New approaches in the fern genus *Pteris* (Pteridaceae) from Brazil

Nuevos enfoques en el género *Pteris* (Pteridaceae) de Brasil

Regina Y. Hirai[1]*, Claudine M. Mynssen[2] & Jefferson Prado[1]

1. Instituto de Pesquisas Ambientais (IPA), São Paulo, Brazil
2. Instituto de Pesquisas Jardim Botânico do Rio de Janeiro, Rio de Janeiro, Brazil

*regina.hirai@gmail.com

Citar este artículo
HIRAI, R. Y., C. M. MYNSSEN & J. PRADO. 2024. New approaches in the fern genus *Pteris* (Pteridaceae) from Brazil. *Bol. Soc. Argent. Bot.* 59: 259-272.

DOI: https://doi.org/10.31055/1851.2372.v59.n3.44498

Summary

Background and aims: *Pteris* is widely distributed with ca. 65 species in the Tropics. In Brazil, 24 species were recognized and five of them are endemic to the Atlantic Forest. The objective of the present paper is to re-evaluate the taxonomy of *Pteris* occurring in Brazil, based on new morphological evidence of old and recent specimens deposited in herbaria, analysis of types, and observations in the field.

M&M: The new approaches are based on morphological data such as SEM images of the spores and from the examination of herbarium collections mainly from SP and RB Herbaria.

Results: Four species are being recognized in the present paper (*P. lata*, *P. organensis*, *P. praealta*, and *P. sericea*). For two of them, two new combinations into *Pteris* are presented: *P. organensis* and *P. praealta*. A key to distinguishing the newly recognized species and its relative taxa, as well as descriptions, illustrations, and comments are presented in this paper.

Conclusions: By reviewing herbarium materials, mainly observing the morphology of the spores, and collecting more specimens in the field, it was possible to recognize three species (*Pteris lata*, *P. organensis*, and *P. praealta*) in Brazil and also verify the correct application of the name *Pteris sericea* to the Brazilian plants. All these names had been previously synonymized in previous studies. After this study, 27 species of *Pteris* are recognized in Brazil.

Key words

Brazilian Atlantic Forest, endemic species, fern, morphology, palynology, taxonomy.

Resumen

Introducción y objetivos: *Pteris* está ampliamente distribuido con ca. 65 especies en los trópicos. En Brasil fueron reconocidas 24 especies y cinco de ellas son endémicas de la Mata Atlántica Brasileña. El objetivo del presente artículo es reevaluar la taxonomía de *Pteris* presentes en Brasil, con base en nueva evidencia morfológica obtenida de especímenes antiguos y recientes depositados en herbarios, análisis de tipos y observaciones de campo.

M&M: Los nuevos enfoques se basan en datos morfológicos, como imágenes SEM de las esporas, y en el examen de colecciones de herbarios, principalmente de SP y RB Herbaria.

Resultados: En el presente artículo se reconocen cuatro especies (*P. lata*, *P. organensis*, *P. praealta* y *P. sericea*). Para dos de ellos se presentan dos nuevas combinaciones en *Pteris*: *P. organensis* y *P. praealta*. En este artículo se presenta una clave para distinguir las especies recientemente reconocidas y sus taxones relacionados, así como descripciones, ilustraciones y comentarios.

Conclusiones: Al revisar los materiales de los herbarios, observando principalmente la morfología de las esporas y recolectando más especímenes en el campo, fue posible reconocer tres especies (*Pteris lata*, *P. organensis* y *P. praealta*) en Brasil y también verificar la correcta aplicación del nombre *Pteris sericea* a las plantas brasileñas. Todos estos nombres habían sido previamente sinonimizados en estudios anteriores. Después de este estudio, se reconocen 27 especies de *Pteris* en Brasil.

Palabras clave

Especie endémica, helecho, Mata Atlántica Brasileña, morfología, palinología, taxonomía.

Recibido: 8 Mar 2024
Aceptado: 1 Jul 2024
Publicado en línea: 30 Sep 2024
Publicado impreso: 30 Sep 2024
Editora: Olga G. Martínez

ISSN versión impresa 0373-580X
ISSN versión on-line 1851-2372

Introduction

The fern genus *Pteris* L. is monophyletic and belongs to the Pteridaceae and subfamily Pteridoideae (Prado *et al.*, 2007; Schuettpelz *et al.*, 2007; Zhang *et al.*, 2015; PPG I, 2016). The genus is widely distributed in the tropics but can reach subtropical and temperate regions. Some species are widely cultivated as ornamentals (e.g., *P. multifida* Poir. and *P. cretica* L.; Walker, 1970) and may occur as naturalized in some places as Brazil (Prado & Hirai, 2024).

Pteris consists of ca. 250 species (PPG I, 2016) and is characterized by having sporangia borne at lamina margins on a commissural vein connecting all veins and indusia strongly differentiated from the recurved margin (Prado & Windisch, 2000). The spores are trilete, tetrahedral, or globose, with an equatorial flange and with surface rugose, rarely granulate or reticulate (Tryon & Tryon, 1982; Tryon & Lugardon, 1990).

According to the previous studies involving *Pteris* in Brazil, 24 species and two varieties were recognized (Prado & Windisch, 2000; Prado *et al.*, 2015; Prado & Hirai, 2024) and five species were recognized as endemic to the Brazilian Atlantic Forest: *P. angustata* (Fée) C.V. Morton, *P. congesta* J. Prado, *P. leptophylla* Sw., *P. limae* Brade, and *P. schwackeana* Christ (Prado & Hirai, 2024).

Chao *et al.* (2014) and Zhang *et al.* (2015) conducted molecular phylogenetic studies showing relationships within *Pteris*. The first carried out a study with 135 species of *Pteris* (ca. 54% of the diversity of genus) from six continents, based on two cpDNA coding regions (*rbcL* and *matK*), to reconstruct the phylogeny of *Pteris* plus the evolution of the leaf morphology and ecological characters, also to understand the expansion and diversification of this cosmopolitan genus. On the other hand, Zhang *et al.* (2015) studied six plastid loci of 119 species of *Pteris* and 18 related genera. The results obtained by Chao *et al.* (2014) with uncertain relationships between *Actiniopteris* Link, *Onychium* Kaulf., and *Pteris* were clarified by Zhang *et al.* (2015), and both found clades well-supported within *Pteris* (11 clades by Chao *et al.*, 2014 versus 15 clades by Zhang *et al.*, 2015).

Recently, studies with *Pteris* spores have shown that they can help with the infrageneric taxonomy of the group, e.g., Palacios-Rios *et al.* (2017) and Chao & Huang (2018). The first study presented six spore patterns of 25 species of *Pteris* from Mexico and Mesoamerica, took into account the cingulum, presence of a commissural flange, types of macro-ornamentation, ornamentation on distal and proximal faces, and spore size.

Chao & Huang (2018) mapped seven *Pteris* spore characters (equatorial flange, laesural ridges, proximal ridges, distal ridges, tubercules on the distal faces, coarse reticules on the distal faces, and a row of extervermiculi between the distal face and the equatorial flange) onto a reconstructed phylogenetic tree based on previous data published by Prado *et al.* (2007), Chao *et al.* (2014), and Zhang *et al.* (2015). Chao & Huang (2018) studied 57 spores of *Pteris* and combined them with data from the literature, totaling 100 species. In this study, there were some species of *Pteris* from Brazil, whose sequences came from Prado *et al.* (2007), but the spores were not observed, and this information appears as missing data, except for *P. denticulata* whose spore's data were used from Martínez & Morbelli (2009). The results of Chao & Huang (2018) showed that most of these characters evolved independently several times in different lineages and, therefore, spore characters need to be combined with leaf characters to help in the infrageneric taxonomy of *Pteris*.

