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Isolated in biogeographic islands: discovery of a disjunct population of a fern in Northeastern Atlantic Forest

Aislados en islas biogeográficas: descubrimiento de una población disyunta de un helecho en el Bosque Atlántico Septentrional

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Abstract

Brejos Nordestinos (northeastern highland wet forests) is a unique ecosystem within the Northeastern Atlantic Forest. This area encompasses a mosaic of humid forests above 600 meters in the semi-arid region, forming an ecotone area. These environmental conditions create an optimal ecosystem for the diversification of plants, including ferns. Pico do Jabre in Paraíba state, with an elevation of 1,208 meters above sea level, is an example of *Brejo Nordestino*. This study reports the occurrence of *Pleopeltis pleopeltidis* in the Northeastern Atlantic Forest, particularly at Pico do Jabre, a new record of *P. pleopeltifolia* for Paraíba state, and the local fern flora. Additional records of *P. pleopeltidis* were found in the municipalities of Triunfo, and Floresta, in Pernambuco state,

which are also classified as *Brejos Nordestinos* with elevations exceeding 1,000 meters above sea level. These findings extend the species' known extent of occurrence by approximately 40%. The conservation status of *P. pleopeltidis* is suggested as Vulnerable (VU) across its entire range and Endangered (EN) in Northeast Brazil. The distance between populations in the Northeastern Atlantic Forest and the nearest populations in Bahia state ranges from 763-931 km, indicating a potential disjunction. Although the species occurs in three relatively close *Brejos Nordestinos*, the fragmented nature of the Northeastern Atlantic Forest results in isolated populations on these biogeographical islands, surrounded by a Caatinga (seasonally dry tropical forest) matrix.

Keywords: *Brejos de Altitude*, Pico do Jabre, *Pleopeltis pleopeltidis*, Species conservation, Species distribution.

Resumen

Los *Brejos Nordestinos* (bosques húmedos de tierras altas del noreste) son un ecosistema único dentro del Bosque Atlántico del Nordeste. Esta área abarca un mosaico de bosques húmedos por encima de los 600 metros en la región semiárida, formando una zona de ecotono. Estas condiciones ambientales crean un ecosistema óptimo para la diversificación de plantas, incluidos los helechos. El Pico do Jabre, en el estado de Paraíba, con una altitud de 1208 metros sobre el nivel del mar, es un ejemplo de Brejo Nordestino. Este estudio reporta la ocurrencia de *Pleopeltis pleopeltidis* en el Bosque Atlántico del Nordeste, particularmente en el Pico do Jabre, un nuevo registro de *P. pleopeltifolia* para el estado de Paraíba, y en la flora local de helechos. Se encontraron registros adicionales de *P. pleopeltidis* en los municipios de Triunfo y Floresta, en el estado de Pernambuco, que también están clasificados como *Brejos Nordestinos* con elevaciones superiores a los 1000 metros sobre el nivel del mar. Estos hallazgos amplían la extensión conocida de ocurrencia de la especie en aproximadamente un 40%. Se sugiere que el estado de conservación de *P. pleopeltidis* sea vulnerable (VU) en toda su área de distribución y en peligro (EN) en el noreste de Brasil. La distancia entre las poblaciones del Bosque Atlántico del Nordeste y las poblaciones más cercanas en el estado de Bahía varía entre 763 y 931 km, lo que indica una posible disyunción. Aunque la especie ocurre en tres *Brejos Nordestinos* relativamente cercanos, la naturaleza fragmentada del Bosque Atlántico del Nordeste da como resultado poblaciones aisladas en estas islas biogeográficas, rodeadas por una matriz de Caatinga (bosque tropical seco estacionalmente).

Palabras clave: Brejos de Altitude, Conservación, distribución, Pico do Jabre, *Pleopeltis pleopeltidis*.

Introduction

The Atlantic Forest is a phytogeographic domain that covers a large part of the Brazilian coast, spanning 17 states, and also has remnants in Argentina and Paraguay (Fundação SOS Mata Atlântica 2023). Originally, the Atlantic Forest covered approximately 136 million hectares, but currently, only around 8% to 22% of the original forest remains, depending on the measurement criteria and the areas considered in the analysis (Franke et al. 2005, Galindo-Leal & Câmara 2005, Vancine et al. 2024). Most of the remaining fragments of the Atlantic Forest are small, with 86% less than 50 hectares, and are surrounded by human-modified landscapes that disrupt biological flows and increase the rate of endangered species (Silva et al. 2016). However, the diversity of this domain is immense. The flora, consists of approximately 20.000 species of vascular plants, 8.000 of

which are endemic (Campanili & Schaffer 2010). Because of its immense species richness and significant deforestation and fragmentation, the Atlantic Forest is considered a biodiversity hotspot (Myers et al. 2000).

