas e ecológicas, bem como a distribuição geográfica das espécies. Na área de estudo, foram registradas 25 espécies distribuídas em 11 famílias. *Blechnum areolatum* e *B. asplenioides* foram registrados pela primeira vez no Maranhão, enquanto *Pteridium esculentum* var. *harpianum*, *Dicranopteris flexuosa*, *Trichomanes pilosum* e *Meniscium serratum* são novos registros para o estado do Piauí.

Original Papers

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Introduction

The ferns (Polypodiopsida) currently include 10,578 species (PPG I 2016), distributed mainly in tropical and subtropical regions of the world (Moran 2008). In Brazil, this plant group comprises 1,223 species, with the highest species diversity in the Atlantic Rainforest [BFG 2021; Flora e Funga do Brasil 2024 (continuously updated)], an important endemism center for the Neotropical region (Tryon 1972; Suissa & Sundue 2020). Within the *Cerrado*, 319 are recorded (Flora e Funga do Brasil 2024, continuously updated).

The *Cerrado* biome covers around 24% of the total area of the Brazilian central plateau, reaching the coast towards the north in Maranhão, with the state of Paraná at its southern limit, housing diverse vegetation types (Sano *et al.* 2007). A diversity of vegetation types is found in

the *Cerrado*, from savannas to grasslands (*campo limpo*, *campo sujo*, *cerrado ralo*, *cerrado rupestre*, and *veredas*) to forest areas (*cerradão*, *mata seca*, *mata de galeria*, and *mata ciliar*) (Ribeiro & Walter 2008). The fully protected areas of the *Cerrado* (National Parks) cover 2.33% of this biome (MMA 2024), a small percentage of protection considering the accelerated deforestation and land transformation process that is taking place (Strassburg *et al*. 2017). Specific studies regarding ferns in protected areas of the *Cerrado* are still scarce, however, we can highlight Windisch & Prado (1990), Prado (1992), Windisch (1992), Prado & Windisch (1996), and Prado (1997) for the Parque Nacional da Serra do Cipó; Salino *et al*. (2013) in the Parque Estadual do Rio Preto, all in Minas Gerais; Nunes & Labiak (2021) for the Parque Estadual do Cerrado in Paraná; Fernandes *et al*. (2022) at the Parque Nacional da Chapada das Mesas in Maranhão; and Schindler *et al*. (2023) in the Estação Ecológica Serra Geral do Tocantins. There are also studies in unprotected areas, carried out in vegetation types comprised by the *Cerrado* biome where ferns are more abundant, such as gallery forests and buriti palm groves (*veredas*) (Athayde Filho & Agostinho 2005; Athayde Filho & Felizardo 2010; Forsthofer & Athayde Filho 2012; Lehn & Assis 2013; Ribeiro *et al*. 2014; Rezende *et al*. 2013; Zambiase *et al*. 2016).

The Parque Nacional das Nascentes do Rio Parnaíba (PNNRP) is the largest Conservation Unit (UC) of the *Cerrado*, part of the Jalapão Mosaic. This region comprises several Conservation Units that are not yet directly impacted by human activities (ICMBio 2021). The PNNRP is part of the ecological corridor Jalapão/Chapada das Mangabeiras, meant to connect several protected areas and aims to preserve the migratory routes of species and gene-flow between populations (IBAMA 2007; ICMBio 2013). This general area is currently affected by the expansion of the agribusiness region known as MATOPIBA (a name coined from the initials of the states of MAranhão, TOcantins, PIauí and BAhia), and thus the implementation, regularization and management of the existing UCs and the creation of new protected areas are fundamental for the protection of the important biodiversity of the biome (Françoso *et al*. 2020).

The objective of the present study is to contribute towards the knowledge of the species of ferns of the PNNRP, presenting a floristic treatment with identification keys, illustrations, and comments about the taxonomy, ecology, and distribution of the taxa recorded in the study area.

Material and Methods

The study area and methodology are fully explained in Castro-Aguiar *et al*. (2024) (Figs. 1; 2). Four expeditions were carried out in April and December 2022 and March and July 2023, lasting five days each. Collected samples were pressed according to fern and lycophyte guidelines (Pietrobom *et al*. 2023) and the material was deposited in the Universidade de Brasília (UB) and Universidade Federal do Maranhão (CCAA) herbaria. A map of the PNNRP showing the sampled points was prepared using Quantum Gis 3.2.0 (QGIS Development Team 2021) using shape maps from the Instituto Brasileiro de Geografia e Estatística and Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio).

Material identification was carried out using specialized literature [Salino & Semir 2002; Mickel & Smith 2004; Dittrich *et al*. 2015; Cárdenas *et al*. 2016; Salino *et al*. 2017; Lima & Salino 2018; Schwartsburd *et al*. 2018; Fernandes & Salino 2020; Flora e Funga do Brasil 2024 (continuously updated)]. For the species distribution, we used Flora e Funga do Brasil (2024, complemented by additional literature). Family circumscription followed PPG I (2016). Identification keys and species descriptions were prepared using the examined material. Taxa are organized alphabetically by family, genus, and species. Morphology used in preparing descriptions follows Lellinger (2002).

Results and Discussion

A total of 25 fern species were recorded for the PNNRP, distributed in 16 genera and 11 families. The most representative families in terms of species diversity were Thelypteridaceae, with six species, followed by Anemiaceae (three spp.), Blechnaceae (three spp.), and Pteridaceae (three spp.). The genera with the most species were *Meniscium* and *Anemia*, with four and three species respectively.

A total of six new records were made during the present study. Two species were recorded for the first time in the state of Maranhão, *Blechnum areolatum* V.A.O.Dittrich & Salino and *Blechnum asplenioides* Sw. For the state of Piauí, the new records were: *Pteridium esculentum* var. *harpianum* Schwartsb. & A. Yanez, *Dicranopteris flexuosa* (Schrad.) Underw., *Trichomanes pilosum* Raddi and *Meniscium serratum* Cav. A complete floristic treatment for the ferns of the PNNRP is presented below.

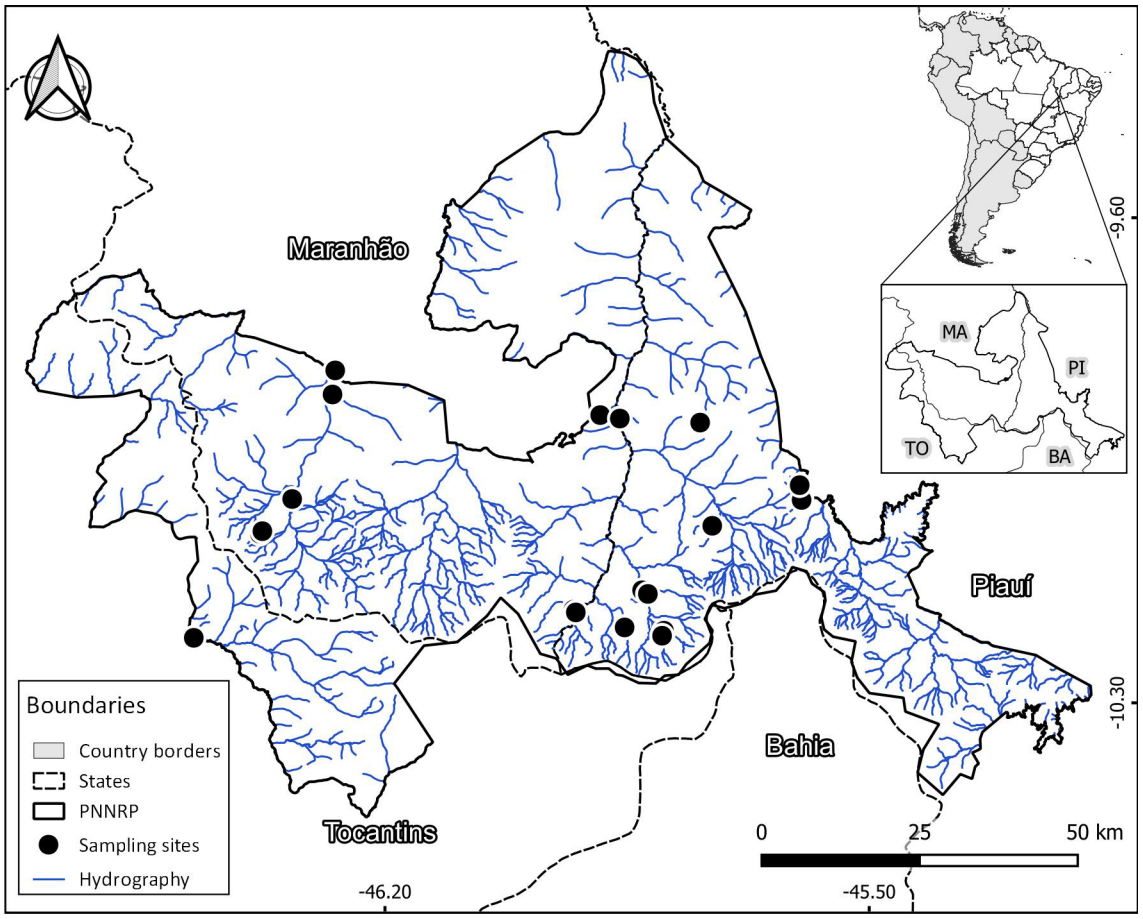

Figure 1 – Location of the study area, Parque Nacional das Nascentes do Rio Parnaíba (PNNRP) in the Brazilian Cerrado, showing sampled sites.

Key for fern genera in the PNNRP, Brazil

1. Sporangia with apical annulus found only in the basal pair of modified pinnae (fronds hemidimorphic) or located at the margin of the pinnae, in this case with the fertile frond distinct from the sterile ones (fronds holodimorphic) ..... 1. *Anemia* (Anemiaceae)

1′. Sporangia with longitudinal or obliquous annulus, gathered in sori beneath or marginally in the laminae

2. Fronds pseudodichotomously cleft, with hairy or scaly dormant buds between the lateral branches, generally scandent over the vegetation; sporangia normally 3–10(–15) per sorus..... ..... 8. *Dicranopteris* (Gleicheniaceae)

2′. Fronds simple, pinnate, or many-divided, without dormant buds, not scandent and not pseudodichotomously cleft; sporangia > 15 per sorus.

3. Arborescent plants with caudices ..... 4. *Cyathea* (Cyatheaceae)

3′. Herbaceous or creeping plants without caudices.

4. Laminae translucent, 1–2 cell layers between the veins; sori marginal, indusium tubular ..... 9. *Trichomanes* (Hymenophyllaceae)

4′. Laminae not translucent, > 2 layers of cells between the veins; sori abaxial or submarginal; indusia or pseudoindusia rounded, oblong or linear.

5. Sori protected by retroflexed laminae margins (pseudoindusium).

6. Stem long-creeping, hairs present; laminae 4-pinnate-pinnatifid, with farinaceous appearance beneath ..... 5. *Pteridium* (Dennstaedtiaceae)

6′. Stem short-creeping to ascendant, scales present; laminae 1- or 2-pinnate, without farinaceous appearance beneath.

7. Presence of veins in the pseudoindusium; fronds 1-pinnate, last segments flabellate, glabrous; stem with concolorous scales ..... 12. *Adiantum* (Pteridaceae)
7′. Absence of veins in the pseudoindusium; fronds 1-pinnate distally to 2-pinnate proximally; last segments ovate-oblong, pubescent; stem with bicolor scales ..... 13. *Cheilanthes* (Pteridaceae)

5′. Sori not protected by retroflexed laminae margins (indusia absent or present).
8. Laminae simple; sori acrostichoid ..... 7. *Elaphoglossum* (Dryopteridaceae)
8′. Laminae divided; sori linear, oblong or rounded.
9. Sori linear, adjacent, and parallel to the midrib.
10. Stem erect or decumbent; fronds pinnatisect or 1-pinnate; pinnae not articulated with the rachis, without scales beneath the midrib ..... 2. *Blechnum* (Blechnaceae)
10′. Stem long-creeping; fronds 1-pinnate; pinnae articulated with the rachis, with scales beneath the midrib..... 3. *Telmatoblechnum* (Blechnaceae)
9′. Sori circular or linear disposed along the veins, not adjacent or parallel to the midrib.
11. Pinnae with white wax abaxially; sori linear along the veins; indusia absent .... 14. *Pityrogramma* (Pteridaceae)
11′. Pinnae without white or yellow wax abaxially; sori not following the veins; indusia absent or present.
12. Fronds 1- or 2-pinnate, pinnae or pinnules dimidiate or semilunar .... 10. *Lindsaea* (Lindsaeaceae)
12′. Fronds 1-pinnate or 1-pinnate-pinnatifid, pinnae or pinnules linear or lanceolate.
13. Sori with indusia.
14. Veins anastomosed; fronds dimorphic, 1-pinnate .... 6. *Cyclodium* (Dryopteridaceae)
14′. Veins free; fronds monomorphic, 1-pinnate-pinnatifid .... 15. *Christella* (Thelypteridaceae)
13′. Sori without indusia.
15. Stem densely pubescent, with multicellular hairs; veins free; sori circular, on the costal midribs..... 11. *Metaxya* (Metaxyaceae)
15′. Stem glabrous; veins anastomosed; sori oblong or linear on the meniscioid veins ..... 16. *Meniscium* (Thelypteridaceae)

Anemiaceae.