Based on the above recent evidence of the importance of some morphological characters, the present paper proposes to re-evaluate the taxonomy of *Pteris* occurring in Brazil. The new approaches here presented are based on new morphological data plus the recent observations of specimens in the field, herbaria specimens, as well as on the type specimens of the newly adopted names.

Materials and Methods

Taxonomic studies

For this study, we analyzed specimens and types from the following herbaria: BHCB, BM, FCAB, HB, HRCB, IPA, K, M, MBM, NY, P, PACA, R, RB, S, SP, SPF, TAIF, UEC, UPCB, UPS, US, and VT. We also observed online collections from other herbaria, which are available at REFLORA (http://reflora.jbrj.gov.br/jabot/herbarioVirtual/ConsultaPublico HVUC/ConsultaPublicoHVUC.do), JStor Global Plants (https://plants.jstor.org/), *speciesLink* (https://specieslink.net), and Smithsonian National Museum of Natural History (http://collections.nmnh.si.edu/search/botany/)

websites, especially types. The last author of this work studied almost all types and specimens from many herbaria during his work published in 2000 (Prado & Windisch, 2000).

We personally studied living populations of *Pteris deflexa* Link, *P. lata* Kaulf., *P. organensis* (Fée) J. Prado & R.Y. Hirai, *P. sericea* (Fée) Christ, and *P. splendens* Kaulf. Field trips were carried out from 2014 to 2016 in the following localities: Pernambuco state (November 2014); Serra da Bocaina, State of São Paulo (February 2015); Angra dos Reis, State of Rio de Janeiro (May 2015); several localities in Paraná and Santa Catarina States (June 2016); several places in the States of Bahia, Minas Gerais, and Espírito Santo (July 2016); and the Serra da Bocaina and Itatiaia Mountain, both in the State of Rio de Janeiro (November 2016). Despite searches in Bahia State (Una region) and Rio de Janeiro State (Angra dos Reis), it was not possible to find *P. praealta* in the field.

The following additional material of *Pteris* were illustrated and commented in the species discussion: *P. deflexa*: BRAZIL. Paraná: *Quatro Barras*, Estrada Velha da Graciosa, Oratório Anjo da Guarda, 25° 20' 49.8" S, 48° 57' 52" W, 860 m elevation, 6-VI-2016, Hirai & Prado 788 (SP); Idem: *Coronel Vivida*, Rod. PR-367, 20-II-1971, Hatschbach 26371 (HB); *P. lechleri*: BOLIVIA. La Paz: *Abel Iturralde*, Parque Nacional Madidi, campamento de guardaparques Sadiri, camino Sadiri-Tumupasa, por la senda a las antenas de Entel, 14° 10' S, 67° 53' W, 990 m elevation, 7-VII-2004, Jiménez & Huaylla 2659 (SP), and *P. splendens*: BRAZIL. São Paulo: *São Paulo*, Parque Estadual das Fontes do Ipiranga (PEFI), trilha que margeia o Zoológico, 20-XII-2005, Prado & Silva 1615 (SP); Idem; id., trilha próximo da Cursino, 20-I-2015, Hirai *et al.* 760 (SP); Rio de Janeiro: *Itatiaia*, Parque Nacional do Itatiaia, na Trilha da Cachoeira Poranga, 22° 26' 26.4" S, 44° 36' 39.9" W, 905 m elevation, 8-V-2015, Prado & Hirai 2395 (SP).

The SEM images of the spores were obtained from the examination of herbarium collections at SP and RB Herbarium (Table 1). All images were prepared at the Instituto de Pesquisas Ambientais (IPA, previously called Instituto de Botânica - IBt), except *Pteris deflexa* were taken at the Kew Herbarium and *P. praealta* at the Instituto de Pesquisas Jardim Botânico do Rio de Janeiro. The spores were described based on the morphology used by Tryon & Lugardon (1990), Lorscheitter *et al.* (2001), Lellinger (2002), and Palacios-Rios *et al.* (2017).

Results and Discussion

Four species are being recognized in the present study: *Pteris lata*, *P. organensis*, *P. praealta*, and *P. sericea* (Figs. 1-4). They are morphologically related mainly to *Pteris deflexa*, *P. lechleri*, and *P. splendens*. All first three species recognized species are endemic to the Brazilian Atlantic Forest and occur only along the east coast of Brazil, except *P. sericea*, which can also occur in northeastern Argentina.

All these four taxa had been previously synonymized in the previous study by Prado & Windisch (2000), and Prado & Hirai (2024) followed these concepts. With this update, 27 species of *Pteris* are now recognized in Brazil.

Key to the segregated species (appear in bold) of *Pteris* from Brazil and its relatives

1. Venation completely areolate
   2. Rhizome long-creeping. ***P. praealta***
   2. Rhizome erect to suberect
      3 Sterile pinnae widely oblong (over 2.5 cm wide). *P. splendens*
      3. Sterile pinnae lanceolate. ***P. organensis***
1. Venation partially areolate or venation free
   4. Venation free
      5. Laminae pedate; (3-)4-pinnate-pinnatifid at base; rachises greenish or pale abaxially. *P. deflexa*
      5. Laminae not pedate, plane; 1–3-pinnate-pinnatifid at base; rachises dark brown abaxially. ***P. lata***
   4. Venation partially areolate
      6. Rhizome erect; rachises dark brown abaxially; veins abaxially easily visible and prominent; laminae densely pilose; Andes. *P. lechleri*
      6. Rhizome creeping; rachises pale abaxially; veins abaxially inconspicuous and not prominent; laminae moderately pilose or just with few hairs spread; east Brazil and northeastern Argentina. ***P. sericea***

Table 1. Spore characteristics of the studied species of *Pteris* from Brazil. The species names in bold correspond to the species segregated ones (the names without bold correspond to the previous name applied to the taxon).

Species	Cingulum = equatorial flange	Commissural flange	Distal view	Proximal view	Figure
P. deflexa	nearly continuous, entire	well-defined	coarsely tuberculate-rugate	sparsely verrucose	Fig. 2A, B
P. lata	nearly continuous, entire	defined	sparsely tuberculate-verrucate	laevigate with scattered globules	Fig. 2C, D
P. splendens	continuous, undulate, flattened	inconspicuous	densely rugate-verrucate	rugate-tuberculate, without perforations	Fig. 4E, F
P. organensis	continuous, slightly undulate	inconspicuous	prominently rugate with globules	low rugate-tuberculate with globules, without perforations	Fig. 4A, B
P. praealta	continuous, entire, with a distal depression	inconspicuous	coarsely rugate	low rugate with some perforations	Fig. 4C, D
P. lechleri	continuous, entire	well-defined	reticulate with free tubercles in the lumens	laevigate with scattered globules	Fig. 2E, F
P. sericea	continuous, entire	inconspicuous	rugate	slightly low tuberculate	Fig. 2G, H

Taxonomic treatment for the segregated species

1. **Pteris lata** Kaulf., *Link, Hort. Berol.* 2: 28-29. 1833. TYPE: BRAZIL. Material from Brazil, cultivated at Hortus Berolinensis, Berlin (*Lectotype*, designated by Prado 1996: 16, M! on 2 sheets [Herb. J.G. Zuccarini Nr. 170602; Herb. M. Fürbringer Nr. 92574]). Figs. 1A-B; 2A-B.