The Northeastern Atlantic Forest (NAF) is a section of the domain north of the São Francisco River that includes remnants in the states of Alagoas, Pernambuco, Paraíba, Rio Grande do Norte, and Ceará (Galindo-Leal & Câmara 2005). This region is one of the most diverse areas of the biome, but it is also the most degraded. Originally covering about 7 million hectares, less than 2% of the original area remains (Pôrto et al. 2006; Silva & Tabarelli 2000). The forest formations exhibit significant altitudinal variation, being part of the Barreiras Formation and the Borborema Plateau, resulting in a diverse range of environments (Pôrto et al. 2004). The *Brejos Nordestinos* (BNs), also known as *Brejos de Altitude* (highland wet forests), are unique ecosystems within the Northeastern Atlantic Forest. These remnants of humid forests, located above 600 meters in the semi-arid region, form an ecotone within a matrix of seasonally dry tropical forest (Rodal et al. 1998, Pôrto et al. 2006). Many of these BNs experience significant anthropogenic interference in their vegetation, such as pasture and slash-and-burn agriculture, which can compromise the conservation of plant species. As a result, many of them are priority areas for biodiversity conservation (Santos & Tabarelli 2004, MMA 2021). One example is Pico do Jabre, Paraíba, Brazil, where, in addition to anthropogenic interference and priority area, there is a gap in knowledge about the composition of the remaining flora, including ferns (Agra et al. 2004).

The environmental characteristics of the BNs, such as high humidity, high altitude, and rich soil nutrients, create an ideal ecosystem for diversifying plant organisms, such as ferns (Barros et al. 2002). In Pernambuco, one of the most well-studied states regarding fern flora in Northeastern Brazil, more than 60% of the 300 species that make up the state's flora are found at the BNs (Barros et al. 2002). In the Northeast Atlantic Forest, Polypodiaceae emerges as one of the families with notable richness among ferns (Santiago 2006), including in the fern flora of BNs (Xavier & Barros 2003, Santiago et al 2004).

Polypodiaceae is one of the most diverse and abundant lineages of ferns (Schneider et al. 2004). This family is monophyletic (Schuettpelz & Pryer 2007) and cosmopolitan, formed by six subfamilies, 65 genera, and 1652 species (Wei & Zhang 2022, PPG I 2016) of which 22 genera and 173 species occur in Brazil (Labiak et al. 2020). These species are mainly found in forested areas, with greater diversity in the rainforest and semideciduous seasonal forests, especially in mountainous regions (Salino et al. 2023).

Pleopeltis Humb. & Bonpl. ex Willd., is the richest genus in Polypodiaceae, predominantly found in the Neotropics (Smith & Tejero-Díez 2014; PPG I 2016), with one species in Africa. It comprises approximately 90 species (PPG I 2016) and is closely related to *Pecluma* M.G.Price, *Polypodium* L., and *Phlebodium* (R.Br.) J.Sm. (Wei & Zhang 2022, Otto et al. 2009). There are 19 species of *Pleopeltis* in Brazil (Souza & Salino 2021), 84% occurring in the Atlantic Forest. Most species are epiphytes, with several also occurring as epipetric and terrestrial (Souza & Salino 2021).

Pleopeltis pleopeltidis (Fée) de la Sota is found in South America, specifically in Argentina and Brazil, from sea level up to 2200 meters in elevation. This plant has an epiphytic habit (Souza & Salino 2021) and is found in the Atlantic Forest and the Pampa. Its distribution in Brazil covers the South, Southeast, and Northeast regions, with records in the latter region only in Bahia state (Souza & Salino 2021). The objective of this study is to report the occurrence of *Pleopeltis pleopeltidis* in the Brazilian Northeastern Atlantic Forest (NAF) and to document the ferns of Pico do Jabre, Paraíba, Brazil.

Material and methods

Study area

This study was conducted at Pico do Jabre (7°15'10.9" S, 37°23'03.1" W; Figure 1), located between the municipalities of Maturéia and Mãe D'água in Paraíba state (Cunha et al. 2013). This area is part of a residual mountain range within the geotectonic zone of Serra do Teixeira, dating back to the Upper Precambrian (Marques et al. 2021). It is characterized as an isolated and relatively small projection on the Borborema Plateau (Moreira 1989), with an elevation of 1,208 meters above sea level (Silva et al. 2024), making it the highest point in the NAF. The climate differs from the surrounding semi-arid region, mainly due to its altitude. According to the Köppen climate classification, it falls under the AS category, characterized by a hot and semi-humid climate (Alvares et al. 2013). The region has low rainfall, with an annual average between 800 and 1000 mm. The average annual temperature exceeds 20 °C and relative humidity is around 65% (Sudema 2022). The region, an ecotone influenced by both Caatinga (seasonally dry tropical forest) and Atlantic Forest domains (Figure 2AB) (Rocha & Agra 2002). Has a mosaic of vegetation types related to the altitudinal variation (Cunha & Silva-Júnior 2018). The lower areas, with a vegetation type of semideciduous seasonal forest, have the presence of rocky outcrops and typical semi-arid Caatinga vegetation (Agra et al. 2004). Formerly known as the Pico do Jabre State Park this area was incorporated into the Serra do Teixeira National Park, expanding from 500 to 61,095 hectares by Decree No. 11,552 issued in June 2023 (Avelar 2023).