This family comprises 98 Neotropical species, while 16 occur in Africa and Madagascar and a single species in India (Mickel 2016).

1. *Anemia* Sw.

Brazil is the center of diversity for this genus, with 65 recorded species, of which 40 are endemic to this country (Mickel 2016; Labiak 2023).

Key for species of *Anemia* in the PNNRP, Brazil

1. Holodimorphic fronds; sterile fronds 2–3-pinnate; sterile pinnae 2–4 pairs, dichotomically divided, glabrescent.....1.1. *Anemia buniifolia*
1′. Hemidimorphic fronds; sterile fronds 1-pinnate; sterile pinnae 5–11 pairs, not dichotomically divided, petiole hairy.
2. Laminae of fertile fronds larger than the sterile ones and overtaking them; petioles of fertile fronds (4.5–)6.2–9.2 cm long ..... 1.2. *Anemia oblongifolia*
2′. Laminae of fertile fronds approximately equal to the sterile ones and not overtaking them in length; petioles of fertile fronds 0.6–4.7(–6) cm long.....1.3. *Anemia presliana*

1.1. *Anemia buniifolia* (Gardner) T.Moore, Index Fil. (T.Moore) 3: cxvi (1857). Fig. 3a

Plants terrestrial or rupicolous. Stem erect, compact, with reddish-brown hairs. Frond holodimorphic, erect, sterile frond 1.5–3 cm long, 2–3 pinnate, fertile frond 1.7–6.8 cm long; petiole paleaceous, not sulcate, glabrescent, petiole of sterile frond 0.7–1.3 cm long, petiole of the fertile frond 2–5 cm long; rachis paleaceous, with sparse hairs; sterile laminae 0.7–3.2 cm long, oblong-ovate, coriaceous; sterile pinnae 4–8 × 0.3–0.5 cm, 2–4 pairs, dichotomically divided, margin entire, glabrescent, fertile pinnae not inserted immediately below the pair of sterile pinnae; veins free.

Figure 2 – a-h. Habitats in the Parque Nacional das Nascentes do Rio Parnaíba – a. area of cerrado sensu stricto; b. *veredas*; c. stream in the gallery forest; d. Sussuapara Waterfall; e. Várzea Grande Waterfall; f. Urubu Waterfall; g. Pintado Waterfall; h. sandstone formations around the waterfall of Pintado.

Examined material: Alto Parnaíba, PNNRP, Ladeira da Galiléia, 10°03′21″S, 46°22′51″W, 578 m, 17.III.2023, *P.H. Castro-Aguiar et al. 280* (CCAA, UB, UPCB).

Anemia buniifolia is distributed throughout South America, occurring in Bolivia, Colombia, Suriname, Venezuela, and Brazil (Mickel 2016), where it occurs in the Amazon and *Cerrado* biomes (Labiak 2023). Specimens in the study area were recorded in the *cerrado rupestre*, growing in crevices of the arenitic rocks amidst treelets and shrubs.

This species is characterized by its holodimorphic fronds with lax, dichotomous sterile pinnae and fertile fronds, with sporangia found throughout the fertile pinnae that are generally longer than the sterile ones. *Anemia buniifolia* resembles *A. millefolia* (Gardner) C. Presl in the holodimorphic fronds, 2–3 pinnate sterile laminae, and segments around 0.5 mm wide (Mickel 2016). However, *A. millefolia* differs by having strictly pinnate sterile pinnae, with a denser aspect, while in *A. buniifolia* the sterile pinnae are dichotomous and lax (Mickel 2016; Smith & Kessler 2017a).

1.2. *Anemia oblongifolia* (Cav.) Sw., Syn. Fil. (Swartz) 156 (1806). Fig. 3b

Plants terrestrial or rupicolous. Stem suberect to erect, with orange hairs. Fronds hemidimorphic, erect, sterile fronds 3–13 cm long, 1-pinnate, fertile fronds 9–15 cm long; larger than the sterile ones and overtaking them, petiole paleaceous, sulcate on the adaxial side, with dense hairs, petiole of sterile fronds 0.3–7.3 cm long, petiole of fertile fronds (4.5–)6.2–9.2 cm long; rachis paleaceous, with dense hairs; sterile laminae 2.8–14 cm long, oblong, chartaceous to coriaceous; sterile pinnae 0.6–2.2 × 0.3–0.5 cm, 5–11 pairs, oblong, denticulate margins, with whitish hairs on both sides, fertile pinnae inserted immediately below the pair of sterile pinnae, exceeding the sterile portion of the laminae; veins free.

Examined material: Alto Parnaíba, PNNRP, descida da Galiléia, 10°03′08″S, 46°22′38″W, 537 m, 17.III.2023, *P.H. Castro-Aguiar et al. 278* (CCAA); ladeira da Galiléia, 10°03′21″S, 46°22′51″W, 578 m, 17.III.2023, *P.H. Castro-Aguiar et al. 279* (CCAA); *P.H. Castro-Aguiar et al. 284* (CCAA); Morro do Cangaia, 9°53′44″S, 45°44′40″W, 512 m, 18.III.2023, *P.H. Castro-Aguiar et al. 290* (CCAA, UB, UPCB).

Anemia oblongifolia is distributed throughout the Neotropical region, occurring from Costa Rica to Brazil (Mickel 2016), where it occurs in the Amazon, *Caatinga*, *Cerrado*, and Atlantic Forest biomes (Labiak 2023). Specimens in the study area were recorded in the *cerrado rupestre*, growing in crevices of the arenitic rocks amidst treelets and shrubs.

This species is characterized by hemidimorphic fronds, oblong sterile pinnae with generally whitish dense hairs on both surfaces, and fertile laminae with elongated petioles, surpassing the sterile fronds. *Anemia oblongifolia* resembles *A. mynsseniana* Mickel and *Anemia andersonii* Mickel & Labiak with its oblong sterile pinnae and fertile fronds with elongated petiole, which surpasses the sterile fronds in length. However, *A. mynsseniana* presents strongly coriaceous and glabrescent laminae (*vs.* moderate to densely pubescent laminae in *A. oblongifolia*). Furthermore, *A. andersonii* presents a larger number of pinnae, between (8–)11–20 pairs (*vs.* 5–11 pairs), and laminae that are distally narrowed (*vs.* laminae that are generally not narrowed at the apex) (Mickel 2016). *Anemia oblongifolia* is widely distributed in Brazil, recorded for the Amazon, *Caatinga*, *Cerrado*, and Atlantic Rainforest biomes, whilst *A. andersonii* and *A. mynsseniana* are recorded only in the *Cerrado*, with *A. mynsseniana* endemic to Brazil (Bahia, Distrito Federal, Goiás, Minas Gerais, and Tocantins) (Labiak 2023).

1.3. *Anemia presliana* Prantl, Unters. Morph. Gefasskrypt. 2: 104 (1881). Fig. 3c

Plants terrestrial or rupicolous. Stem suberect to erect, with pale brown hairs. Fronds hemidimorphic, erect, sterile fronds 4.5–15.5 cm long, 1-pinnate, fertile fronds 11.5–20 cm long; petiole paleaceous, adaxially sulcate, with dense hairs, petiole of sterile fronds 1.2–3.5 cm long, petiole of fertile fronds 0.6–4.7(–6) cm long; rachis paleaceous, with dense hairs; sterile laminae 2.8–14 cm long, oblong, chartaceous; sterile pinnae 1–1.8 × 0.6–0.8 cm, 8–12 pairs, oblong, denticulate margins, with hairs on both sides, fertile pinnae inserted immediately below the pair of sterile pinnae, not exceeding the sterile portion of the laminae; veins free.

Examined material: MARANHÃO: Alto Parnaíba, PNNRP, 10°10′09.8″S, 45°55′27.4″W, 21.IV.2023, *P.H.C. Aguiar et al. 20* (CCAA, UB); trilha em direção à Cachoeira do Sussuapara, 10°10′10″S, 45°55′27″W, 407 m, 15.XII.2023, *P.H. Castro-Aguiar et al. 170* (CCAA, UB). PIAUÍ: Barreiras do Piauí, PNNRP, Cachoeira do Pintado, 10°11′26″S, 45°51′08″W, 436 m, 13.XII.2022, *P.H. Castro-Aguiar et al. 61* (CCAA); *P.H. Castro-Aguiar et al. 73* (CCAA); Cachoeira do Urubu, 10°11′45″S, 45°47′48″W, 470 m, 14.XII.2023, *P.H. Castro-Aguiar et al. 103* (CCAA); margem do Rio Parnaíba, entrando no Maranhão, 09°53′23″S, 45°51′38″W, 390 m, 18.III.2023, *P.H. Castro-Aguiar et al. 292* (CCAA, UB). TOCANTINS: São Félix do Tocantins, PNNRP, Cachoeira do Prata, 10°12′22″S, 46°28′35″W, 485 m, 15.III.2023, *P.H. Castro-Aguiar et al. 249* (CCAA, UB); *P.H. Castro-Aguiar et al. 251* (CCAA, UB).

Anemia presliana has a Neotropical distribution, occurring from Mexico to Brazil (Mickel 2016). In Brazil, it occurs primarily in the *Cerrado* biome (Labiak 2023). In the area of study, dense populations were recorded growing on rock formations within the interior of the gallery forest and close to waterfalls.

Figure 3 – a. *Anemia buniifolia* – habit. b. *Anemia oblongifolia* - habit. c. *Anemia presliana* – habit. d-e. *Blechnum areolatum* – habit. f. *Blechnum asplenioides* – habit. g. *Telmatoblechnum serrulatum* – habit. h. *Pteridium esculentum* var. *harpianum* – habit. i. *Cyclodium meniscioides* – habit. (a. *P.H. Castro-Aguiar et al. 280*; b. *P.H. Castro-Aguiar et al. 290*; c. *P.H. Castro-Aguiar et al. 170*; d. *P.H.C. Aguiar et al. 21*; e. *P.H. Castro-Aguiar et al. 171*; f. *P.H. Castro-Aguiar et al. 168*; g. *P.H.C. Aguiar et al. 05*; h. *P.H. Castro-Aguiar et al. 243*; i. *P.H. Castro-Aguiar et al. 160*).

This species is characterized by the 1-pinnate lamina, with oblong pinnae and fertile fronds approximately the same length as the sterile fronds. One of the species most resembling *Anemia presliana* is *A. pubescens* Mickel & Labiak, recently described for the state of Goiás, differing because the latter has long and abundant hairs c. 1mm in length and a thin lamina towards the apex. In comparison, in *A. presliana* the hairs are shorter than 1 mm, and laminae do not become thinner towards the apex (Mickel 2016). It resembles *Anemia oblongifolia* due to the pubescence and format of the pinnae, but it differs with fertile laminae which are the same length as the sterile ones (*vs.* fertile laminae that surpass the sterile ones).

Blechnaceae Newman.

Subcosmopolitan, comprising 24 genera and around 265 species (Gasper *et al.* 2016; PPG I 2016). In Brazil, 10 genera and around 35 species are recorded (Dittrich *et al.* 2023).

2. *Blechnum* L.

Blechnum comprises around 25 species, the majority of these being Neotropical, with some species occurring in southern Africa (Gasper *et al.* 2016). In Brazil, 15 species occur (Dittrich & Gasper 2023). In the area of study, two species were recorded, with both new records in the State of Maranhão. Within these species, *Blechnum areolatum* V.A.O. Dittrich & Salino is highlighted as a new occurrence for the Brazilian *Cerrado*.