Plants terrestrial. Rhizomes 1-2 cm thick, short and compact, creeping to erect, woody, densely clothed at apex with lanceolate scales 0.2–0.5 cm long. Fronds 24-121 x 15-64 cm, monomorphic to subdimorphic (fertile pinnae narrower than sterile pinnae), erect; petioles 18-70 x 0.1-0.5 cm, 1-sulcate on the adaxial surface, light brown to dark brown at base, yellowish at median and distal portions, with scales at base, glabrous, surface smooth; laminae chartaceous, not pedate, plane, tripartite, deltate, 1-3-pinnate-pinnatifid at base, 1- or 2-pinnate-pinnatifid at medium and distal portion, 21-51 x 12-20 cm, with (4-)6-9 pairs of pinnae, these opposite, subopposite to alternate, long-lanceolate or long-elliptic, sessile or petiolulate, bases asymmetric, cuneate, petiolules 1-sulcate on the adaxial surface and shortly winged, costae 1-sulcate on the adaxial surface and prominent on the abaxial surface, deflexed, glabrous or with spreading whitish hairs; proximal pinnae 15–22 x 5.0-21 cm, 1- or 2-pinnate-pinnatifid; rachises 40-60 x 0.1-1 cm, 1-sulcate on the adaxial surface, dark brown abaxially; middle pinnae 7-10 x 1.7-2.5 cm, pinnatifid, diverging from rachises at an acute angle; distal pinnae 4-8 x 0.8-1 cm towards frond apex; apical pinna 7-10 x 2-3 cm, deeply pinnatifid; segments alternate, falcate or deltate, or lanceolate, towards frond apex, pinnae or pinnules with margins entire, smooth or dentate, or serrulate at apex of the segments, apices acute, sometimes apiculate, costules awned at the base on the adaxial surface and prominent on the abaxial face; apical segment tapering, sinuses between the segments acute or roundish or sometimes biangulate; venation free, veins simple or furcate, reaching margins of the segments, clavate at tip. Sori interrupted in the sinuses and absent at apex of the segments; indusia pale, with entire margin; spores trilete; cingulum nearly continuous, entire, distal view sparsely tuberculate-verrucate, proximal view laevigate with scattered globules, showing a defined commissural flange.

Distribution: Endemic of the East coast Brazil (Rio de Janeiro and São Paulo States); it occurs at forest margins; ca. 650-1600 m elevation.

Selected specimens: BRAZIL. Rio de Janeiro: *Itatiaia*, Parque Nacional do Itatiaia, Hotel Simon abandonado, trilha dos Três Picos, 22° 26’ 8.8” S, 44° 36’ 43.7” W, 1116 m elevation, 9-V-2015, Prado

Fig. 1. A-B: *Pteris lata*. **A**: Habit. **B**: Detail of the rachis dark brown abaxially. **C**: *Pteris deflexa*; part of the frond. **D-E**: *Pteris organensis*. **D**: Fertile frond. **E**: Detail of the veins and sori. **F-G**: *Pteris splendens*. **F**: Habit. **G**: Detail of the veins and sori. **H-I**: *Pteris sericea*. **H**: Frond. **I**: Detail of the pinna abaxially (A: *Prado et al. 2391*, SP; B: Mynssen *et al. 1435*, SP; C: Hirai & Prado 788, SP; D-E: Hirai & Prado 793, SP; F: Hirai et al. 760, SP; G: Prado & Hirai 2395, SP; H-I: Prado & Hirai 2403, SP).

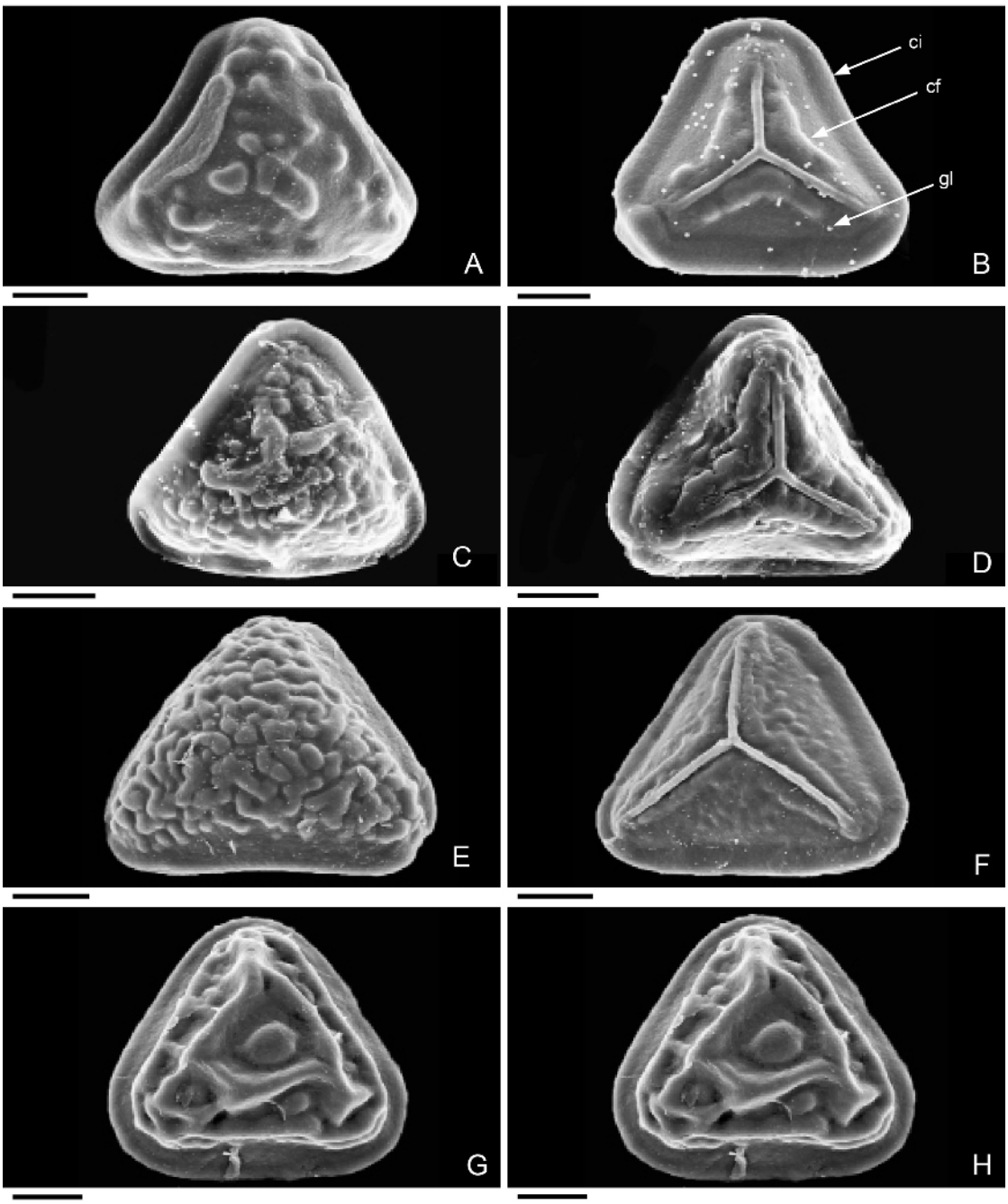

Fig. 2. Trilete spores of *Pteris*. **A-B**: *P. lata*. **A**. Distal view sparsely tuberculate-verrucate. **B**. Proximal view laevigate with scattered globules, showing a defined commissural flange and entire cingulum. **C-D**: *P. deflexa*. **C**: Distal view coarsely tuberculate-rugate. **D**: Proximal view sparsely verrucose, showing a well-defined commissural flange. **E-F**: *P. sericea*. **E**: Distal view rugate. **F**: Proximal view slightly low tuberculate showing inconspicuous commissural flange and entire cingulum. **G-H**: *P. lechleri*. **G**: Distal view reticulate. **H**: Proximal view showing a well-defined commissural flange and entire cingulum. Abbreviations= ci: cingulum; cf: commissural flange; gl: globules. Scale= 10 µm (A-B: Mynssen 1435, SP; C-D: Hatschbach 26371, HB; E-F: Labiak 4264, SP; G-H: Jiménez & Huaylla 2659, SP).