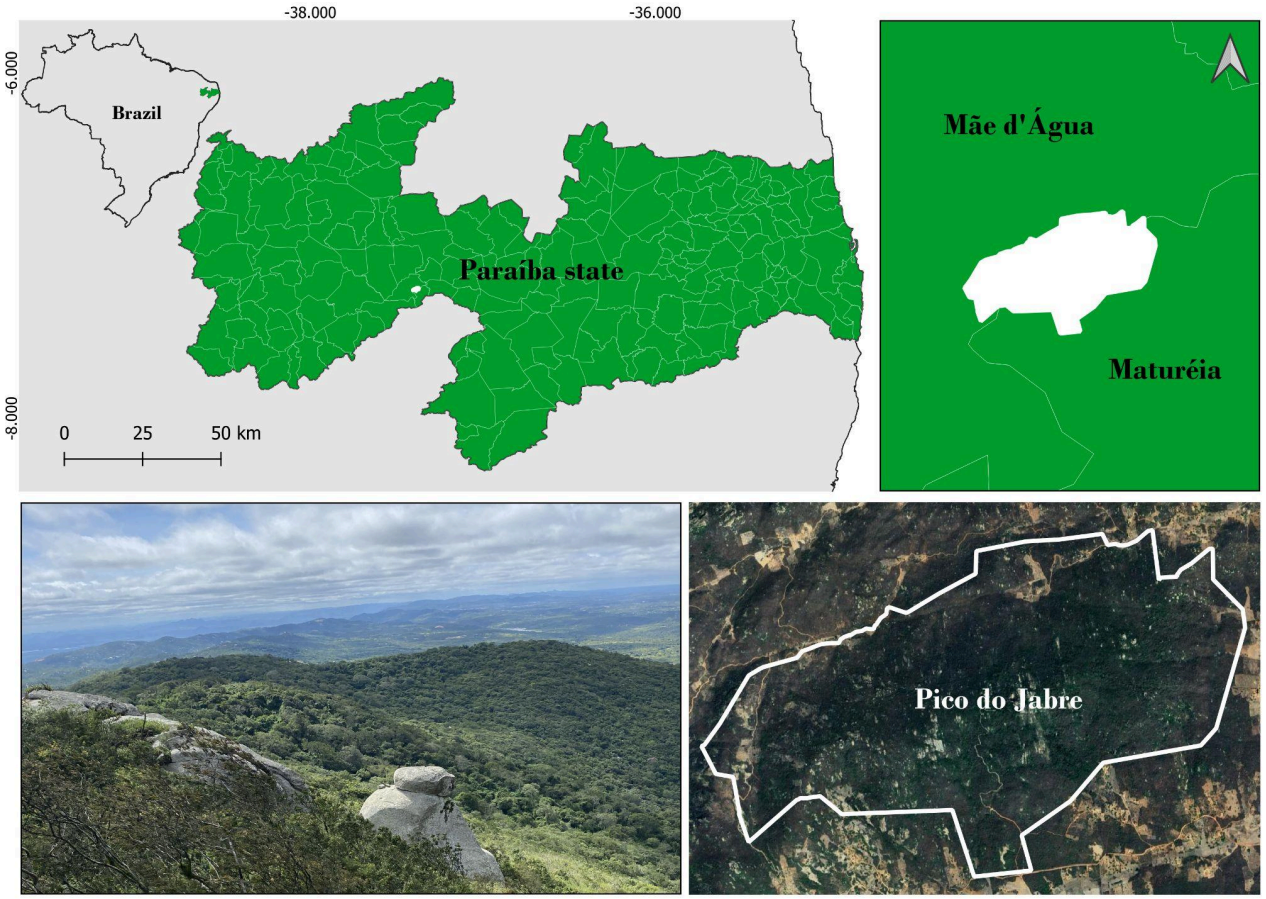

Figure 1. Map of the study area: Location of Pico do Jabre in the municipalities of Mãe d'Água and Maturéia in the state of Paraíba, Brazil, showing the vegetation and boundaries from a satellite view.