Key for the species of *Blechnum* in the PNNRP, Brazil

1. Veins partially anastomosing; lamina 1-pinnate, not narrowed at the base; 1–2 pairs of pinnae ..... 2.1. *Blechnum areolatum*
1′. Veins free; lamina pinnatisect, gradually narrowed towards the base, forming semicircular lobes; 5–21 pairs of pinnae ..... 2.2. *Blechnum asplenioides*

2.1. *Blechnum areolatum* V.A.O.Dittrich & Salino, Syst. Bot. 37(1): 40, f.1-3 (2012). Fig. 3d-e

Plants rupicolous. Stem erect or decumbent, scales lanceolate, 2.4–4.3 cm long, pale brown. Fronds 7.5–30.2 cm long, monomorphic, 1-pinnate, the fertile longer than the sterile; petiole (2.1–) 3.8–16.8 cm long, paleaceous to brown, adaxially sulcate, with scales at the base similar to those on the stem; rachis adaxially sulcate, with short hairs abaxially; laminae 4.7–13.6 × 1.9–10.3 cm, 1-pinnate, triangular to deltoide, truncate at base; pinnae (2.4–)3–11 × 0.8–1.6 cm, 1–2 pairs, lanceolate, membranaceous, with short hairs abaxially; sessile to adnate, finely denticulate margins, obtuse to acute apex; veins partially anastomosing, form areoles along costae lent free towards the margin. Sori linear, parallel to the costae; indusia linear, introrse.

Examined material: Alto Parnaíba, PNNRP, 10°10′09″S, 45°53′27″W, trilha em direção à Cachoeira do Sussuapara, 407 m, 21.IV.2022, *P.H.C. Aguiar et al. 21* (CCAA, UB); 15.XII.2022, *P.H. Castro-Aguiar et al. 171* (CCAA).

Blechnum areolatum is endemic in Brazil and has been recorded in the states of Pará and Mato Grosso (Dittrich & Gasper 2023). In the present study it has been recorded for the first time in the *Cerrado*, in the state of Maranhão, and is found growing on shaded rock formations, inside gallery forest.

This species can be characterized by pinnae with only one row of areoles (occasionally two) along the sides, with inconspicuously denticulated margins (apparently entire) and without auricules in the acroscopic portion. Hairs minute and sparse, found principally at the base of the pinnae and are present only beneath the lamina.

Blechnum areolatum resembles *B. heringeri* Brade e *B. longipilosum* V.A.O. Dittrich & Salino due to the partially anastomosed veins. *Blechnum heringeri* differs in its acroscopic basal portion of the auriculate pinnae, pubescent adaxially (*vs.* the acroscopic basal portion of the pinnae are truncated, glabrous adaxially in *B. areolatum*), whereas in *B. longipilosum* the laminae have 4–7 pairs of pinnae, densely pubescent on both surfaces (*vs.* laminae with 1–2 pairs of pinnae, with minute hairs abaxially in *B. areolatum*) (Dittrich *et al.* 2012).

2.2. *Blechnum asplenioides* Sw., Kongl. Vetensk. Acad. Handl. 72, t.3, f.3 (1817). Fig. 3f

Plants terrestrial or rupicolous. Stem erect, scales lanceolate, 2.1–2.6 mm long, pale brown to blackish. Fronds (3.4–)4.1–10.2 cm long, monomorphic; pinnatisect, petiole 4–9 mm long, paleaceous, adaxially sulcate, with scales at the base similar to those on the stem; rachis adaxially sulcate, with scales at the base and sparse hairs abaxially, scales similar to those on the stem; laminae 3.6–9.7 × 0.8–1.2 cm, linear-lanceolate, gradually narrowed towards the base, forming semicircular lobes; pinnae 5–7 × 4–5 mm, 5–21 pairs, triangular, chartaceous, with sparse diminutive hairs mainly

beneath the basal pinnae, which is adnate to the rachis, median and apical pinnae ascending with entire to slightly denticulate margins, apex rounded to subacute; veins free. Sori linear, parallel to the costae; indusia linear, introrse.

Examined material: Alto Parnaíba, PNNRP, Cachoeira do Sussuapara, 10°09′56′′S, 45°55′38′′W, 422 m, 21.IV.2022, *P.H.C. Aguiar et al. 30* (CCAA, UB); 15.XII.2022, *P.H. Castro-Aguiar et al. 168* (CCAA); *P.H. Castro-Aguiar et al. 180* (CCAA); *P.H. Castro-Aguiar et al. 235* (CCAA).

Blechnum asplenioides is a South American species, occurring from the region of the Guianas to Argentina (Dittrich *et al*. 2015). In Brazil, it occurs in the Amazon, *Cerrado*, Atlantic Rainforest, and Pampa biomes (Dittrich *et al.* 2015; Dittrich & Gasper 2023). This is the first record of this species for the state of Maranhão, where it was collected in the PNNRP on the shore of the Sussuapara waterfall, forming large populations on humid rocks close to waterfalls.

Blechnum asplenioides is characterized by the pinnatisect frond, gradually narrowed in the direction of the base, with the first pinnate pair adnate to the rachis, forming semicircular lobes, and medium pinnae ascending distally.

Blechnum asplenioides resembles *B. polypodioides* Raddi, which also occurs in the Brazilian *Cerrado*. The two species have pinnatisect fronds, gradually narrowed in the direction of the base. However, in *B. polypodioides* the basal pinnae are generally surcurrent with an acute apex, while *B. asplenioides* presents semicircular basal pinnae with a rounded apex (Dittrich *et al.* 2015).

3. *Telmatoblechnum* Perrie, D.J.Ohlsen & Brownsey.

Telmatoblechnum includes two species, one in tropical America, and the other in Australasia/Oceania (Gasper *et al.* 2016).

3.1. *Telmatoblechnum serrulatum* (Rich.) Perrie, D.J.Ohlsen & Brownsey, Taxon 63(4): 755 (2014). Fig. 3g

Plants terrestrial. Stem long-creeping, scales lanceolate, 2.6–3.1 mm long, pale brown to blackish. Fronds (41.1–)62.9–82.9 cm long, subdimorphic, 1-pinnate; petiole (12.6–)22.5–41.5 cm long, paleaceous to pale brown, adaxially sulcate; rachis adaxially sulcate, glabrous; laminae 28.5–52.6 × 6.2–18.7(–23.2) cm, oblong-linear, truncate base; pinnae 1.7–12.7 × 0.7–1.3 cm, 16–32 pairs, oblong-linear, chartaceous to coriaceous abaxially, with scales on the costae, articulate to rachis, ascending, ascending, margin conspicuously serrate, apex acute to acuminate; veins free. Sori linear, parallel to the costae; indusia linear, introrse.

Examined material: MARANHÃO: Alto Parnaíba, PNNRP, Povoado Curupá, 09°53′05′′S, 45°53′20′′W, 380 m, 19.IV.2022, *P.H.C. Aguiar et al. 05* (CCAA, UB); *P.H.C. Aguiar et al. 09* (CCAA); Brejo ruim, 09°51′18′′S, 46°16′33′′W, 406 m, 19.VII.2023, *P.H. Castro-Aguiar et al. 312* (CCAA, UB). PIAUÍ: Barreiras do Piauí, PNNRP, Passagem do Padre Velho, 10°08′34′′S, 45°49′12′′W, 407 m, 16.XII.2022, *P.H. Castro-Aguiar et al. 239* (CCAA, UB).

Telmatoblechnum serrulatum is widely distributed in the Neotropical region, occurring from Mexico to Argentina (Gasper *et al*. 2016). In Brazil, it has been recorded in almost all the states, except Acre and Ceará (Gasper & Dittrich 2023). In the study area it was found growing preferentially along the edge of the *vereda*, in areas where it would be exposed to light, or in the interior of the *vereda*, in shaded areas.

It is characterized by having 1-pinnate frond, pinnae articulated at the spine, with scales on the costae abaxially, and a conspicuously serrate margin.

Cyatheaceae Kaulf.

The family is Pantropical comprising of three genera and around 643 species (PPG I 2016). In Brazil, three genera are recorded, with around 59 species (Pietrobom *et al.* 2023).

4. *Cyathea* J.Sm.

Cyathea comprises around 235 species distributed in the Neotropical region (Lehnert 2016). For Brazil, 53 species are recorded, of which around 26% are endemic (Pietrobom *et al.* 2023). In the study area only one species was recorded.

4.1. *Cyathea delgadii* Pohl *ex* Sternb., Vers. Fl. Vorwelt 1: 47. 1820.

Plants terrestrial. Stem erect, arborescent. Fronds 140–215.2 cm long, monomorphic, 2-pinnate-pinnatifid, pendent; petiole 52–92 cm long, brown to blackish brown, adaxially sulcate, with prickles and lanceolate scales at the base, scales 0.9–1.7 cm long, shiny, pale brown, concolorous, rarely with the central portion near the base slightly blackish; rachis adaxially sulcate, with short prickles on the proximal portion, and dense hairs adaxially, sparse abaxially; laminae 69.5–137 × 10–14.6 cm, oblong, gradually narrowed distally; pinnae ca. 55 × 17 cm, 17–21 pairs, pinnules 6.5–8.5 × 1.3–2 cm, pinnatifid, chartaceous, abaxially with sparse and short hairs, and scales at the base of the costae, margins crenate to serrate, pinnatifid apex; veins forked. Sori rounded, medial to supramedial; indusia sphaeropteroid, globose.

Examined material: MARANHÃO: Alto Parnaíba, PNNRP, Cachoeira do Sussuapara, 10°09′56′′S, 45°55′38′′W, 380 m, 21.IV.2022, *P.H.C. Aguiar et al. 38* (CCAA); *P.H.C. Aguiar et al. 39* (CCAA); *P.H. Castro-Aguiar et al. 163* (CCAA); *P.H. Castro-Aguiar et al. 164* (CCAA); Fazenda do Merval, próxima a casa de serraria, 09°49′22′′S, 46°16′14′′W, 373 m, 19.VII.2023, *P.H. Castro-Aguiar et al. 319* (CCAA, UB). PIAUÍ: Barreiras do Piauí, PNNRP, Cachoeira do Urubu, 10°11′45′′S, 45°47′48′′W, 470 m, 14.XII.2022, *P.H. Castro-Aguiar et al. 107* (CCAA).

Cyathea delgadii has a Neotropical distribution, occurring from Costa Rica to Paraguay (Lehnert 2011; Weigand & Lehnert 2016). In Brazil, it is recorded for all biomes (Pietrobom *et al.* 2023). In the study area, it was observed exposed to the sun, close to waterfalls, and in shaded areas on the banks of streams, inside the gallery forest.

Cyathea delgadii is characterized by having concolorous scales, shiny petiole, laminae abaxially with scarce and minute hairs on the veins, glabrous adaxially, and spheropteroid, globose indusia.

Dennstaedtiaceae Lotsy.

This Pantropical family comprises 10 genera and close to 265 species (PPG I 2016). In Brazil, eight genera and close to 26 species are recorded (Schwartsburd & Pena 2023).

5. *Pteridium* Gled. *ex* Scop.

Pteridium has a subcosmopolitan distribution, being absent in extremely arid or cold areas (Schwartsburd *et al.* 2018). According to the PPG I (2016), *Pteridium* is composed of around four species, however is uncertain due to the recognition of various subspecies in the genus (Schwartsburd *et al.* 2018).

5.1. *Pteridium esculentum* var. ***harpianum*** Schwartsb. & A.Yañez, Phytotaxa 333(1): 36 (2018). Fig. 3h

Plants terrestrial. Stem long-creeping, hair pale brown. Fronds approximately 154–178 cm long, monomorphic, 4-pinnate-pinnatifid, pendent; petiole approximately 96–47.5 cm long, paleaceous, adaxially sulcate, glabrous; rachis paleaceous, adaxially sulcate, glabrous; laminae approximately 58–130.5 cm long, lanceolate, apex gradually narrowed; pinnae approximately 17 pairs; ultimate segments coriaceous, with hairs on the costae abaxially, and farinaceous appearance between the veins, distal segments simple, linear, up to 2.5 cm long; veins free. Sori linear, marginal; pseudoindusia linear, glabrous.

Examined material: Barreiras do Piauí, PNNRP, Brejo do Curicaca, 10°00'26''S, 45°35'52''W, 446 m, 21.IV.2022, *P.H.C. Aguiar et al. 46* (CCAA); cabeceira do Curicaca, 10°00'25''S, 45°35'50''W, 457 m, 16.XII.2022, *P.H. Castro-Aguiar et al. 243* (CCAA).