& Hirai 2404 (SP); idem, Trilha para a Cachoeira Véu da Noiva, 22° 25' 33.5" S, 44° 37' 19.5" W, 1200 m elevation, 7-XI-2016, Prado & Hirai 2454 (SP); *Rio de Janeiro*, Parque Nacional da Tijuca, trilha para o Bico do Papagaio, 22° 56' 51" S, 43° 17' 29" W, 698 m elevation, 6-IX-2014, Mynssen *et al.* 1435 (NY, RB, SP); *Terezópolis*, Rua Paulo Barreto, 22° 27' S, 42° 57' W, 935 m elevation, 14-VII-1992, Prado *et al.* 1089 (NY, SP). *São José do Barreiro*, subindo a trilha atrás da Pousada Campos da Bocaina, 22° 43' 12.3" S, 44° 37' 8.7" W, 1590 m elevation, Prado *et al.* 2391 (SP); Idem, descendo a mata à direita, em frente a Pousada Campos da Bocaina, 22° 42' 54.7" S, 44° 37' 8.9" W, 1528 m elevation, 11-XI-2016, Prado & Hirai 2479 (SP); São Paulo: *São Luiz do Paraitinga*, Parque Estadual da Serra do Mar, Núcleo Santa Virgínia, trilha do Rio Paraitinga, 19-XI-1998, Kameyama *et al.* 125 (SP); *Ubatuba*, Parque Estadual da Serra do Mar, Núcleo Cunha, 18-XII-1996, Salino 2950 (BHCB, SP).

The Brazilian specimens of *Pteris lata* were treated together with the specimens of *P. deflexa* by Prado & Windisch (2000) and Prado & Hirai (2024). Whereas *P. lata* is restricted to the East coast of Brazil, *P. deflexa* occurs in Central America, Antilles, and South America (Colombia to Argentina); in Brazil from the South of Bahia and Mato Grosso to Rio Grande do Sul states.

Both species can be distinguished morphologically: The lamina of *Pteris lata* is plane and 1-3-pinnate-pinnatifid at base (Fig. 1A; versus pedate and 4-pinnate-pinnatifid at base in *P. deflexa*, Fig. 1C), the color of the rachises dark brown abaxially (Fig. 1B; versus pale or greenish). It is often difficult to observe the division of the lamina in herbarium specimens because many of them only show part of the plant, especially in *P. deflexa* (with fronds up to 2.5 m long), which are generally much larger plants than *P. lata* (up to ca. 1.2 m long). The pedate lamina division of *P. deflexa* is easily observed in plants in the field but it is generally absent in the herbarium specimens. Furthermore, the spores in *P. lata* are morphologically distinct by the sparsely tuberculate-verrucate in distal view (Fig. 2A-B; versus coarsely tuberculate-rugate in *P. deflexa*, Fig. 2C-D).

Martínez & Prado (2011) described a new species from northwestern Argentina, *Pteris exigua* Martínez & Prado, also similar to *P. deflexa*. However, *P. exigua* has smaller indusia, 0.5-5 mm long (versus larger 5-12 mm long) and whitish (versus paleaceous); costules sparsely scaly abaxially (versus sparsely pilose), segment apex obtuse (versus acute), and conspicuous dentate margins of the sterile segments (versus entire). The spore of *P. exigua* (Fig. 3A-C from Martínez & Prado, 2011) is more similar to *P. lata* (Fig. 2A-B) than *P. deflexa* (Fig. 2C-D).

2. **Pteris organensis** (Fée) J. Prado & R.Y Hirai, **comb. nov.** *Litobrochia organensis* Fée, *Cr. Vasc. Br.* 1: 240. 1869. *Pteris splendens* Kaulf. var. *organense* (Fée) Dutra, *An. 1ª Reun. Sul Amer. Bot*. 2: 33. 1938.). TYPE. BRAZIL. Rio de Janeiro, Serra dos Órgãos, VI-1869, A. Glaziou 3329 (*Lectotype*, first-step designated by Prado, 1996: 12, P!; second-step here designated P! barcode P00609078; *isolectotypes,* P! barcode P00609077, RB! barcode RB00543343). Figs. 1D-E; 3A-C; 4A-B.

Plants terrestrial. Rhizomes 1-4 cm thick, erect or suberect, short, woody, densely clothed at the apex with long-lanceolate scales 0.2-0.5 cm long. Fronds 40-100 x 15-60 cm, subdimorphic (fertile pinnae narrower than sterile pinnae), erect; petioles stout, 10-100 x 0.2-0.4 cm, deeply 1-sulcate on the adaxial surface, dark brown to reddish at base and light brown in the median and distal portions, with scales on the base, clothed with whitish to light brown hairs; laminae subcoriaceous, 1-pinnate-imparipinnate, oblong-lanceolate, 40-120 x 15-60 cm, with (2-)6-10 pairs of pinnae, these entire, lanceolate (the sterile ones) or narrowly oblong or lanceolate (the fertile ones), opposite or subopposite, petiolulate, short-petiolulate or sessile, bases cuneate or asymmetric, costae sulcate on the adaxial surface and prominent on the abaxial surface, margins entire to dentate; proximal pinnae 10-25 x 1-2.5 cm, entire; rachises 10-60 x 0.1-0.3 cm, 1-sulcate on the adaxial surface; middle pinnae 9-25 x 1-2 cm, diverging from the rachises at an acute angle; distal pinnae 6.5-20 x 0.9-1.5 cm towards frond apex, base shortly decurrent on the rachises; apical pinna 8-15 x 1.5-2 cm, entire; venation areolate, visible and prominent on the abaxial surface of the pinnae, large areoles joined to the costa, oblique, approximately isodiametric, free