Figure 2. A-B. The vegetation of Pico do Jabre. C. *Pleopeltis* species in sympatry. D. Habit of *P. pleopeltidis*

Fieldwork and taxonomic inventory

Collections were made by the authors in 2010 and 2024 using the walking survey method (Filgueiras et al. 1994), along with records collected by Domingos Sávio Pimentel in 2005. All collected material was deposited in the UFP herbarium. Additionally, previously collected specimens were examined at the EAN, JPB, PEUFR, and UFP herbaria (herbarium codes follow Thiers 2024). Specimens were identified using references from Flora e Funga do Brasil (2024) and other relevant specialized literature. We follow the current classification of PPG I (2016), and the names and respective authorship are per the Flora and Funga of Brazil (2024). We used GIMP software, version 2.10.38 (The GIMP Development Team 2024) to process the images and create the plates. Records of *P. pleopeltidis* were compiled from GBIF (https://doi.org/10.15468/dl.bb2g4q), processed, and cleaned to determine the previous distribution of the species. Subsequently, new records identified in this study were integrated into the database using QGIS 3.38.0 software (QGIS Development Team 2024) to map and calculate the expansion of the species' range and the distance of the new records from the previously northernmost known population in Bahia state, Brazil. To assess the conservation status of the species, we use georeferenced occurrence data in GeoCAT Tool (https://geocat.iucnredlist.org/), which considers the extent of occurrence (EOO) and area of occupation (AOO) using 2 km as the cell. Additionally, we evaluated how many of the records occurred within protected areas. These metrics are part of the IUCN Red List categories and criteria (Bachman et al. 2011).

Results and discussion

During the expedition to Pico do Jabre, we collected specimens of *P. pleopeltidis* from a small population (Figure 2D), all of which were epiphytes living in sympatry, sometimes on the same tree, with *Pleopeltis astrolepis* (Liebm.) E.Fourn. and *Pleopeltis minima* (Bory) J.Prado & R.Y.Hirai (Figure 2C). This new record at Pico do Jabre marks the Northernmost occurrence of the species. After analyzing the UFP herbarium collection, we found two additional records of *P. pleopeltidis* in the NAF. These new records are from Pernambuco state, specifically in two other BNs. One is located at Reserva Biológica de Serra Negra, between the municipalities of Tacaratu, Floresta, and Inajá, at an elevation of 1,009 meters above sea level. The other records are from the municipality of Triunfo, at 1,100 meters above sea level. These specimens were previously misidentified as *P. angusta* Humb. & Bonpl. ex Willd., *P. pleopeltifolia* (Raddi) Alston, and *Polypodium* sp.

Pleopeltis pleopeltidis (Fée) de la Sota (2007: 239). (Figure 3)
Plant epiphytic**. Rhizome** long-creeping, with linear-lanceolate scales. **Fronds** monomorphic, with angulate petioles, glabrescent or sparsely scaly. **Laminae** pinnatisect to pinnate-pinnatifid, deltate to lanceolate, base truncate base, apex acuminate. Rachises terete, sparsely scaly. **Pinnae** linear, bases adnate to the rachises, featuring hydathodes. **Frond scales** lanceolate to ovate, hyaline to stramineous. **Sori** rounded, medial, appearing glabrous. **Spores** verrucate with sparse globules.

Examined material. Brazil - Paraíba: Maturéia, Pico do Jabre; 7°15'10.9" S, 37°23'03.1" W; 1208 m alt.; 11.VI.2024; T.E. Almeida 5141; UFP 95545. idem; 09.II.2010; A.C.P. Santiago 1000; UFP 95575. idem; 7°15'27" S, 37°23'22" W; 1200 m alt.; 07.VIII.2005; D.S. Pimentel s.n.; UFP 95542. Teixeira (sic), Pico do Jabre; 29.VII.1991; L.P. Felix 4070; EAN 6254. idem; 1990; L.P. Felix s.n.; EAN 7793.

Additional material examined: Brazil - **Paraíba**: Teixeira, Pico do Jabre; 7°13'22.0" S 37°15'15.1" W; 29.VII.1991; *Felix, L.P.; Vasquez, S.F.* 4070 (JPB 22595). **Pernambuco**: Triunfo, Sítio Lagoa Nova; 7°50'06.2" S, 38°06'09.8" W; 1100 m alt.; 10.III.1995; *A.M. Miranda 2127* (UFP 59473). Inajá-Floresta, Reserva Biológica de Serra Negra; 8°39'18.2" S, 38°01'31.9" W; 1109 m alt.; 15.VIII.2002; J.A. *Siqueira-Filho 1273* (UFP 33322).

Distribution. Argentina: Corrientes, Jujuy, La Pampa, and Mendoza. **Brazil:** Bahia, Espírito Santo, Minas Gerais, Paraíba, Paraná, Pernambuco, Rio de Janeiro, Rio Grande do Sul, Santa Catarina, and São Paulo (Figure 4).