Pteridium esculentum var. *harpianum* is a South American taxon, occurring in the region of the Guianas and in Brazil (Schwartsburd *et al.* 2018). In Brazil, it is found in the Amazon and the *Cerrado* (Schwartsburd & Pena 2023; Fernandes *et al.* 2022). This is the first record for this species for the state of Piauí, where it has only been recorded growing in disturbed *veredas* and marshes in the PNNRP.

Pteridium esculentum var. *harpianum* is characterized by simple distal segments, exceeding 4 cm in length, hairs on the secondary veins, and farinaceous appearance of laminae tissue between the veins.

Dryopteridaceae Herter.

Cosmopolitan, comprising 26 genera and around 2,115 species (PPG I 2016), is the most diverse fern family in the world. In Brazil, 16 genera and around 193 species are recorded (Matos *et al.* 2023).

6. *Cyclodium* C.Presl.

Cyclodium is a genus of Neotropical ferns, with 13 recognized species. Six species are recorded for Brazil, distributed within the Amazon, *Cerrado* and Atlantic Rainforest biomes (Bohn *et al.* 2020). In the study area, a single species was recorded.

6.1. *Cyclodium meniscioides* (Willd.) C.Presl, Tent. Pterid. 85, t.2, f.20 (1836). Fig. 3i

Plants terrestrial or rupicolous. Stem short to long-creeping, linear-lanceolate scales, 6–14 mm long, pale brown to blackish. Fronds dimorphic, 1-pinnate, fronds sterile 74–111 cm long, fronds fertile 84–108 cm long; petiole paleaceous to pale brown, adaxially sulcate, with scales similar to those on the stem at the base, petiole of sterile fronds 23–52 cm long, petiole of fertile fronds 26–65 cm long; rachis paleaceous to brown, adaxially sulcate, laminae lanceolate, sterile laminae 42–58 cm long, fertile laminae 32–42 cm long; pinnae 5–7 pairs, lanceolate, chartaceous to coriaceous, slightly ascending, median sterile pinnae 11.3–16 cm long, median fertile pinnae 6–8.5 cm long, with scales and micro-scales abaxially, margins crenate to serrate, base acute to cuneate, apex acute to acuminate; veins anastomosing, with 4–7 areoles between the costa and the pinnae margin. Sori rounded; indusia rounded, peltate.

Examined material: Alto Parnaíba, PNNRP, Cachoeira do Sussuapara, 10°09'56''S, 45°55'38''W, 425 m, 21.IV.2022, *P.H.C. Aguiar et al. 29* (CCAA); *P.H.C. Aguiar et al. 41* (CCAA); 15.XII.2022, *P.H. Castro-Aguiar et al. 160* (CCAA, UB); *P.H. Castro-Aguiar et al. 161* (CCAA, UB).

Cyclodium meniscioides has a South American distribution, from the Guianas region to Argentina (Bohn *et al.* 2020). In Brazil, it occurs in the Amazon, *Cerrado*, and Atlantic Rainforest biomes (Bohn *et al.* 2023). In the study area, this species was found forming large populations in arenitic soil near the waterfall margins.

Cyclodium meniscioides is characterized by dimorphic and, 1-pinnate fronds, anastomosed veins, and peltate indusia with minute hairs at the margin. Resembles *Cyclodium pubescens* Bohn & Labiak due to the 1-pinnate frond with conforming apex, and anastomosed veins, though *C. pubescens* differs with the presence of aciculate

hairs, multicellular and translucent on the lamina, costae and rachis, while *C. meniscioides* has scales and microscales abaxially of the lamina (Bohn *et al.* 2020).

7. *Elaphoglossum* Schott *ex* J.Sm.

Elaphoglossum comprises approximately 600 species, being the second most diversified genus of ferns, after *Asplenium* L., with around 700 species (PPG I 2016). It has a pantropical distribution, however, around 80% of the species are found in the Neotropical region (Moran *et al.* 2007). In Brazil, 90 species are recorded, distributed between the Amazon, *Cerrado*, Atlantic Rainforest, and Pampa biomes (Matos 2023). In the study area, only one species was recorded.

7.1. *Elaphoglossum scalpellum* T.Moore, Index Fil. (T.Moore) 3: 14 (1857). Fig. 4a

Plants rupicolous. Stem short-creeping, with linear-lanceolate scales, 1.7–9.5 mm long, pale brown. Fronds 16.5–27.3 cm long, monomorphic; petiole 6–9.6 cm long, paleaceous, adaxially sulcate, with linear to linear-lanceolate scales and sparse stellate scales abaxially; laminae 11–16.5 × 3.6–4.7 cm, simple, oblong to lanceolate, chartaceous to coriaceous, with sparse stellate scales and irregularly divided lanceolate scales abaxially, glabrous adaxially, margin thickened, cartilaginous, base cuneate to decurrent, apex cuneate to rounded; veins free. Sori not observed.

Examined material: Alto Parnaíba, PNNRP, 10°10′10′′S, 45°55′27′′W, 21.IV.2022, *P.H.C. Aguiar et al. 48* (CCAA); trilha em direção a Cachoeira do Sussuapara, 10°10′10′′S, 45°55′27′′W, 15.XII.2022, *P.H. Castro-Aguiar et al. 172* (CCAA).

Elaphoglossum scalpellum is endemic to Brazil and is recorded for the states of Amazonas, Roraima, Tocantins, Bahia, Maranhão, Piauí, Distrito Federal, Goiás, Mato Grosso, Minas Gerais, and São Paulo, in the Amazon and *Cerrado* biomes (Fernandes *et al.* 2022; Matos 2023). A few sterile individuals were discovered in the study area, growing on rock formations inside the gallery forest.

Elaphoglossum scalpellum belongs to *Elaphoglossum* section *Elaphoglossum*, which is generally characterized by the presence of phyllopodia and glabrous laminae or inconspicuously scaled (Rouhan *et al.* 2004). *Elaphoglossum scalpellum* is characterized by its creeping rhizome with brown-orange scales, laminae with a strongly coriaceous consistency, attenuated base, and apex rounded to acute.

Gleicheniaceae C.Presl.

Pantropical, composed of around 157 species, distributed in seven genera (PPG I 2016; Lima *et al.* 2023). In Brazil, three genera and around 17 species are recorded (Lima & Salino 2023).

8. *Dicranopteris* Bernh., Neues J. Bot. 1(2): 38 (1805).

Genus with a pantropical distribution, composed of approximately 12 species (Lima & Salino 2018). In Brazil, four species are recorded, distributed in all biomes (Lima & Salino 2023). A single species was recorded in the study area.

8.1. *Dicranopteris flexuosa* (Schrad.) Underw., Bull. Torrey Bot. Club 34: 254 (1907). Fig. 4b-c

Plants terrestrial. Stem long-creeping, with multicellular, reddish-brown hairs. Fronds 16–142.5 cm long, monomorphic, 2–4 forked, erect or scandent; petiole 8.1–39.8 cm long, paleaceous, cylindrical, glabrous; rachis paleaceous, cylindrical, glabrous; laminae 7.9–53.2 cm long, isotomically branched, buds between the bifurcations covered by hairs, reddish-brown; pinnae (ultimate segments) dichotomously branched, pectinate, chartaceous, with globose hairs only on the secondary veins, margins slightly revolute, apex pectinated to pinnatifid, accessory pinnae present at the base; veins free. Sori rounded, medial to supramedial; indusia absent.

Examined material: MARANHÃO: Alto Parnaíba, PNNRP, 10°10′09′′S, 45°55′27′′W, 21.IV.2022, *P.H.C. Aguiar et al. 36* (CCAA, UB); Cachoeira do Sussuapara, 10°09′56′′S, 45°55′39′′W, 425 m, 15.XII.2022, *P.H. Castro-Aguiar et al. 179* (CCAA, UB); acampamento Várzea Grande, 10°00′21′′S, 46°20′03′′W, 437 m, 17.III.2023, *P.H. Castro-Aguiar et al. 277* (CCAA). PIAUÍ: Barreiras do Piauí, PNNRP, Cachoeira do Pintado, 10°11′28′′S, 45°51′12′′W, 21.IV.2022, *P.H.C. Aguiar et al. 43* (CCAA, UB); *P.H. Castro-Aguiar et al. 63* (CCAA); *P.H. Castro-Aguiar et al. 67* (CCAA, UB); *P.H. Castro-Aguiar et al. 71* (CCAA); Cachoeira do Urubu, 10°11′45′′S, 45°47′48′′W, 470 m, 14.XII.2023, *P.H. Castro-Aguiar et al. 105* (CCAA); margem do Rio Parnaíba, 09°53′23′′S, 45°51′38′′W, 390 m, 18.III.2023, *P.H. Castro-Aguiar et al. 293* (CCAA, UB); *P.H. Castro-Aguiar et al. 294* (CCAA).

Dicranopteris flexuosa has a Neotropical distribution, occurring from Mexico to Paraguay (Lima & Salino 2018). In Brazil, it is a widely distributed species occurring in all biomes (Lima & Salino 2023) and considered in the present study as a new occurrence for Piauí. Piauí is one of the least sampled states of the Northeastern region, which might explain the absence of records of the species until this present moment. In the PNNRP it was discovered in a wide range of environments, occurring close to waterfalls, on the edges of streams, and in the gallery forest.

This species is characterized by 2–4 forked fronds, with unicellular, globose glandular hairs on the secondary veins, abaxially. *Dicranopteris flexuosa* is morphologically related to *D. rufinervis* (Mart.)

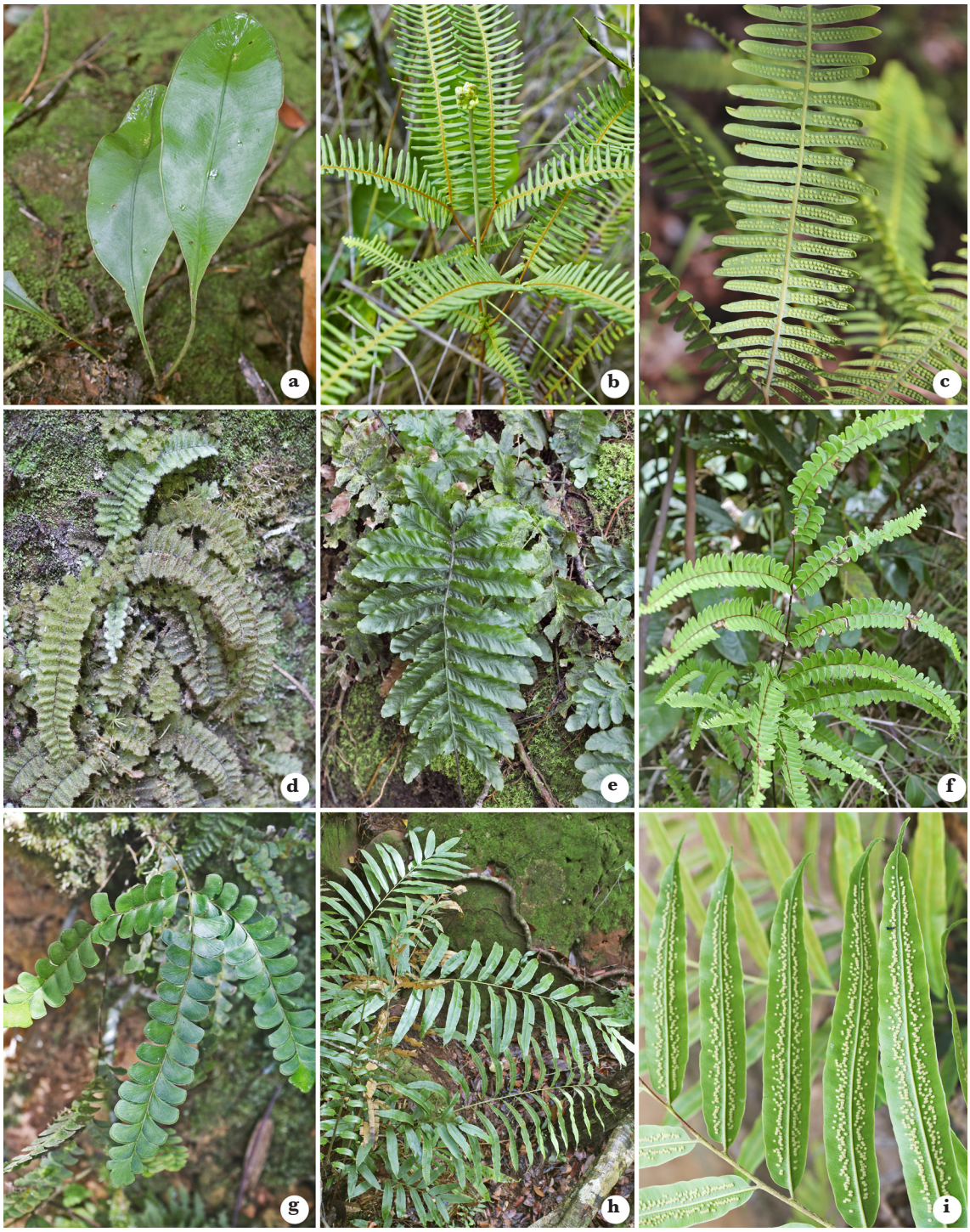

Figure 4 – a. *Elaphoglossum scalpellum* – habit. b-c. *Dicranopteris flexuosa* – b. habit; c. sori on the abaxial surface. d. *Trichomanes pilosum* – habit. e. *Trichomanes pinnatum* – habit. f. *Lindsaea divaricata* – habit. g. *Lindsaea lancea* – habit. h-i. *Metaxya parkeri* – h. babit; i. sori on the abaxial surface. (a. *P.H. Castro-Aguiar et al. 172*; b-c. *P.H. Castro-Aguiar et al. 67*; d. *P.H. Castro-Aguiar et al. 238*; e. *P.H. Castro-Aguiar et al. 173*; f. *P.H.C. Aguiar et al. 8*; g. *P.H.C. Aguiar et al. 28*; h-i. *P.H. Castro-Aguiar et al. 165*).