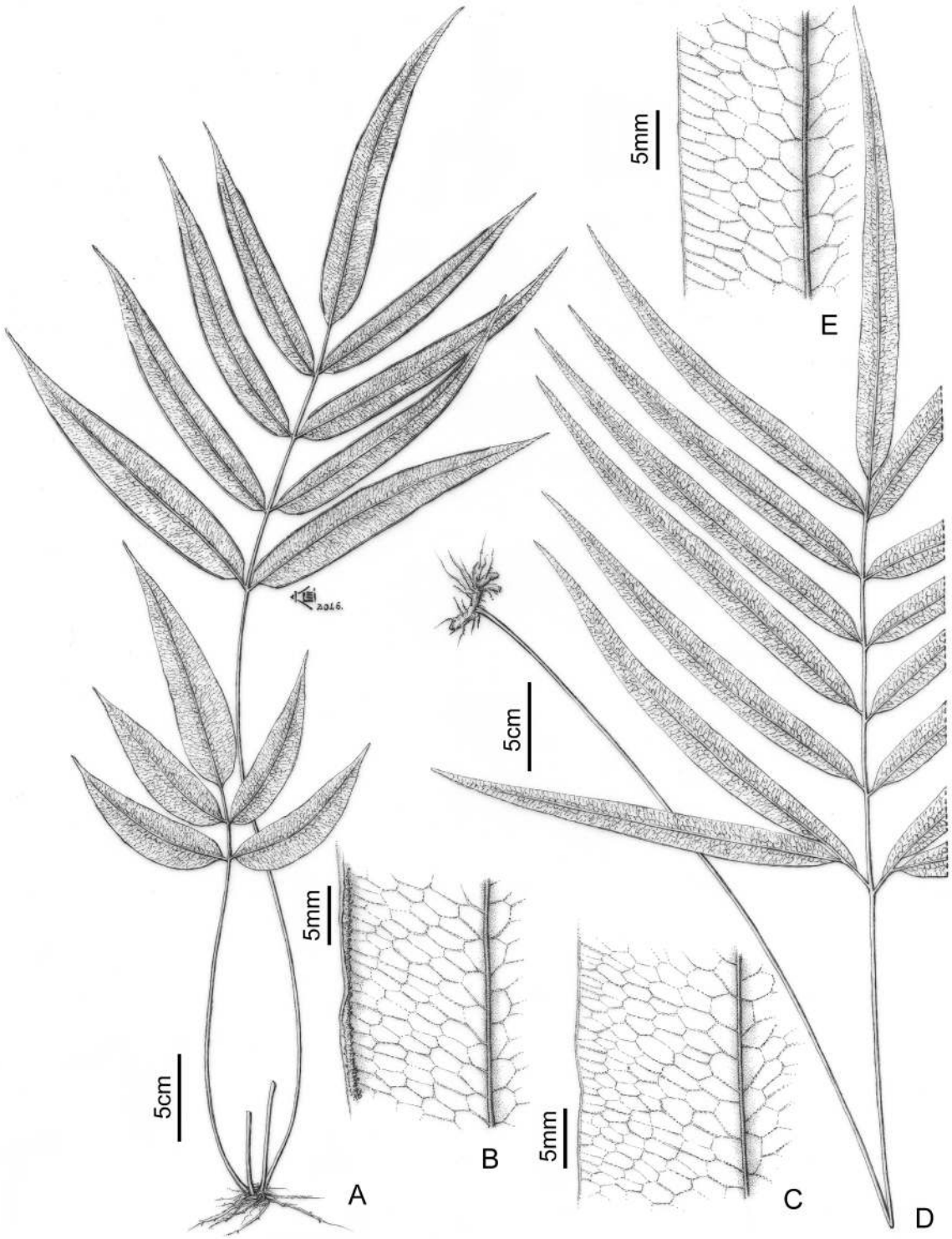

Fig. 3. A-C: *Pteris organensis*. **A**: Habit with one sterile and one fertile frond. **B**: Detail of the venation in a fertile pinna. **C**: Detail of the venation in a sterile pinna. **D-E**: *Pteris praealta*. **D**: Habit. **E**: Detail of the venation in a sterile pinna. (A-C: Hirai & Prado 778B, SP; D-E: Paciencia 375, SP).

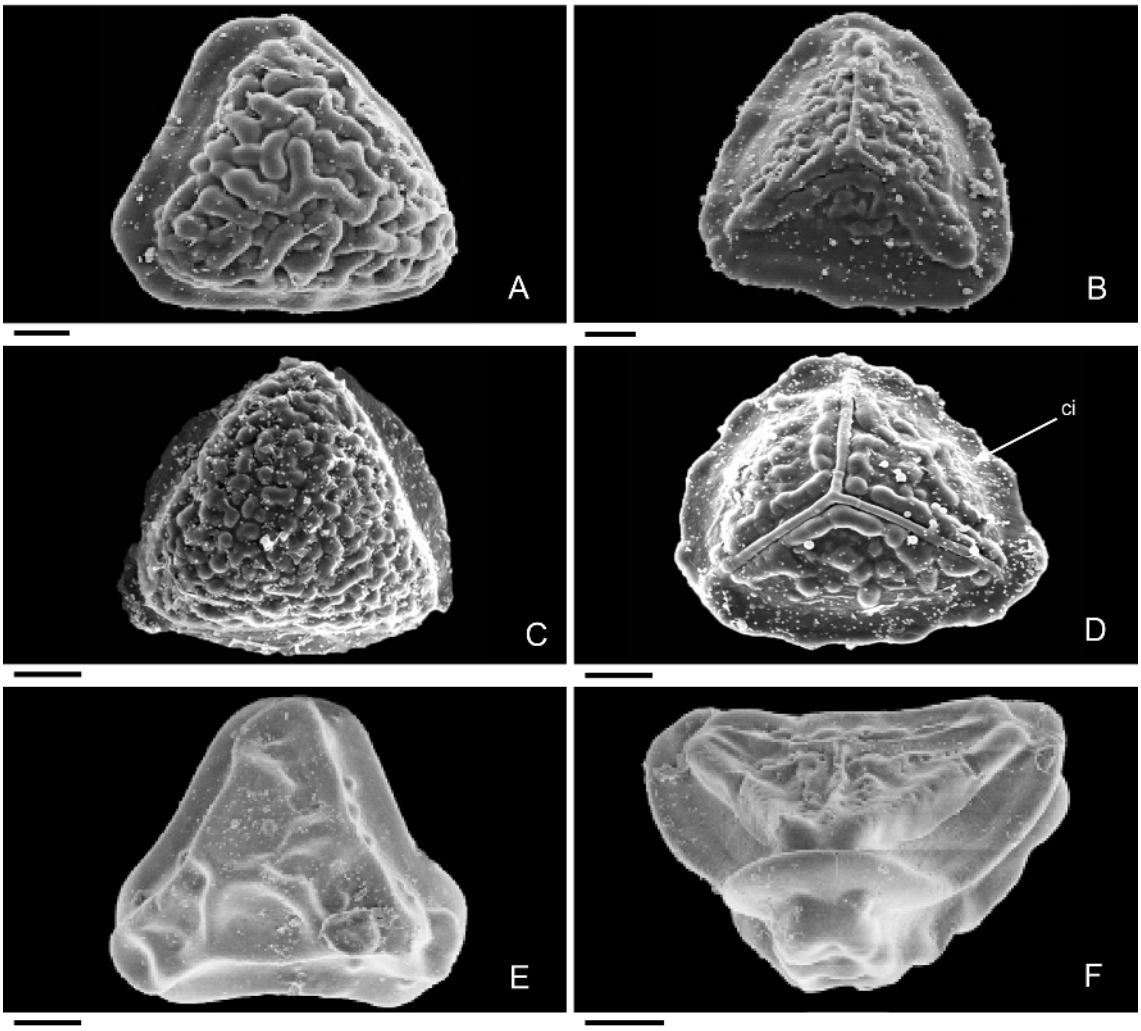

Fig. 4. Trilete spores of *Pteris*. **A-B**: *P. organensis*. **A**: Distal view prominently rugate. **B**: Proximal view low rugate-tuberculate with inconspicuous commissural flange. **C-D**: *P. splendens*. **C**: Distal view densely rugate-verrucate. **D**: Proximal view rugate-tuberculate with inconspicuous commissural flange, cingulum undulate. **E-F**: *P. praealta*. **E**: Distal view coarsely rugate. **F**: Proximal view low rugate with some perforations, cingulum continuous with a distal depression. Scale= 10 µm (A-B: Prado & Hirai 2482, SP; C-D: Prado & Silva 1615, SP; E-F: Brade 14944, RB).

veins arising from the areoles near the margins of the pinnae, in the sterile frond the apex of the veins clavate. Sori absent at base and at the apex of the pinnae; indusia pale, margin entire; spores trilete; cingulum continuous, slightly undulate, distal view prominently rugate with globules, proximal view low rugate-tuberculate with globules, without perforations, and inconspicuous commissural flange.

Distribution: Endemic of the East coast Brazil (Bahia, Minas Gerais, Espírito Santo, Rio de Janeiro, São Paulo, and Paraná); it grows inside forests at medium elevations; ca. 450-1700 m elevation.