Comments: Specimens of *P. pleopeltidis* collected in the BNs were misidentified as *P. angusta* and *P. pleopeltifolia*. The confusion between *P. pleopeltidis* and *P. angusta* arises because both species have pinnatisect fronds and brown scales on the abaxial side; however, *P. angusta* does not occur in South America, as it is native to Mexico and Central America (Mickel & Smith 2004, Souza & Salino 2021). The morphological similarity between *P. pleopeltidis* and *P. pleopeltifolia* is due to the sparse scales on the abaxial side of the leaf blade and the scaleless sori (Souza & Salino 2021). However, *P. pleopeltidis* can be distinguished from *P. pleopeltifolia* by its long-creeping rhizome and ovate to elliptic blade with free veins, in contrast to the short-creeping rhizome and lanceolate blade with anastomosed veins of *P. pleopeltifolia* (Souza & Salino 2021).

Conservation status: The extent of occurrence (EOO) of the species before the new records was 2,671,709 km², which has increased to 3,736,686 km² – an increase of approximately 40%. Pico do Jabre is located 931 km from RPPN Serra Bonita, in the municipality of Camacan, Bahia, which was previously the Northernmost record and the only one in northeastern Brazil. The area of occupation (AOO) has also increased, from 856 km² prior to the new records to 868 km², representing a 1.4% increase. Therefore, the conservation status of the species is suggested as Vulnerable (VU), since apart from the AOO only 26% of the species' records are in Federal Conservation Units. For northeastern Brazil specifically, the EOO is 28,266 km² and the AOO is only 16 km². Thus, the conservation status of this species for northeastern Brazil is here suggested to be Endangered (EN).

The occurrence of *P. pleopeltidis* in the NAF meets additional criteria outlined by the IUCN (2024) for determining the threat category of a species. One of these factors is the rarity of collections. For instance, in the BNs of Pernambuco, the localities have unique records that were collected more than two decades ago. The limited extent of these areas, characterized by discontinuous vegetation and anthropogenic interference, is an aggravating challenge for the conservation of the species in the region. As pointed out by Gonçalves & Vital (2019) in their study of the BNs in the municipality of Triunfo, Pernambuco, threats such as fires, deforestation, siltation of water sources, and soil degradation are prevalent. Although 75% of the species' range in northeastern Brazil is located inside protected areas, the influence of anthropic actions is still significant. Therefore, the combination of few collections, small habitat extent, and high levels of anthropogenic disturbance underlines the urgency of specific conservation actions for *P. pleopeltidis*. There is a critical need for robust and effective strategies to mitigate human impacts and preserve the biodiversity of the BNs, such as the establishment of protected areas and increased environmental monitoring.

The distance between the populations of *P. pleopeltidis* in the NAF and the closest populations in Bahia state varies between 763-931 km, indicating a possible disjunction according to the criteria proposed by Tryon (1986). In addition to the significant distance between populations, which can hinder gene flow, the discontinuity of the vegetation in the Northeastern part of the Atlantic Forest is a unique feature of the region that can influence these processes. The species occurs in three relatively close BNs; however, due to the characteristic of the ecosystem -high-altitude islands of humid forests- in the NAF it does not have a continuous distribution, being isolated in a surrounded matrix of Caatinga.

High-elevation areas like Pico do Jabre are widely recognized to harbor climatic conditions favorable to ferns, such as water availability and temperature (Kessler et al. 2011). For example, *P. pleopeltidis* occurs from sea level to 2,200 m (Souza & Salino 2021). In the areas of the NAF where this species occurs, all are above 1,000 m. In Bahia, the species is also found at higher altitudes, reaching up to 900 meters. This pattern may be related to the microclimate of these areas, which includes lower temperatures, higher humidity, and increased precipitation (Andrade & Lins 1964). These factors are more prevalent in southeastern Brazil, allowing the species to occupy a broader range of altitudes. In contrast, in northeastern Brazil, the species' ecological niche limits its occurrence to specific environments, such as BNs.