Ching, a species more commonly found in *campo rupestre*, all with pseudostipules and accessory branches opposite the principal branches, however *D. rufinervis* differs due to the white to reddish multicellular hairs on the central vein of the segments abaxially, whereas *D. flexuosa* has glabrous central veins (Lima & Salino 2018).

Hymenophyllaceae Gaudich.

Subcosmopolitan, composed of approximately 434 species, distributed in two subfamilies: Trichomanoideae C. Presl, which includes eight genera with tubular involucrae, and Hymenophylloideae Burnett. with a single genus *Hymenophyllum* Sm., characterized by bivalvate involucrae (PPG 2016; Gonzatti *et al.* 2020). In Brazil, there are seven genera and around 83 species recorded (Gonzatti & Windisch 2023).

9. *Trichomanes* L.

Trichomanes is predominantly Neotropical, with this species in Asia consisting of sixty species (Windisch 2014; PPG I 2016). Thirty-four species are recorded in Brazil, distributed in all the biomes, except the Pampa (Gonzatti & Windisch 2023). Two species were recorded in the study area.

Key for the species of *Trichomanes* in the PNNRP, Brazil

1. Fronds 1-pinnate, with sparse to moderate hairs on the rachis, costae, and abundant false veins parallel to the true veins adaxially; sori sessile to short-pedicellate .....9.2. *Trichomanes pinnatum*
1′. Fronds pinnatifid, with dense hairs on both sides, false veins absent; sori with involucrae immersed in the laminar tissue .....9.1. *Trichomanes pilosum*

9.1. *Trichomanes pilosum* Raddi, Opusc. Sci. 3: 296 (1819). Fig. 4d

Plants terrestrial or rupicolous. Stem ascending, decumbent or short-creeping, with dark-brown to blackish hairs. Fronds 5–24.7 cm long, monomorphic, pinnatifid; petiole 1.8–8.8 cm long, dark-brown to black, not alate, with pale brown hairs; rachis alate, with pale brown to slightly dark-brown hairs on both sides, without rooting apex; laminae 4–19.3 × 2.8–3.9 cm, lanceolate to arched; pinnae 1.1–1.7 × 0.3–0.7 cm, linear, membranaceous, with pale brown hairs on both sides, margins crenate, adnate to subsessile, apex rounded, contiguous to imbricate; veins free, false veins absent. Sori on the margin of the pinnae; indusia immersed in the laminar tissue.

Examined material: MARANHÃO: Alto Parnaíba, PNNRP, 10°10′09″S, 45°55′27″W, 21.IV.2022, *P.H.C. Aguiar et al. 22* (CCAA); Cachoeira do Sussuapara, 10°09′56″S, 45°55′38″W, 425 m, 21.IV.2022, *P.H.C. Aguiar et al. 27* (CCAA, UB); *P.H.C. Aguiar et al. 32* (CCAA); 15.XII.2022, *P.H. Castro-Aguiar et al. 176* (CCAA); *P.H. Castro-Aguiar et al. 238* (CCAA, UB). PIAUÍ: Barreiras do Piauí, PNNRP, Cachoeira do Pintado, 10°11′28″S, 45°51′12″W, 436 m, 21.IV.2022, *P.H.C. Aguiar et al. 45* (CCAA); 10°11′26″S, 45°51′08″W, 436 m, 13.XII.2022, *P.H. Castro-Aguiar et al. 59* (CCAA); *P.H. Castro-Aguiar et al. 65* (CCAA, UB); *P.H. Castro-Aguiar et al. 68* (CCAA); *P.H. Castro-Aguiar et al. 72* (CCAA); Cachoeira do Urubu, 10°11′45″S, 45°47′48″W, 470 m, 14.XII.2022, *P.H. Castro-Aguiar et al. 95* (CCAA); *P.H. Castro-Aguiar et al. 96* (CCAA); *P.H. Castro-Aguiar et al. 102* (CCAA); Cachoeira Várzea Grande, 10°12′11″S, 45°47′58″W, 474 m, 14.XII.2022, *P.H. Castro-Aguiar et al. 111* (CCAA); *P.H. Castro-Aguiar et al. 116* (CCAA); *P.H. Castro-Aguiar et al. 117* (CCAA). TOCANTINS: São Félix do Tocantins, PNNRP, Cachoeira do Prata, 10°12′22″S, 46°28′35″W, 16.III.2023, *P.H. Castro-Aguiar et al. 252* (CCAA, UB).

Trichomanes pilosum has South American distribution occurring in Bolivia, Brazil, Paraguay, and Uruguay (Windisch 2014). In Brazil, it occurs in all biomes, except the Pampa (Gonzatti & Windisch 2023). In the study area, it was recorded growing on the soil or rocks, close to the edges of waterfalls, streams, and inside the gallery forest.

Trichomanes pilosum resembles *T. cristatum* Kaulf. due to the presence of involucrae subtended by lateral veins, stems decumbent to ascendant, and hairs light-chestnut to lightly dark-chestnut on the rachis. Meanwhile, *T. cristatum* differs principally in its erect linear to lanceolate 15–55 cm long fronds, whilst in *T. pilosum* the laminae are arched to lanceolate, reaching 25 cm long at most (Windisch 1992; Kessler & Smith 2017).

9.2. *Trichomanes pinnatum* Hedw., Fil. Gen. Sp. t.4, f.1 (1799). Fig. 4e

Plants terrestrial or rupicolous. Stem erect to short-creeping, with blackish hairs. Fronds 8.2–28.2 cm long, subdimorphic, 1-pinnate, with fertile fronds longer than sterile ones; petiole (1.6–)3.2–15.2 cm long, dark-brown to black, with sparse dark-brown hairs; laminae 5–13 × 5.3–15.5 cm, oblong to ovate; rachis alate, with sparse to moderate dark-brown hairs adaxially, rooting apex on sterile laminae; pinnae 2.3–9.9 × 0.8–1.3 cm, 4–15 pairs, linear to oblong, membranaceous, sessile to adnate to the rachis, with sparse hairs mainly on the veins, margin dentate, apex rounded to acute, not imbricate; veins free, ending in a main

collecting vein at the margin, with abundant false veins parallel to the true veins. Sori on the margin of the pinnae; indusia tubular, sessile to short pedicellate.

Examined material: MARANHÃO: Alto Parnaíba, PNNRP, Cachoeira do Sussuapara, 10°09'56''S, 45°55'38''W, 21.IV.2022, *P.H.C. Aguiar et al. 26* (CCAA, UB); *P.H.C. Aguiar et al. 37* (CCAA); *P.H.C. Aguiar et al. 49* (CCAA); 10°09'56''S, 45°55'39''W, 15.XII.2023, *P.H. Castro-Aguiar et al. 177* (CCAA); *P.H. Castro-Aguiar et al. 237* (CCAA); 10°10'09''S, 45°55'27''W, 21.IV.2022, *P.H.C. Aguiar et al. 49* (CCAA); trilha em direção a Cachoeira do Sussuapara, 10°09'56''S, 45°55'39''W, 15.XII.2022, *P.H. Castro-Aguiar et al. 173* (CCAA). PIAUÍ, Barreiras do Piauí, PNNRP, Cachoeira do Pintado, 10°11'26''S, 45°51'08''W, 436 m, 13.XII.2022, *P.H. Castro-Aguiar et al. 60* (CCAA); *P.H. Castro-Aguiar et al. 62* (CCAA); *P.H. Castro-Aguiar et al. 79* (CCAA); Cachoeira do Urubu, 10°11'45''S, 45°47'48''W, 14.XII.2022, *P.H. Castro-Aguiar et al. 99* (CCAA); Cachoeira Várzea Grande, 10°12'11''S, 45°47'58''W, 474 m, 14.XII.2022, *P.H. Castro-Aguiar et al. 114* (CCAA, UB); *P.H. Castro-Aguiar et al. 115* (CCAA, UB).

Trichomanes pinnatum is a Neotropical species, occurring from Mexico to South America, and in the Caribbean region (Kessler & Smith 2017). In Brazil, it occurs in the Amazon, *Cerrado*, and Atlantic Rainforest biomes (Gonzatti & Windisch 2023). In the study area, it was recorded growing close to waterfalls, on river margins and streams inside the gallery forest.

Trichomanes pinnatum is characterized by subdimorphic fronds, with the fertile laminae frequently a little larger and with petioles longer than the sterile ones, pedicellate indusia, and abundant false veins perpendicular to the true veins.

In the examined specimens from the study area, the sterile laminae can present the apex conform or continuous, with the rachis proliferating distally.

Lindsaeaceae C.Presl.

Pantropical family, with species also occurring in subtropical regions, in South America, Eastern Asia, and New Zealand, consisting of seven genera and approximately 234 species (Lehtonen *et al*. 2010; PPG I 2016).

10. *Lindsaea* Pic.Serm.

Pantropical genus, comprising around 150 species, some of which extend to the subtropical regions of Japan, Australia, and New Zealand (Lehtonen *et al*. 2010). In Brazil, 33 species are found in the Amazon biome (Pena *et al*. 2023). Two species were recorded in the study area.

Key for the species of *Lindsaea* in the PNNRP, Brazil

1. Fronds 2-pinnate; petioles dark brown to reddish-brown throughout, cylindrical abaxially, with wings paleaceous adaxially; pinnules dimidiate .....10.1. *Lindsaea divaricata*
1'. Fronds 1- or 2-pinnate; petiole dark brown only at the base, paleaceous distally, quadrangular, not winged; pinnae or pinnules sub-trapeziform .....10.2. *Lindsaea lancea*

10.1. *Lindsaea divaricata* Klotzsch, Linnaea 18(5): 547 (1845). Fig. 4f

Plants terrestrial. Stem short-creeping, with lanceolate scales, 1.3–1.9 cm long, pale brown to dark brown. Fronds 16.5–70 cm long, monomorphic, 2-pinnate, erect; petiole 9.7–43.4 long, dark brown to reddish-brown throughout, cylindrical abaxially, with two adaxial paleaceous wings distally, glabrous adaxially, with scales similar to those on the stem only at the base; rachis cylindrical abaxially, wings pale adaxially; laminae 7–27 × (3.2–)9–19.7 cm, triangular; pinnae 5.7–17.5 × 1.5–3.5 cm, 1-pinnate, 1–4 pairs, terminal pinnae conform, usually larger than the lateral pinnae; pinnules 0.8–2 × 0.4–0.7 cm, dimidiate, chartaceous, glabrous on both sides, margins denticulate to crenate, apex rounded; veins free. Sori linear along the acroscopic margin of the pinnules; indusia linear.