Selected specimens: BRAZIL. Bahia: *Almadina*, Serra dos Sete Paus, 6 km de Almadina na estrada para Ibitupã, 7 km N para a Comunidade de Sete

Paus, na nascente do Rio Almada, 14° 44' S, 39° 42' W, 578 m elevation, 19-VII-2005, Matos *et al. 708* (SP). Minas Gerais: *Araponga*, Parque Estadual da Serra do Brigadeiro, Serra das Cabeças, 1400 m elevation, 30-I-2002, Valente *et al. 868* (SP); *Descobertos*, Reserva Biológica do Grama, trilha principal, 15-VI-2005, Jascone *et al.* 432 (SP); *Lima Duarte*, Parque Estadual do Ibitipoca, 21° 42' 11" S, 43° 53' 0.6" W, 10-VIII-2005, Mynssen *et al. 826* (RB, SP). Espírito Santo: *Santa Teresa*, Alto de Santo Antônio, terreno do Bozza, 19° 54' 31" S, 40° 35' 28" W, 760 m elevation, 12-VII-2007, Labiak *et al.* 4043 (SP, UPCB); Idem, id., entrada à esquerda (Madeireira MADEFEL), 19° 54' 36.3" S, 40° 35' 30.2" W, 810 m elevation, 8-VII-2016, Hirai & Prado 793 (SP). Rio de Janeiro: *Angra dos Reis*, Serra do Mar, descendo pela BR 494, entrada à direita, estacionamento da Capela, 22° 52' 8" S, 44° 15' 12.1" W, 467 m elevation, 11-V-2015, Hirai & Prado 778B (SP), Idem, id., 22° 52' 8" S, 44° 15' 12.1" W, 467 m elevation, 4-XI-2016, Prado & Hirai 2444 (SP); *Petrópolis*, Vale das Videiras, subida do Morro da Cuca, 13-VI-2000, Prado *et al.* 1086 (NY, SP); *Santa Maria Madalena*, Pedra Dubois, trilha para o alto da pedra, 800-1000 m, 18-VI-2004, Mello-Silva *et al.* 2649 (SP, SPF). São Paulo: *São José do Barreiro*, subindo a trilha atrás da Pousada Campos da Bocaina, 22° 43' 12.3" S, 44° 37' 8.7" W, 1590 m elevation, 23-II-2015, Prado *et al.* 2387 (SP); Idem, Parque Nacional da Serra da Bocaina, na trilha para a Cachoeira Santo Izidro, 22° 44' 37.5" S, 44° 36' 56.2" W, 1562 m elevation, 22-II-2015, Hirai *et al.* 766 (SP); Idem, trilha para o Condomínio, que começa em frente à Pousada do Lageado, 22° 42' 34.8" S, 44° 37' 30.5" W, S-SE, 1710 m elevation, 12-XI-2016, Prado & Hirai 2482 (SP). Paraná: *Alexandra*, PARNA Saint-Hilaire/Lange (Serra da Prata), 1030 m elevation, 21-V-2005, Paciencia *et al.* 2195 (SP); *Sengés*, Vale do Corisco, próximo ao Mirante, 24° 12' 16" S, 49° 21' 6" W, 880 m elevation, 4-I-2008, Prado *et al.* 1801 (UPCB, SP).

This species was put in synonym of *Pteris splendens* by Prado & Windisch (2000) and Prado & Hirai (2024) followed this concept, but the re-analyses of more herbarium specimens, as well as some populations of *P. organensis* in the field, we are now able to recognize it as a different species. It can be recognized by the sterile pinnae lanceolate (Fig. 3A; versus widely oblong in *P. splendens*, Fig. 1F) and by the fertile pinnae narrowly oblong or lanceolate (Figs. 1D, 3A; versus widely oblong in *P. splendens*). Furthermore, *Pteris organensis* has prominently rugate spores in distal view (Fig. 4A), whereas *P. splendens* has densely rugate-verrucate spores (Fig. 4C).

Pteris splendens occurs in Paraguay and Brazil (from the state of Ceará to Rio Grande do Sul) and *P. organensis* is restricted to the East coast of Brazil.

3. **Pteris praealta** (Fée) J. Prado & R.Y. Hirai, **comb. nov.** *Litobrochia praealta* Fée, *Cr. vasc. Br.* 1: 46, t. 11, fig. 2. 1869. TYPE. BRAZIL. Rio de Janeiro, Jacuecanga, 16-VI-1868, A. Glaziou 2304 (*Lectotype*, designated by Prado, 1996: 13, P! on 4 sheets barcodes P00609073, P00609074, P00609075, P00609076; *isolectotypes*, K! barcode K000589370, S05-9754 image!). Figs. 3D-E; 4E-F.

Plants terrestrial. Rhizomes 1-4 cm thick, long-creeping, woody, densely clothed at apex with long-lanceolate scales 0.2-0.5 cm long. Fronds 40-200 x 20-60 cm, monomorphic to subdimorphic (fertile pinnae narrower than sterile pinnae), erect; petioles stout, 20-120 x 0.2-0.4 cm, deeply 1-sulcate on the adaxial surface, dark brown to reddish at base, median and distal portions, with scales on the base; laminae subcoriaceous, 1-pinnate-imparipinnate, oblong-lanceolate, 30-150 x 15-60 cm, with 4-8 pairs of pinnae, these entire, narrowly lanceolate to oblong, opposite or subopposite, petiolulate, short-petiolulate or sessile, bases cuneate or asymmetric, costae sulcate on the adaxial surface and prominent on the abaxial surface, margins entire to dentate; proximal pinnae 10-30 x 1-2 cm, entire or furcate; rachises 10-40 x 0.1-0.2 cm, 1-sulcate on the adaxial surface, shortly winged in the distal region, dark brown abaxially; middle pinnae 9-20 x 1-2 cm, diverging from the rachises at an acute angle; distal pinnae 15-20 x 0.9-2 cm towards frond apex, base shortly decurrent on the rachises; apical pinna 10-20 x 1.5-2 cm, entire; venation areolate, visible and prominent on the abaxial surface of the pinnae, large areoles joined to the costa, oblique, approximately isodiametric, free veins arising from the areoles near the margins of the pinnae, in the sterile frond the apex of the veins clavate. Sori absent at base and at the apex of the pinnae; indusia pale, margin

entire; spores trilete; cingulum continuous, entire, with a distal depression, distal view coarsely rugate, proximal view low rugate with some perforations, and inconspicuous commissural flange.

Distribution: Endemic of the East coast Brazil (Bahia and Rio de Janeiro); it grows inside forests at low elevations near the coast; 0-600 m elevation.

Selected specimens: BRAZIL. Bahia: *Una*, REBio de Una, 16-IV-1999, Paciencia 375 (SP). Rio de Janeiro: *Angra dos Reis*, Serra do Mar, 600 m elevation, 29-VI-1935, Brade 14944 (RB).

Prado & Windisch (2000) treated this species as a synonym of *Pteris splendens* and Prado & Hirai (2024) followed this concept. However, the rhizome of *Pteris praealta* is long-creeping (Fig. 3D), whereas in *P. splendens* is short, erect to suberect. In 1935, Brade had already observed this morphological characteristic of the rhizome of *P. praealta* and he noted this information on his herbarium specimen label (Brade 14944).

Additionally, *Pteris praealta* has pinnae narrower (up to 2 cm wide) than *P. splendens* (up to 4 cm wide). Distally the main rachis in *P. praealta* is dark brown abaxially (versus light brown or yellowish in *P. splendens*). The spores in *P. praealta* are different in both views: coarsely rugate in the distal view (Fig. 4E) and low rugate with some perforations in the proximal view (Fig. 4F), whereas the spores of *P. splendens* are densely rugate-verrucate in the distal view (Fig. 4C) and rugate-tuberculate in the proximal view (Fig. 4D).