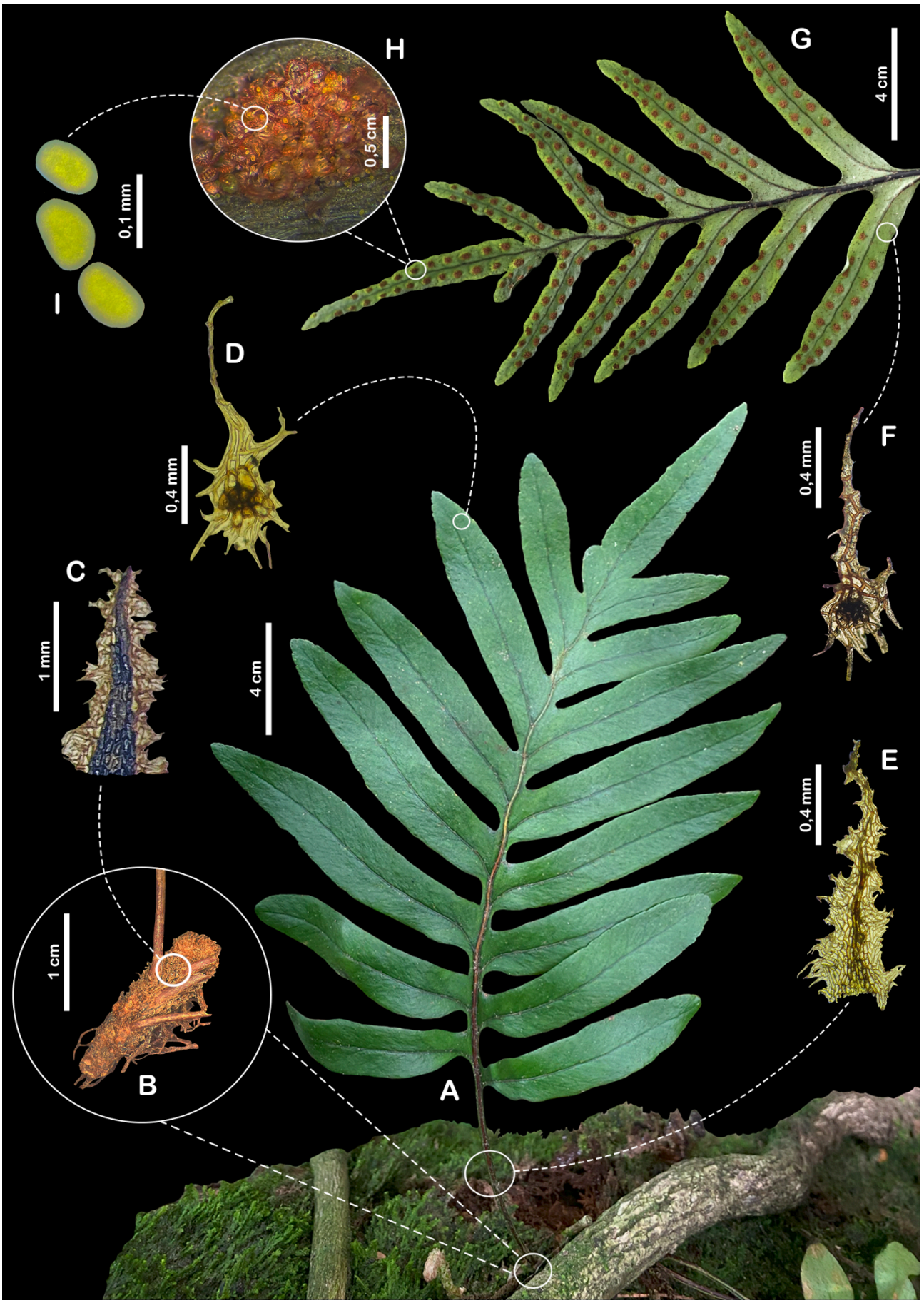

Figure 3. *Pleopeltis pleopeltidis* (Fée) de la Sota. A. habit. B. Rhizome. C. Rhizome scale. D.

Adaxial laminar scale. E. Petiole scale. F. Abaxial laminar scale. G. Abaxial laminar. H. Mature sorus. I. Spores