Examined material: MARANHÃO: Alto Parnaíba, PNNRP, Povoado Curupá, 09°53'05''S, 45°53'20''W, 380 m, 19.IV.2022, *P.H.C. Aguiar et al. 8* (CCAA, UB); 10°10'09''S, 45°55'27''W, 21.IV.2022, *P.H.C. Aguiar et al. 34* (CCAA); Cachoeira do Sussuapara, 10°09'56''S, 45°55'38''W, 425 m, 21.IV.2022, *P.H.C. Aguiar et al. 25* (CCAA); *P.H.C. Aguiar et al. 33* (CCAA); *P.H.C. Aguiar et al. 35* (CCAA); 15.XII.2022, *P.H.C. Aguiar et al. 169* (CCAA, UB); *P.H.C. Aguiar et al. 178* (CCAA); trilha em direção a Cachoeira do Sussuapara, 10°10'10''S, 45°55'27''W, 407 m, 15.XII.2022, *P.H. Castro-Aguiar et al. 175* (CCAA, UB); Fazenda do Merval, próxima a casa de serraria, 09°49'22''S, 46°16'14''W, 373 m, 19.VII.2023, *P.H. Castro-Aguiar et al. 318* (CCAA, UB). PIAUÍ: Barreiras do Piauí, PNNRP, Cachoeira do Pintado, 10°11'26''S, 45°51'08''W, 436 m, 13.XII.2022, *P.H. Castro-Aguiar et al. 64* (CCAA); *P.H. Castro-Aguiar et al. 66* (CCAA); Cachoeira do Urubu, 10°11'45''S, 45°47'48''W, 470 m, 14.XII.2022, *P.H. Castro-Aguiar et al. 100* (CCAA, UB); Cachoeira Várzea Grande, 10°12'11''S, 45°47'58''W, 474 m, 14.XII.2022, *P.H. Castro-Aguiar et al. 112* (CCAA); Margem do Rio Curriola, 10°08'15''S, 45°49'42''W, 408 m, 13.XII.2022, *P.H. Castro-Aguiar et al. 80* (CCAA); *P.H. Castro-Aguiar et al. 81* (CCAA); 14.XII.2022, *P.H. Castro-Aguiar et al. 159* (CCAA, UB).

Lindsaea divaricata has a Neotropical distribution, occurring from Costa Rica to South America and in the Caribbean region (Rojas-Alvarado & Tejero-Díez 2017). In Brazil, it is

recorded for the Amazon, *Cerrado*, and Atlantic Rainforest biomes (Pena *et al.* 2023). In the study area, it was recorded occurring in a wide range of habitats, growing along the margins of rivers, within gallery forests, around waterfalls, and in *veredas*.

Lindsaea divaricata is characterized by dark-chestnut to reddish-brown petioles, with two adaxial paleaceous wings distally, 1–2-pinnate fronds, ascendant pinnae, and pinnules 2–2.4 times as long as wide, dimidiate and ascendant.

10.2. ***Lindsaea lancea*** (L.) Bedd., Suppl. Ferns Brit. India 6: 292. 1876. Fig. 4g

Plants terrestrial. Stem short-creeping, with lanceolate scales, 0.9–1.1 mm long, pale brown to dark brown. Fronds 7.6–35.5 cm long, monomorphic, 1 or 2-pinnate, erect; petiole 3.2–21.8 cm long, dark-brown only at the base, paleaceous distally, quadrangular, not winged, glabrous, with scales similar to those on the stem only at the base; rachis paleaceous to brown, quadrangular, glabrous; laminae 6.6–20.8 × 2.2–15.8 cm, triangular; pinnae 11.4–16.2 × 2.8–3.3 cm, 1-pinnate, 2–4 pairs, up to 12 pairs in 1-pinnate, terminal pinnae conform, usually larger than the lateral pinnae; pinnules 1.2–1.5 × 0.6–0.8 cm, sub-trapeziform, chartaceous, glabrous on both sides, margin entire, apex rounded; veins free. Sori linear along the acroscopic margin of the pinnules; indusia linear.

Examined material: MARANHÃO: Alto Parnaíba, PNNRP, Cachoeira do Sussuapara, 10°09′56′′S, 45°55′38′′W, 425 m, 21.IV.2022, *P.H.C. Aguiar et al. 24* (CCAA); *P.H.C. Aguiar et al. 28* (CCAA, UB); 15.XII.2022, *P.H. Castro-Aguiar et al. 162* (CCAA); *P.H. Castro-Aguiar et al. 167* (CCAA). PIAUÍ: Barreiras do Piauí, PNNRP, Cachoeira do Pintado, 10°11′26′′S, 45°51′08′′W, 436 m, 13.XII.2022, *P.H. Castro-Aguiar et al. 70* (CCAA); Cachoeira do Urubu, 10°11′45′′S, 45°47′48′′W, 470 m, 14.XII.2022, *P.H. Castro-Aguiar et al. 98* (CCAA); *P.H. Castro-Aguiar et al. 101* (CCAA, UB); Cachoeira Várzea Grande, 10°12′11′′S, 45°47′58′′W, 474 m, 14.XII.2022, *P.H. Castro-Aguiar et al. 110* (CCAA).

Lindsaea lancea has a Neotropical distribution, occurring from Mexico to South America and in the Caribbean region (Smith & Kessler 2017b; Rojas-Alvarado *et al.* 2023). In Brazil, it is recorded for the Amazon, *Caatinga*, *Cerrado*, Atlantic Rainforest, and Pantanal biomes (Pena *et al.* 2023). In the study area, it was recorded growing in gallery forest, humid arenitic cliffs, and on rocks surrounding waterfalls.

Lindsaea lancea is characterized by the basally dark brown, distally paleaceous petioles. The fronds are 1–2-pinnate, with pinnae or pinnules c. 1.6 to 2 x longer than wide, slightly narrower towards the apex, sub-trapeziform, with the acroscopic side rounded and basiscopic side angular.

Metaxyaceae Pic.Serm.

Neotropical, constituted of a single genus, *Metaxya* C.Presl, of around six species (Cárdenas *et al.* 2016; PPG I 2016). In Brazil, four species are recorded (Pietrobom & Santiago 2023).

11.1. ***Metaxya parkeri*** (Hook. & Grev.) J.Sm., London J. Bot. 1: 668 (1842). Fig. 4h-i

Plants terrestrial. Stem short-creeping, with pale brown hairs. Fronds 75.5–107.7 cm long, monomorphic, 1-pinnate, patent; petiole 35.5–47.5 cm long, paleaceous to brown, sulcate adaxially, with hairs similar to those on the stem at the base; rachis sulcate adaxially, cylindrical abaxially; laminae 40–79 × 22.5–42 cm, oblong to lanceolate; pinnae 13.2–23.5 × 2.2–2.5 cm, 8–14 pairs, linear-lanceolate, chartaceous, glabrous adaxially, with hairs abaxially, more densely arranged close to the costae, margins serrate at the apex, sometimes extending to the middle of the pinnae length, base acute to cuneate, apex acute to acuminate, terminal pinnae conform; veins free. Sori rounded, 1–2(–3) per vein, either concentrated near the costa or irregularly dispersed over most of the pinna, paraphyses present; indusia absent.

Examined material: MARANHÃO: Alto Parnaíba, PNNRP, Cachoeira do Sussuapara, 10°09′56′′S, 45°55′38′′W, 425 m, 21.IV.2022, *P.H.C. Aguiar et al. 19* (CCAA, UB); *P.H.C. Aguiar et al. 40* (CCAA); 15.XII.2022, *P.H. Castro-Aguiar et al. 165* (CCAA). PIAUÍ: Barreiras do Piauí, PNNRP, Cachoeira do Pintado, 10°11′26′′S, 45°51′08′′W, 436 m, 13.XII.2022, *P.H. Castro-Aguiar et al. 77* (CCAA, UB).

Metaxya parkeri has a Neotropical distribution, occurring in South America and in the Caribbean (Cárdenas *et al.* 2016). In Brazil, it is the most widely distributed species of the genus, occurring in the Amazon, *Cerrado*, and Atlantic Rainforest biomes (Pietrobom & Santiago 2023). In the study area, it was observed growing in large populations in the vicinity of waterfalls, and on the margins of streams within gallery forest.

Metaxya parkeri resembles *M. rostrata* (Kunth) C.Presl mainly due to the chartaceous laminae and the arrangement of the sori, with 2–4 per venule, close to the costae or irregularly dispersed over the surface of the pinnae. Nevertheless, *M. parkeri* differs from *M. rostrata* by having laminae with more than seven pairs of pinnae (*vs.* 8–14 pairs in the study area), and with pinnae distally long-attenuated to caudate, with serrate margins that can extend up to half of the length of the pinnae or until the base, whilst *M. rostrata* has up to seven pairs of lateral pinnae, with cuspidate to caudate apex, margins irregularly dentate and almost entire (completely entire excluding the apex) (Cárdenas *et al.* 2016).

In Brazil, *Metaxya parkeri* and *M. rostrata* occur together in the Amazon biome, in the state of Amazonas. In addition, *M. rostrata* is also found in Amapá, whilst *M. parkeri* has a wider distribution, extending to the Eastern coast and occurring in the *Cerrado* and Atlantic Rainforest biomes (Cárdenas *et al*. 2016; Fernandes *et al*. 2022; Pietrobom & Santiago 2023).

Within the species of the genus, *Metaxya parkeri* is characterized by a wide variation in the margin of the pinnae and the arrangement of the sori, with the margins generally serrate only apically (up to half the length of the pinnae), but sometimes reaching the base. The sori can be concentrated close to the costae, slightly away from the costae, or irregularly distributed through a large portion of the abaxial pinnae (Cárdenas *et al*. 2016). On the specimens of the study area, the sorus can form a row slightly away from the costae, up to 2.5 mm of distance, with the others lightly dispersed on the abaxial pinnae, and the margin can be serrated only apically or up to half of the pinnae.

Pteridaceae E.D.M.Kirchn.

This family is cosmopolitan, consisting of 53 genera and around 1,210 species (Schuettpelz *et al*. 2007; PPG I 2016).

12. ***Adiantum*** L.

Adiantum has a pantropical distribution and around 225 species (PPG I 2016). In the Neotropical region, around 110 species occur, with 65 recorded for Brazil (Prado & Hirai 2020).

12.1. ***Adiantum deflectens*** Mart., Icon. Pl. Crypt. 94 (1834).

Plants terrestrial or rupicolous. Stem erect, with linear-lanceolate scales, 1.4–2 mm long, dark brown with pale brown margins. Fronds 10.5–18.5 cm long, monomorphic, 1-pinnate, erect; petiole 4–9.5 cm long, dark brown to black, glabrous, only at the base with scales similar to those on the stem; rachis cylindrical, dark brown to black, glabrous; laminae 4–13.5 × 2.2–3.5 cm, linear-lanceolate; pinnae 0.8–1.1 × 1.1–1.6 cm, 4–14 pairs, flabellate, slightly chartaceous, glabrous on both sides, margins denticulate, base obtuse, apex rounded; veins free. Sori oblong-linear along the acroscopic margin; pseudo-indusia glabrous.

Examined material: MARANHÃO: Alto Parnaíba, Povoado Porto Alegre, 09°51′50′′S, 46°06′03′′W 385 m, 18.III.2023, *P.H. Castro-Aguiar et al. 296* (CCAA, UB). PIAUÍ: Barreiras do Piauí, Rio Uruçuí Vermelho, 09°57′14′′S, 45°34′15′′W, 396 m, 20.IV.2022, *P.H.C. Aguiar et al. 18* (CCAA).

Adiantum deflectens is a Neotropical species, occurring from Mexico to Argentina (Kessler *et al*. 2017). In Brazil, it occurs in the Amazon, *Cerrado*, and Atlantic Rainforest biomes (Prado & Hirai 2023a). In the study area it was observed growing on arenitic cliffs, roadsides, and in shaded areas within the forest.

This species is characterized by the1-pinnate lamina, flabellate pinnae articulated to the rachis, with denticulate margins, and pseudo indusia oblong-linear, glabrous.

13. ***Cheilanthes*** Sw.

Cheilanthes comprises approximately 70 species with pantropical distribution (Ponce *et al*. 2023). Of around thirty species present in South America, ten are recorded in Brazil (Ponce & Scataglini 2018; Ponce *et al*. 2023).

13.1. ***Cheilanthes pohliana*** (Kunze) Mett., Abh. Senckenberg. Naturf. Ges. 3: 67; n. 13 (1859).