4. **Pteris sericea** (Fée) Christ, *Bull. Herb. Boissier*, sér. 2, 2: 551. 1902. *Litobrochia sericea* Fée, *Cr. Vasc. Br*. 1: 118, t. 11, fig 3. 1869. TYPE. BRAZIL. Rio de Janeiro, 1868, A. Glaziou 2312 (*Lectotype*, designated by Prado, 1995[1996]: 40, P! on 4 sheets barcodes P00609054, P00609055, P00609056, P00609057; *isolectotypes* BR barcode BR0000013206406 image!, BR barcode BR0000013206413 image!, K! barcode K000589377, S05-9753 image!). Figs. 1H-I; 2E-F.

Plants terrestrial. Rhizomes 0.5-1 cm thick, creeping, woody, clothed at apex with lanceolate scales 0.3-0.5 cm long. Fronds 25-200 x 10-60 cm, monomorphic to subdimorphic (fertile pinnae narrower than sterile pinnae), erect; petioles 20-70 x 0.2-0.5 cm, 2- or 3-sulcate on the adaxial surface, light brown to dark brown (sometimes reddish at base), with scales at base, clothed with a prominent sericeous indument, hairs whitish, 1-3-celled, ca. 1 mm long, this indument covering moderately and occurring on all parts of the frond or just with few hairs spread; laminae chartaceous, deltate, 1-pinnate-pinnatifid, 15-90 x 10-60 cm, with 3-6 pairs of pinnae, these opposite to subopposite, oblong-lanceolate to elliptic, sessile to petiolulate (proximal pinnae), bases of the basiscopic side shortly decurrent on the rachises, costae sulcate on the adaxial surface and prominent on the abaxial surface; pair of proximal pinnae furcate, pinnatifid, basiscopic portion of the fork 9-20 x 2.5-7 cm, towards frond base, acroscopic portion of the fork 10-30 x 4-8 cm; rachises 7-70 x 0.1-0.4 cm, 2-sulcate on the adaxial surface, pale abaxially; middle pinnae 8-23 x 3-8 cm, diverging from the rachises at an acute angle; distal pinnae 6-9 x 1.5-3 cm towards frond apex; apical pinna 9-15 x 4-6 cm, deeply pinnatifid; proximal segments shorter than the median segments, alternate, linear to lanceolate, slightly falcate, apices acute or obtuse-roundish, margins entire, slightly dentate at apex; apical segment short, lobate to pinnatifid, costules prominent on the abaxial surface, sinuses between the segments acute, roundish, or biangulate; venation partially areolate, one large and elongate areole, another small areole joined to the costa, between two adjacent costules, the areolate joined to the costule and with free veins arising from the areoles near the margins of the segments, veins abaxially inconspicuous and not prominent, apex of the veins slightly clavate. Sori interrupted in the sinuses and absent at apex of the segments; indusia pale or whitish, margin entire; spores trilete; cingulum continuous, entire, distal view rugate, proximal view slightly low tuberculate, and inconspicuous commissural flange.

Distribution: Southeastern Brazil (Espírito Santo, Minas Gerais, Rio de Janeiro, São Paulo, Paraná, Santa Catarina, and Rio Grande do Sul), and northeastern Argentina; it grows inside forests; ca. 600-1750 m elevation.

Selected specimens: BRAZIL. Espírito Santo: *Venda Nova do Imigrante*, Pedra do Rego, na trilha, 20° 18' 21" S, 41° 10' 25" W, 1230 m elevation, 9-IV-2019, Cordeiro & Brotto 6246 (MBM). Minas Gerais: *Caldas*, 1873, Mosén 3088 (K, P, R, S, UPS); *Poços de Caldas*, Morro do Ferro, 26-IV-1968, Ana-Lima 68-102 (IPA). Rio de Janeiro: *ltatiaia*, Parque Nacional do Itatiaia, Hotel Simon abandonado, trilha dos Três Picos, 22° 26' 8.8" S, 44° 36' 43.7" W, 1116 m elevation, 9-V-2015, Prado & Hirai 2403 (SP); *Macaé*, Glicério, trilha Água Fria, ca. 800 m elevation, 7-VI-2004, Mynssen & Bovini 637 (RB, SP); *Nova Friburgo*, subida para o Pico da Caledônea, 22° 40' S, 42° 35' W, 1706 m elevation, 15-VI-2000, Prado *et al.* 1093 (NY, SP); *Rio Funil*, perto do Estado de São Paulo, 8-XI-1956, Handro 668 (SP, SPF); *Teresópolis*, Toca dos Caçadores, 1300 m, s.d., Brade 9318 (BM, R). São Paulo: *Campos do Jordão*, III-1946, Leite 156 (FCAB); *Iporanga/Apiaí*, Parque Estadual Turístico do Alto Ribeira (PETAR), 24° 32' 22" S, 48° 41' 36." W, 7-VII-2012, Mazziero & Albiero 1115 (SP, UPCB); *Jundiaí*, Serra do Japi, trilha indo para a Cachoeira Paraíso, 23° 14' S, 46° 56' W, 996 m elevation, 13-XI-2009, Prado *et. al.* 2061 (SP, UEC); *Paranapiacaba*, Serra de Paranapiacaba-Serra da Boa Vista, 700 m elevation, X-1925, Brade 8404 (HB, R); *São José dos Campos*, estrada São Francisco Xavier-Jardinópolis, Faz. Santa Cruz, 14-IV-1981, Vieira 24 (HRCB); *São Paulo*, Parque Estadual das Fontes do Ipiranga, 23-IV-1979, Tosta Silva 303 (SP); Idem, Jaraguá, 2-II-1922, Luederwaldt s.n. (SP 21648). Paraná: *Adrianópolis*, Parque Estadual das Lauráceas, 24° 40' S, 48° 32' W, 12-XII-2006, Matos *et al.* 1296 (SP, UPCB); *Antônio Olinto*, Água Amarela, 1-X-1969, Hatschbach 22304 (MBM, PACA, UPCB); *Balsa Nova*, Serra de São Luis, 16-VIII-1970, Hatschbach 24479 (MBM, PACA); *Campo Largo*, Rodovia BR-277, junto ao viaduto de acesso a Campo Largo, 25° 26' 3" S, 49° 30' 31" W, 975 m elevation, 3-IV-2011, Fiaschi *et al.* 3720 (SP, SPF); *Campo Mourão*, Mata do lado da Usina Mourão, 24° 7' 6" S, 52° 19' 13" W, 600 m elevation, 24-XII-2007, Labiak *et al.* 4264 (SP, UPCB); *Curitiba*, Parque Iguaçú, 22-VIII-1984, Oliveira 807 (MBM); *Guarapuava*, Estrada Municipal Benedito de Paula Louro, próximo a Cachoeira São Francisco, 25° 3' S, 51° 12' W, 1080 m elevation, 15-X-2011, Prado & Hirai 2190 (SP, SPF, TAIF, UPCB, VT); *Ponta Grossa*, Parque Estadual de Vila Velha, 25° 14' S, 50° 0' W, 1000 m elevation, 10-XI-2003, Schwartsburd 1 (SP, UPCB); *Serra do Mar*, Ypiranga, "in silva primaeva", 830 m elevation, 16-I-1914, Dusén 14423a (BM, K, US). Santa Catarina: *Canoinhas*, Rio da Areia, 21-IV-1962, Reitz & Klein 12713 (HB, MBM); *Fragoso*, s.d., Hatschbach 2492 (MBM, RB); *Marata*, Porto União, 19-I-1952, Reitz 4705 (HB, PACA); *Hammonia*, 11-X-1922, Luederwaldt s.n. (SP 21650); *Porto União*, Pinheiral near Porto União on road to Santa Rosa, 750–800 m elevation, 18-XII-1956, Smith & Reitz 8749 (HB, K, R, US); *Xanxerê*, "Pinheiral and ruderal", Faxinal dos Guedes, 700-900 m elevation, 3-I-1957, Smith & Reitz 9790 (R). Rio Grande do Sul: *Santa Cruz*, Herval do Paredão, s.d., Juergens & Stier 190 (PACA).