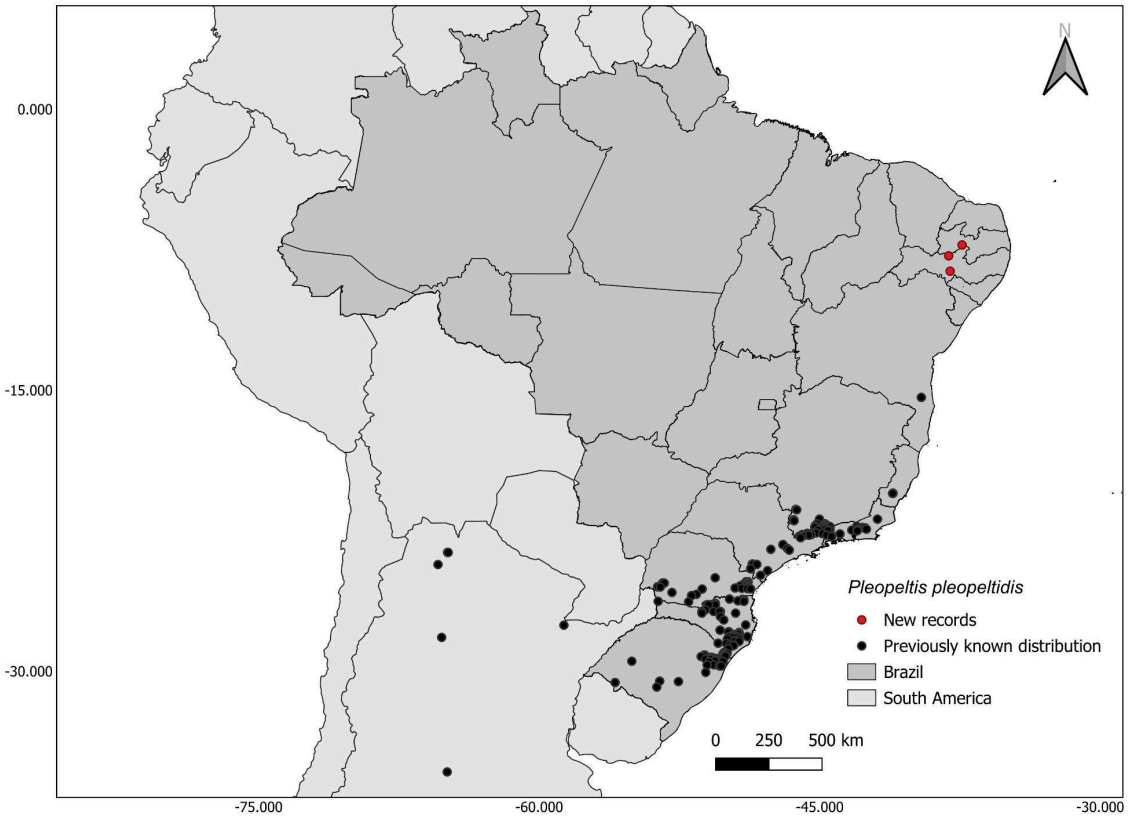

Figure 4. Distribution of *P. pleopeltidis* with new records highlighted in red.

In Pico do Jabre, nine fern species (class Polypodiopsida) were recorded (Figure 5), representing six genera and three families (Table 1). The richest genus was *Pleopeltis*, with four species. Regarding the preferential substrate, five species are exclusively epiphytes, one is terricolous, one is rupicolous and another can be found as both terricolous and rupicolous. All species found at Pico do Jabre are also found in other areas of the Atlantic Forest, both in the northeastern and southern regions, all of them also in the Cerrado and five in the Caatinga. Species such as *P. astrolepis*, *Phlebodium pseudoaureum* (Cav.) Lellinger, and *Serpocaulon triseriale* (Sw.) A.R.Sm. have a wide distribution in Brazil, occurring in the six phytogeographic domains (Table 1). In the worldwide geographical distribution, five species occur only in South America and four have a neotropical distribution. In addition to *P. pleopeltidis*, Pico do Jabre is the only location where *P. pleopeltifolia* has been recorded in Paraíba, marking the first time it has been documented in the state.

In the lowland areas of Serra do Teixeira National Park, there are records of other fern species such as *Salvinia auriculata* Aubl. (CSTR 2597), *Azolla filiculoides* Lam. (IPA 91258), *Pteridium esculentum* subsp. *arachnoideum* (Kaulf.) Thomson (JPB 31010), and the lycophyte *Selaginella convoluta* (Arn.) Spring (CSTR 1834), which were not recorded so far at Pico do Jabre.

Table 1. List of fern species found at Pico do Jabre, indicating their distribution worldwide, Brazilian phytogeographic domains (AM = Amazonia, CA = Caatinga, CE = Cerrado, AF = Atlantic Forest, PM = Pampa, PA = Pantanal), habit and Vouchers.

Family	Species	World distribution	Brazilian phytogeographic domains	Habit	Voucher
Aspleniaceae	*Asplenium pumilum* Sw.	Neotropical	CA, CE, AF	Rupicolous, Terrestrial	T.E. Almeida 5143
Polypodiaceae	*Phlebodium pseudoaureum* (Cav.) Lellinger	Neotropical	AM, CA, CE AF, PA, PM	Epiphyte	T.E. Almeida 5146
	Pleopeltis astrolepis (Liebm.) E.Fourn.	Neotropical	AM, CA, CE AF, PA, PM	Epiphyte	T.E. Almeida 5142
	Pleopeltis minima (Bory) J.Prado & R.Y.Hirai	South America	CE, AF. PM	Epiphyte	T.E. Almeida 5140
	Pleopeltis pleopeltidis (Fée) de la Sota	South America	CE, AF	Epiphyte	T.E. Almeida 5141
	Pleopeltis pleopeltifolia (Raddi) Alston	South America	AF, PM	Epiphyte	D.S Pimentel s.n. (UFP 95539)
	Serpocaulon triseriale (Sw.) A.R.Sm.	Neotropical	AM, CA, CE AF, PA, PM	Epiphyte	D.S Pimentel s.n. (UFP 95538)
Pteridaceae	*Doryopteris collina* (Raddi) J.Sm.	South America	AM, CA, CE, AF	Rupicolous	T.E. Almeida 5145
	Hemionitis tomentosa (Lam.) Raddi	South America	CE, AF	Terrestrial	T.E. Almeida 5144