Fig. 5a

Plants rupicolous. Stem creeping, with linear-lanceolate scales, 1.2–1.7 mm long, bicolorous, dark brown, with pale brown margins. Fronds 2.2–9.5 cm long, monomorphic, 2-pinnate proximally to 1-pinnate distally, erect; petiole 0.7–5.2 cm long, dark brown to black, cylindrical, with short hairs; rachis similar to the petiole; laminae 1.5–4.3 × 1–1.9 cm, triangular; proximal pinnae 0.5–0.9 × 0.4–0.6 cm, 3–12 pairs, pinnules 0.2–0.4 × 0.1–0.25 cm, ovate-oblong, chartaceous to coriaceous, both sides with dense multicellular hairs, lobed margins, base slightly cordate to truncate, apex obtuse, veins free. Sori rounded to oblong along the margin of the segments, pseudo-indusia with hairs.

Examined material: Alto Parnaíba, PNNRP, descida da Galiléia, 10°03′08′′S, 46°22′38′′W, 537 m, 17.III.2023, *P.H. Castro-Aguiar et al. 282* (CCAA, UB); Ladeira da Galiléia, 10°03′21′′S, 46°22′51′′W, 578 m, 17.III.2023, *P.H. Castro-Aguiar et al. 283* (CCAA, UB).

Cheilanthes pohliana is endemic to Brazil, occurring in the Amazon and *Cerrado* in the states of Goiás, Maranhão, Mato Grosso do Sul, Mato Grosso, Minas Gerais, Pará and Tocantins (Ponce *et al*. 2023). In the study area, the specimens of *C. pohliana* were recorded in the *cerrado rupestre*, growing on rock formations among tree-shrubby vegetation.

It is characterized by the basally 2-pinnate frond that is once-pinnate distally, petioles and rachis cylindric, dark brown to black, with short hairs, and ovate-oblong pinnules with dense, pluricellular hairs on both sides.

14. ***Pityrogramma*** Link.

Pityrogramma is predominantly Neotropical with some species occurring in Africa and Madagascar and comprising around 20 species (PPG I 2016; Prado *et al*. 2017). In Brazil, four species are recorded (Prado & Hirai 2023b).

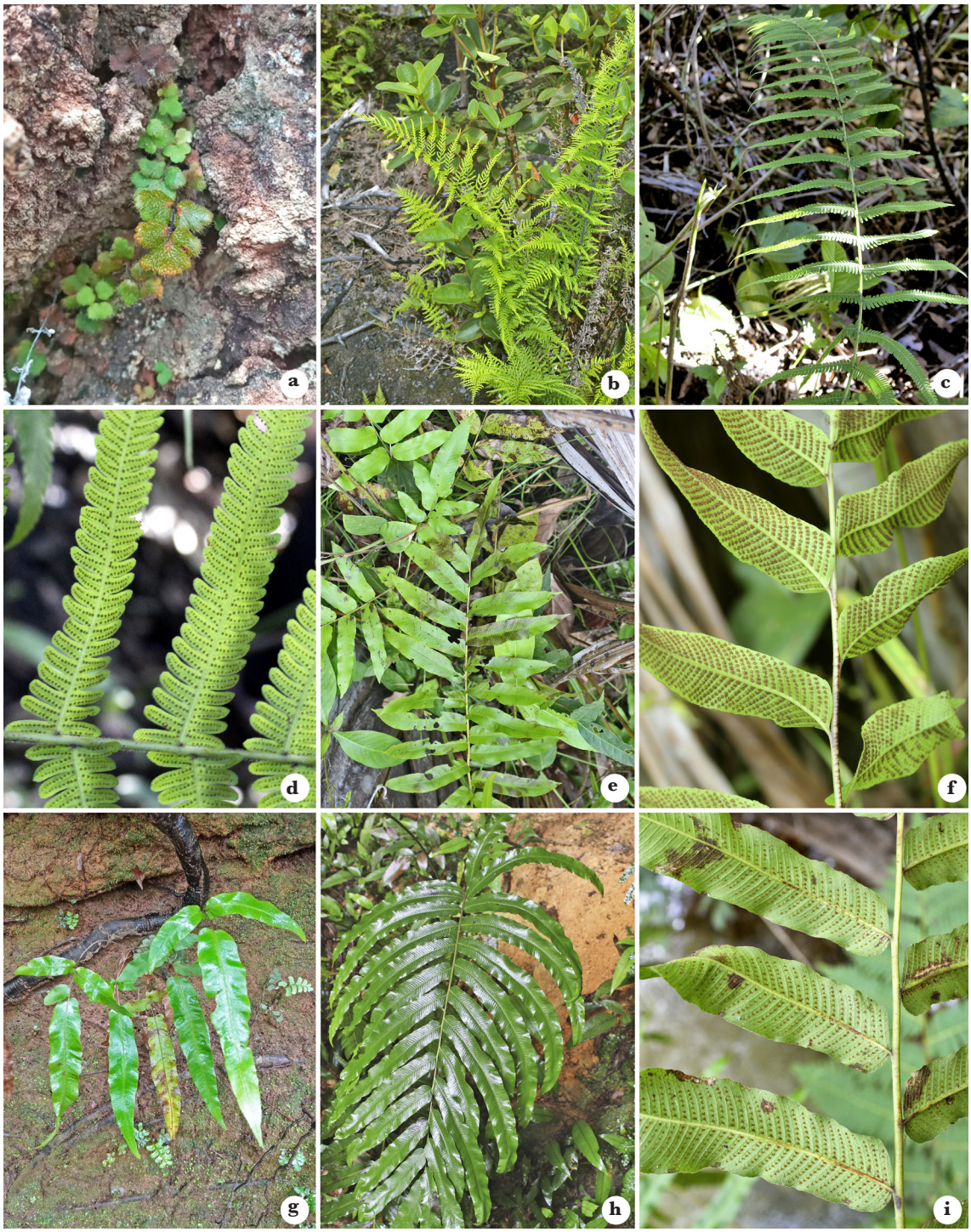

Figure 5 – a. *Cheilanthes pohliana* – habit. b. *Pityrogramma calomelanos* – habit. c-d. *Christella hispidula* – c. habit; d. sori on the abaxial surface. e-f. *Meniscium arborescens* – e. habit; f. sori on the abaxial surface. g. *Meniscium delicatum* – habit. h-i. *Meniscium maxonianum* – h. habit; i. sori on the abaxial surface. (a. *P.H. Castro-Aguiar et al. 283*; b. *P.H. Castro-Aguiar et al. 244*; c-d. *P.H.C. Aguiar et al. 12*; e-f. *P.H.C. Aguiar et al. 6*; g. *P.H. Castro-Aguiar et al. 97*; h-i. *P.H. Castro-Aguiar et al. 166*).

14.1. ***Pityrogramma calomelanos*** (L.) Link, Handb. Gewachse 3: 20 (1833). Fig. 5b

Plants terrestrial. Stem ascending to short-creeping, with lanceolate scales, 2.5–5 mm long, pale brown. Fronds 73–119.5 cm long, monomorphic, 1- or 2-pinnate-pinnatifid (rarely 3-pinnate-pinnatifid), erect; petiole 30.5–53.5 cm long, dark brown to black, glabrous, sulcate adaxially, with scales similar to those on the stem at the base; rachis similar to the petiole; laminae 42.5–66 cm long, lanceolate to oblong-lanceolate; rachis similar to the petiole, pinnae 3.4–14.7 cm long, 13–32 pairs, pinnules lanceolate, chartaceous, with a whitish farinaceous wax abaxially, margins entire to coarsely denticulate, base cuneate, apex acute. Sori linear along the veins; indusia absent.

Examined material: MARANHÃO: Alto Parnaíba, PNNRP, Povoado Curupá, 09°53′05″S, 45°53′20″W, 380 m, 19.IV.2022, *P.H.C. Aguiar et al. 13* (CCAA); próxima a casa de serraria na Fazenda do Merval, 09°49′22″S, 46°16′14″W, 373 m, 19.VII.2023, *P.H. Castro-Aguiar et al. 320* (CCAA, UB). PIAUÍ: Barreiras do Piauí, PNNRP, Brejo do Curicaca, 10°00′26″S, 45°35′52″W, 446 m, 21.IV.2022, *P.H.C. Aguiar et al. 47* (CCAA); Cabeceira do Curicaca, 10°00′25″S, 45°35′50″W, 457 m, 16.XII.2022, *P.H. Castro-Aguiar et al. 244* (CCAA, UB).

Pityrogramma calomelanos is widely distributed in the Neotropical region, occurring from the south of the United States (Florida) to Argentina (Kessler *et al.* 2017; Prado *et al.* 2017). In Brazil, it is found in all states and biomes (Prado & Hirai 2023b). In the study area, it was recorded in various environments, occurring on the inside and margins of the *vereda*, in the gallery forest, and disturbed areas.

The species is characterized by the 1- or 2-pinnate-pinnatifid (rarely 3-pinnate-pinnatifid) fronds, pinnules ascendant and by the sori along the veins. In the study area the specimens have leaves abaxially farinaceous white.

Thelypteridaceae Pic.Serm.

Cosmopolitan, composed of approximately 1,190 species and 37 genera, comprising around 10% of all fern diversity (Fawcett & Smith 2021). In Brazil, nine genera and around 101 species are recorded (Salino *et al.* 2023).

15. ***Christella*** H.Lév.

Christella is comprised of around 66 paleotropical species, from China and the Southeast of continental Asia to India, where the center of diversity of the genus is found. In the Neotropical region three species are recorded, with one naturalized, *Christella dentata* (Forssk.) Brownsey & Jermy (Fawcett & Smith 2021). In Brazil, three species are recorded, distributed principally in the *Cerrado* and Atlantic Rainforest biomes (Salino *et al.* 2023). In the study area, two species were recorded.

Key for the species of *Christella* in the PNNRP, Brazil

1. Pinnae with acicular and glandular hairs; basal veins of adjacent segments always joining at the sinus; indusia with acicular and glandular hairs ..... 15.1. *Christella conspersa*
1′. Pinnae with only acicular hairs; basal veins of adjacent segments joining well below the sinus, rarely at the sinus; indusia with only acicular hairs ..... 15.2. *Christella hispidula*

15.1. ***Christella conspersa*** (Schrad.) Á.Löve & D.Löve, Taxon 26: 326 (1977).

Plants terrestrial. Stem erect to short-creeping, with lanceolate scales com, 4–8.5 mm long, dark brown, pilose. Fronds 114–147.5 cm long, monomorphic, pinnate-pinnatifid; petiole 39.3–60 cm long, paleaceous to pale brown, sulcate adaxially, with hairs on both sides; rachis sulcate adaxially, with acicular hairs on both sides; laminae 54–100.5 × 21–33 cm long, lanceolate, base with com 1–2(–3) pairs of reduced pinnae; pinnae median 10.5–16.5 × 1.5–1.8 cm, 12–37 pairs, linear-lanceolate, pinnatisect, chartaceous, both sides with acicular and stalked glandular hairs on the costae, veins, and laminar tissue between the veins, margins entire, base truncate, apex acute to rounded; basal veins of adjacent segments always joining at the sinus. Sori rounded, median, indusia rounded, with acicular and glandular hairs.

Examined material: Alto Parnaíba, PNNRP, próxima à casa de serraria na Fazenda do Merval, 09°49′22″S, 46°16′14″W, 373 m, 19.VII.2023, *P.H. Castro-Aguiar et al. 313* (CCAA); *P.H. Castro-Aguiar et al.* 314 (CCAA, UB).

Christella conspersa has Neotropical distribution, occurring from Panamá to South America, and in the Caribbean region (Ponce 2007; Smith & Kessler 2017c). In Brazil, it occurs in the *Cerrado* and the Atlantic Rainforest, and in areas of dense ombrophilous forest in the Amazon biome (Salino *et al.* 2023). In the study area, it was found in shaded areas, inside the forest and on river banks along the rapids and waterfalls, and in wet soils exposed to light, in the *vereda*.

This species is characterized by the 1-pinnate-pinnatifid fronds, with acicular and glandular hairs and on both surfaces, basal veins of adjacent segments united at the sinus, indusia with both acicular and glandular hairs.

Christella conspersa can be confused with *C. hispidula*, which also occurs in the study area. However, they can be differentiated primarily by the indusia, which in *C. conspersa* have acicular and glandular hairs, whilst in *C. hispidula* the indusia have only acicular hairs. Additionally, the basal veins of the adjacent segments in *C. conspersa* are united always at the sinus, whilst in *C. hispidula* they are united, with rare exceptions, significantly below the sinus.