Prado & Windisch (2000) and Prado & Hirai (2024) treated the Brazilian specimens of this species as *Pteris lechleri* Mett, but the available name to apply to this species from Brazil is *P. sericea*. *Pteris lechleri* occurs in Central America (Panama) and South America (from Colombia to Bolivia).

Pteris sericea differs from *P. lechleri* in having rhizome creeping, laminae less pubescent, rachises pale abaxially, and geographically it is isolated in the Atlantic Forest (East coast of Brazil and Misiones in northeastern Argentina), whereas *P. lechleri* has its distribution restricted to the Andes, rhizome erect, laminae densely pubescent, and rachises dark brown. Tryon & Stolze (1989) had already observed that *P. lechleri* has an erect rhizome in plants from Peru, where the type specimen of the name came from. However, this characteristic may go unnoticed because many materials in herbaria are without rhizomes. The ornamentation of the spores is also different in both species: *P. lechleri* has reticulate spores with free tubercles in the lumens (Fig. 2G-H) and *P. sericea* has rugate spores in distal view (Fig. 2E-F).

In the general aspect, *Pteris sotae* O. Martínez resembles *P. sericea*, but differs by the entire and long terminal segment of the pinnae, sometimes caudate (versus lobate to pinnatifid and short), rounded apex of the laminar hairs (versus acicular), and coarsely rugate spores on distal view (versus rugate). *Pteris sotae* occurs only in the Tucuman-Bolivia forests in Argentina (Martínez, 2016).

Conclusions

The present study revised the current circumscriptions of three species of *Pteris*: *P. deflexa*, *P. lechleri*, and *P. splendens* and based on morphological evidence four new taxa were recognized: *P. lata* segregated from *P. deflexa*; *P. organensis* and *P. praealta* from *P. splendens*; and *P. sericea* from *P. lechleri*. These new data revealed that the Brazilian Atlantic Forest has more species of ferns than previously recognized in the Flora of Brazil by Prado *et al.* (2015).

Acknowledgements

This study was largely funded by a grant to the first author from Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq, grant no. 158895/2014-2) and the last author from Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP, grants no. 2013/23702-0, 2022/12597-0, 2023/13634-0). We thank Dra. Luciana Benjamim Benatti (Instituto de Pesquisas Ambientais-IPA, former Instituto de Botânica-IBt) for preparing the SEM images of the spores. We also thank the anonymous reviewers for suggestions to improve this manuscript.

Author Contributions

RYH and JP contributed to the study conception and prepared the descriptions with taxonomical and nomenclatural approaches. All authors, including CMM, helped in the fieldwork and prepared the material and images of the spores for SEM, as well as writing this manuscript.

Bibliography

CHAO, Y.-S. & Y.-M. HUANG. 2018. Spore morphology and its systematic implication in *Pteris* (Pteridaceae). *Plos One* 13: e0207712. https://doi.org/10.1371/journal.pone.0207712

CHAO, Y.-S., G. ROUHAN, V. B. AMOROSO & W.-L. CHIOU. 2014. Molecular phylogeny and biogeography of the genus *Pteris* (Pteridaceae). *Ann. Bot.* 114: 109-124. https://doi.org/10.1093/aob/mcu086

LELLINGER, D. B. 2002. A modern multilingual glossary for taxonomic Pteridology. *Pteridologia* 3: 1-263.

LORSCHEITTER, M. L., A. R. ASHRAF, P. G. WINDISCH & V. MOSBRUGGER. 2001. Pteridophyte spores of Rio Grande do Sul flora, Brazil. Part III. *Palaeontographica* 260: 1-165.

MARTÍNEZ, O. G. 2016. *Pteris sotae* (Pteridaceae), a new endemic species for the Argentinean flora. *Phytotaxa* 267: 291-295. http://dx.doi.org/10.11646/phytotaxa.267.4.6

MARTÍNEZ, O. G. & M. A. MORBELLI. 2009. The spores of *Pteris cretica* complex (Pteridaceae-Pteridophyta) in America. *Grana* 48: 193-204.

MARTÍNEZ, O. G. & J. PRADO. 2011. *Pteris exigua* (Pteridaceae), a new endemic species from Tucumano-Boliviano forests in northwestern Argentina. *Brittonia* 63: 295-299. http://dx.doi.org/10.1007/s12228-010-9166-9

PALACIOS-RIOS, M., C. PRADA, J. M. G. GALÁN & J. NOA. 2017. Spore types in Mexican and Mesoamerican species of *Pteris* L. (Pteridaceae). *Grana* 56: 241-256. http://dx.doi.org/10.1080/00173134.2016.1217038

PPG I. 2016. A community-derived classification for extant lycophytes and ferns. *J. Syst. Evol.* 54: 563-603. https://doi.org/10.1111/jse.12229

PRADO, J. 1995[1996]. Two lectotypifications and one synonymy in Brazilian *Pteris* L. (Pteridaceae). *Hoehnea* 22: 39-40.

PRADO, J. 1996. A survey of types in *Pteris* L. *Bradea* 8: 11-20.

PRADO, J. & R.Y. HIRAI. 2024. *Pteris* in Flora e Funga do Brasil. Jardim Botânico do Rio de Janeiro. Available at: https://floradobrasil.jbrj.gov.br/FB91978 [Accessed on: 14 February 2024].

PRADO, J. & P. G. WINDISCH. 2000. The genus *Pteris* L. (Pteridaceae) in Brazil. *Bol. Inst. Bot. (São Paulo)* 13: 103-199.

PRADO, J., C. N. RODRIGUES, A. SALATINO & M. F. L. SALATINO. 2007. Phylogenetic relationships among Pteridaceae, including Brazilian species, inferred from *rbcL* sequences. *Taxon* 56: 355-368. https://doi.org/10.1002/tax.562008

PRADO, J., L. S. SYLVESTRE, P. H. LABIAK, P. G. WINDISCH, …, & F. B. MATOS. 2015. Diversity of ferns and lycophytes in Brazil. *Rodriguésia* 66: 1073-1083. https://doi.org/10.1590/2175-7860201566410

SCHUETTPELZ, E., H. SCHNEIDER, L. HUIET, M. D. WINDHAM & K. M. PRYER. 2007. A molecular

phylogeny of the fern family Pteridaceae: assessing overall relationships and the affinities of previously unsampled genera. *Molec. Phylogenet. Evol.* 44: 1172-1185. https://doi.org/10.1016/j.ympev.2007.04.011

TRYON, A. F. & B. LUGARDON. 1990. *Spores of the Pteridophyta. Surface, wall structure and evolution based on electron microscope studies*. Springer-Verlag, New York.

TRYON, R. M. & R. G. STOLZE. 1989. Pteridophyta of part II, 13. Pteridaceae-15. Dennstaedtiaceae. *Fieldiana, Bot.* 22: 1-128.

TRYON, R. M. & A. F. TRYON. 1982. *Ferns and allied plants, with special reference to tropical America*. Springer-Verlag, New York.

WALKER, T. G. 1970. Species of *Pteris* commonly in cultivation. *Brit. Fern Gaz.* 10: 143-151.

ZHANG, L., C. J. ROTHFELS, A. EBIHARA, E. SCHUETTPELZ, …, & L.-B. ZHANG. 2015. A global plastid phylogeny of the brake fern genus *Pteris* (Pteridaceae) and related genera in the Pteridoideae. *Cladistics* 31: 406-423. https://doi.org/10.1111/cla.12094