Figure 5. Ferns from Pico do Jabre. A-F. Species collected by the authors. A. *Asplenium pumilum* Sw. B. *Doryopteris collina* (Raddi) J.Sm. C. *Hemionitis tomentosa* (Lam.) Raddi. D. *Phlebodium pseudoaureum* (Cav.) Lellinger. E. *Pleopeltis astrolepis* (Liebm.) E.Fourn. F. *Pleopeltis minima* (Bory) J.Prado & R.Y.Hirai. G-H. Species analyzed from herborized material. G. *Pleopeltis pleopeltifolia* (Raddi) Alston. H. *Serpocaulon triseriale* (Sw.) A.R.Sm.

Pico do Jabre was the BN with the least vegetation cover in the study by Santos & Tabarelli (2004), covering only 5.52 km², which represents about 0.58% of the total area of the forest remnant. This is due to the various anthropogenic pressures that surround it. An example is the presence of several communication towers in the upper part of the remnant used by various radio, television, internet and cell phone companies, which has reconfigured much of the vegetation (Ramalho et al. 2009). A study carried out by Alves et al. (2021) on the use of Pico do Jabre showed that sporting activities such as paragliding, climbing, and abseiling are more attractive to the population than its natural

aspects. More than 60% of the community considered tourism to be the greatest importance of Pico do Jabre, while only 6% cited the ecological contribution of the remnants.

Despite the challenges of anthropization, Pico do Jabre has a wide variety of species of plants and animals. A partial survey of the flora by Agra et al. (2004) identified 76 families, 207 genera, and 315 species. Subsequently, there have been studies on specific groups such as Cactaceae (Rocha & Agra 2002), Bignoniaceae (Lopes-Silva et al. 2022), and woody flora (Cunha & Silva-Júnior 2018). A more recent study by Gomes (2022) identified 439 genera and 354 species. The fauna of the region is also very diverse, with records of 111 bird species (Mariano & Martins 2017), 22 reptile species (Arruda 2017), with a recently discovered new snake species, *Bothrops jabrensis* Barbo et al. (Barbo et al. 2022). In addition, the area hosts 132 butterfly species (Ferreira-Júnior 2013), including the recent description of a new species, *Vehilius jabre* Medeiros, Souza & Kerpel (Souza et al. 2023).

Anthropic pressures are significantly present in the BNs. Batista et al. (2024) emphasized that this ecosystem is highly susceptible to degradation, loss of vegetation and vulnerability due to human actions. The use of these remnants for agricultural and livestock production is very pronounced. The combination of fertile, deep, and well-structured soils with a favorable water balance creates a favorable environment for these activities (Rodrigues et al. 2010). Currently, about 14.2% of the original vegetation of the BNs remains, which once represented at least 18,500 km² of semideciduous seasonal forests (Santos & Tabarelli 2004). In Pernambuco and Paraíba, the states with the highest number of BNs, about 949 km² remain, just 5.13% of the original extent, mostly composed of semideciduous seasonal forests (Santos & Tabarelli 2004).

The new populations of *P. pleopeltidis* found in the BNs reinforces the importance of this ecosystem for the conservation of Neotropical biodiversity. It is essential to increase conservation efforts in these biogeographical islands, which represent an ideal habitat for several fern species. The intense anthropogenic influence in these areas, such as Pico do Jabre, could threaten already fragile populations, such as that of *P. pleopeltidis*, which is suggested by our analysis to be endangered in northeastern Brazil and vulnerable throughout its distribution. The disjunction between the populations of this species between southeastern Brazil and the BNs is another factor that highlights the importance of this ecosystem, which the microclimate formed by environmental factors such as high altitude and high humidity make up an area of suitability for *P. pleopeltidis*, these remnants of humid forest are a rupture in the continuity of the Caatinga vegetation that is the majority in northeastern Brazil.

Author's Contribution

DVSS: Conception, data collection, manuscript preparation, and addition of intellectual content.
NAM: Data collection, manuscript preparation, and addition of intellectual content.
MFB: Data collection, critical revision, and addition of intellectual content
TEA: Data collection, critical revision, addition of intellectual content.
ACPS: Conception, data collection, critical revision, addition of intellectual content.

Competing interests

The authors declare that they have no conflict of interest.

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Ethics and legals
The authors declare that they have not violated or omitted ethical or legal standards when carrying out the research and this work.

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