15.2. *Christella hispidula* (Decne.) Holttum, Kew Bull. 31(2): 312 (1976). Fig. 5c-d

Plants terrestrial. Stem decumbent to short-creeping, with lanceolate scales, 4.5–7 mm long, dark brown, pilose. Fronds 76–133.5 cm long, monomorphic, pinnatisect; petiole 33.5–54 cm long, paleaceous to pale brown, sulcate adaxially, with hairs on both sides; rachis sulcate adaxially, with acicular hairs on both sides; laminae 42.5–84.5 × 18–42 cm, pinnate-pinnatifid, lanceolate, base with 1–2(–3) pairs of reduced pinnae; pinnae median 10.8–20.6 × 1.4–2.6 cm, 23–28 pairs, linear-lanceolate, chartaceous, both sides with acicular hairs on the costae, veins, and laminar tissue between the veins, margins entire, base truncate, apex acute to rounded; basal veins of adjacent segments joining well below the sinus, rarely at the sinus. Sori rounded, median, indusia rounded, with acicular hairs.

Examined material: Alto Parnaíba, PNNRP, Povoado Curupá, 09°53′05″S, 45°53′20″W, 19.IV.2022, *P.H.C. Aguiar et al. 12* (CCAA, UB).

Christella hispidula is a pantropical species of wide distribution, occurring from the Southeast of the United States to Argentina, also occurring in the Caribbean region, in tropical and subtropical Africa (Smith & Kessler 2017c; Fawcett & Smith 2021). In Brazil, it is recorded for the Amazon, *Cerrado*, and Atlantic Rainforest biomes (Salino *et al*. 2023). In the study area, it was found in the margin and interior of the *vereda*, in shaded, dry banks.

Characterized by the 1-pinnate-pinnatisect, with acicular hairs on both sides, costae abaxially with hairs of unequal length, reaching until 1mm in length; the basal veins united almost always well below the sinus, forming an excurrent vein that leads to the sinus, the indusia only bear acicular hairs. *Christella hispidula* can also be confused with *C. dentata* (Forssk.) Brownsey & Jermy, however, the latter differs due to the generally brown petioles and rachis, and by the costae with predominantly short and uniform hairs abaxially, the majority of 0.1 to 0.2 mm in length, while *C. hispidula* has paleaceous pale-brown petioles and rachis and abaxial hairs over 0.3 mm long, sometimes reaching more than 0.5 mm. (Smith & Kessler 2017c).

16. *Meniscium* Schreb.

This genus consists of around 25 species in the Neotropical region (Fernandes & Salino 2020). In Brazil, twelve species occur, of which a single one recorded in the study area, *Meniscium delicatum* R.S. Fernandes & Salino, is endemic (Amazonas, Goiás, Maranhão, Mato Grosso do Sul, Piauí) (Salino *et al*. 2023). In the study area, four species were recorded.

Key for the species of *Meniscium* in the PNNRP, Brazil

1. Pinnae with serrate margins ..... 16.4. *Meniscium serratum*
1′. Pinnae with entire, undulate, or crenate margins.
    2. Twisted acicular hairs on the costae and veins abaxially, rarely on the laminar tissue and between the veins; 1–2 pairs of distal pinnae abruptly reduced ..... 16.1. *Meniscium arborescens*
    2′. Only glandular hairs or glandular hairs and sparse acicular hairs present on the costae, veins, and laminar tissue between the veins abaxially; distal pinnae not abruptly reduced.
        3. Laminae membranaceus; median pinnae 1.6–2.3 cm wide, with two kinds of hairs, glandular and sparse acicular, present on the costae, veins, and laminar tissue between the veins abaxially, 6–8 areoles between the costae and the margin; sporangium receptacle with acicular hairs ... . 16.2. *Meniscium delicatum*
        3′. Laminae chartaceous; median pinnae 2.7–3.8 cm wide, with only glandular hairs abaxially, 9–12 areoles between the costae and the margin; sporangium receptacle with glandular hairs ..... 16.3. *Meniscium maxonianum*

16.1. *Meniscium arborescens* Humb. & Bonpl. *ex* Willd., Sp. Pl., ed. 4 [Willdenow] 5: 133 (1810). Fig. 5e-f

Plants terrestrial. Stem short-creeping, glabrous. Fronds 131.5–244.5 cm long, monomorphic, pinnate; petiole 76.5–127 cm long, paleaceous to pale brown, angular, glabrescent; rachis paleaceous to pale brown, sulcate adaxially, with sparse acicular hairs on both sides; laminae 53–117.5 × 16.5–64 cm, linear to oblong-lanceolate, with 1–2 pairs of distal pinnae abruptly reduced; pinnae median 10.5–32.5 × 1.5–4.3 cm, 14–21 pairs, linear

to oblong-lanceolate, chartaceous, abaxially with sparse twisted hairs on the costae and veins, rarely on the laminar tissue between the veins, adaxial side rarely with hairs on the costae and veins, margins undulate to rarely crenate, base cuneate, apex acute to acuminate; veins anastomosed, 9–13 areoles between the costae and the margin of the pinnae. Sori oblong-arcuate; indusia absent.

Examined material: Alto Parnaíba, PNNRP, povoado Curupá, 09°53′05′′S, 45°53′20′′W, 380 m, 19.IV.2022, *P.H.C. Aguiar et al. 6* (CCAA); *P.H.C. Aguiar et al. 10* (CCAA); Fazenda do Merval, próxima a casa de serraria, 09°49′22′′S, 46°16′14′′W, 373 m, 19.VII.2023, *P.H. Castro-Aguiar et al. 315* (CCAA, UB); *P.H. Castro-Aguiar et al. 316* (CCAA, UB); *P.H. Castro-Aguiar et al. 317* (CCAA, UB).

Meniscium arborescens has Neotropical distribution, occurring from México to South America, and in the Caribbean region (Fernandes & Salino 2020). In Brazil, it occurs in the Amazon Rainforest, *Cerrado*, and Atlantic Rainforest biomes (Salino *et al.* 2023). In the study area it was recorded growing in shady areas in flooded areas of the *vereda*, on the margins, in sunny areas, and in humid rock faces inside the gallery forest.

This species is characterized by chartaceous, ascendant pinnae, with twisted hairs principally on the costae and veins, and sparse on the abaxial laminar tissue between the veins. The specimens from the study area generally present between 1–2 distal abruptly reduced pinnae.

16.2. ***Meniscium delicatum*** R.S.Fern. & Salino, Phytotaxa 273(3): 176 (2016). Fig. 5g

Plants terrestrial. Stem short-creeping, glabrous. Fronds 38–90.5 cm long, monomorphic, pinnate; petiole 16.1–42 cm long, slightly paleaceous to pale brown, sulcate adaxially, glabrous; rachis paleaceous to pale brown, sulcate adaxially, with sparse glandular hairs; laminae 20.5–48.5 × (10–)19–23.5 cm, ovate; pinnae median 7.7–20 × 1.6–2.5 cm, 3–7 pairs, linear-lanceolate, slightly falcate, petiolulate, membranaceous, abaxially with two kinds of hairs, glandular and sparse acicular, present on the costae, veins, and laminar tissue between the veins, margins undulate to crenate, base rounded, apex acuminate; veins anastomosed, 6–8 areoles between the costa and the margin of the pinnae. Sori round to oblong-arcuate, with acicular hairs on the sporangium receptacle; indusia absent.

Examined material: Barreiras do Piauí, PNNRP, Cachoeira do Urubu, 10°11′45′′S, 45°47′48′′W, 470 m, 14.XII.2022, *P.H. Castro-Aguiar et al. 97* (CCAA); *P.H. Castro-Aguiar et al. 104* (CCAA); *P.H. Castro-Aguiar et al. 106* (CCAA); *P.H. Castro-Aguiar et al. 109* (CCAA, UB).

Meniscium delicatum is endemic to Brazil and is recorded in the states of Amazonas, Mato Grosso do Sul, Goiás, Maranhão, and Piauí in the Amazon, *Caatinga*, and *Cerrado* biomes (Fernandes & Salino 2020). In the study area it was found growing with pendulous fronds in humid and shady arenitic rock formations, on the cliffs of the Cachoeira do Urubu.

Characterized by the membranaceous laminae, with the base of the pinnae median and rounded distals, short petiolated, with 6–8 areoles between the costae and the margin of the pinnae, and the sporangium receptacle with acicular hairs.

16.3. ***Meniscium maxonianum*** (A.R.Sm.) R.S.Fern. & Salino, Phytotaxa 184(1): 9 (2014). Fig. 5h-i

Plants terrestrial. Stem short-creeping, glabrous. Fronds (30.5–)136–168 cm long, monomorphic, pinnate; petiole (15.5–)68.5–85.5 cm long, pale brown to greenish, sulcate adaxially, with sparse glandular hairs; rachis paleaceous to pale brown, adaxially sulcate, with glandular hairs on both sides; laminae (15–)64–84 × (9.5–)30–60 cm, pinnate, oblong-lanceolate; pinnae median (5.8–)21.5–32.5 × (1.3–)2.7–3.8 cm, (3–)10–13 pairs, linear-lanceolate, usually slightly falcate, chartaceous, abaxially with only glandular hairs, glabrous or with sparse glandular hairs adaxially, margins undulate to crenate, base basiscopic, usually rounded, rarely long-cuneate, apex acute to rarely acuminate; veins anastomosed, 9–12 areoles between the costa and the margin of the pinnae. Sori oblong-arcuate, with glandular hairs on the sporangium receptacle; indusia absent.

Examined material: Alto Parnaíba, PNNRP, Cachoeira do Sussuapara, 10°09′56′′S, 45°55′39′′W, 422 m, 21.IV.2022, *P.H.C. Aguiar et al. 31* (CCAA); *P.H.C. Aguiar et al. 42* (CCAA); 15.XII.2022, *P.H. Castro-Aguiar et al. 166* (CCAA, UB).

Meniscium maxonianum has a South America distribution (Fernandes & Salino 2020). In Brazil, it occurs in the Amazon, *Cerrado*, and Atlantic Rainforest (Salino *et al.* 2023). In the study area, it was recorded growing on the edges of streams in the gallery forest and surrounding waterfalls.

This species is characterized by the chartaceous laminae, with numerous glandular, short-pedicellate hairs abaxially, by the cuneate pinnae base, 9–12 areoles between the costae and the margin of the pinnae, and the receptacles of the sporangium bearing glandular hairs.

16.4. ***Meniscium serratum*** Cav., Descr. Pl. (Cavanilles) 548 (1803).

Plants terrestrial. Stem short-creeping, glabrous. Fronds 97–110 cm long, monomorphic, pinnate; petiole 39–57.5 cm long, paleaceous to pale brown, angular, glabrous; rachis paleaceous, sulcate adaxially, with sparse acicular hairs on both sides; laminae 49–60 × 26.5–32 cm, lanceolate to oblong; pinnae median 14.5–18 × 3.2–3.7 cm, 8–11 pairs, oblong-lanceolate, chartaceous, abaxially with twisted acicular hairs on the costae and veins, rarely on the laminar tissue between the veins,

adaxially glabrous, with sparse acicular hairs on the costae, margins serrate, base cuneate to rounded, apex acute to acuminate; veins anastomosed, 12–14 areoles between the costae and the margin of the pinnae. Sori not observed.

Examined material: Barreiras do Piauí, Rio Uruçuí Vermelho, 09°57'14''S, 45°34'15''W, 396 m, 20.IV.2022, *P.H.C. Aguiar et al. 17* (CCAA).

Meniscium serratum has wide Neotropical distribution, from Mexico to Argentina and in the Caribbean region (Fernandes & Salino 2020). In Brazil, it occurs in the Amazon, *Cerrado*, and Atlantic Rainforest biomes (Salino *et al*. 2023). In the present study, it is recorded as a new occurrence for the state of Piauí, having been observed in arenitic soil along the river banks.

It is the only species of the genus in Brazil with pinnae with serrate margins. According to Fernandes & Salino (2020), *Meniscium serratum* resembles *M. arborescens* due to its generally ascendant and lanceolate pinnae, secondary veins forming a sigmoid pattern and twisted hairs abaxially on the costae veins and laminar tissue between the veins, whiles *M. arborescens* has undulate and crenate pinnate margins.

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Data Availability Statement

In accordance with Open Science communication practices, the authors inform that all data are available within the manuscript.

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