



A new species of *Blechnum* L. (Blechnaceae, Polypodiopsida) from central-western Brazil, with an updated key to the species in the country

Vinícius Antonio de Oliveira Dittrich¹ , Alexandre Salino² and André Luís de Gasper³ 

Received: June 01, 2022

Accepted: September 26, 2022

ABSTRACT

We describe a new species of *Blechnum* from Mato Grosso, Brazil: *Blechnum rivulorum* sp. nov. This new species was discovered as a result of visits to the herbaria BM, K, P, PR, and S, as part of the Reflora Project, by the first author. We also indicate its position in a new *Blechnum* phylogeny. Additionally, we confirm the occurrence of *Blechnum meridense* Klotzsch in Brazil and provide an updated key to all species of *Blechnum* in the country.

Keywords: *Blechnum*, Blechnaceae, Polypodiopsida, ferns, pteridophytes, central-western Brazil, biodiversity, taxonomy.

Introduction

Blechnaceae is a fern family with about 265 species (Gasper *et al.* 2016; PPG 1 2016), these characterized by monomorphic to dimorphic fronds, petioles with numerous vascular bundles forming a ring in cross section (Rothfels *et al.* 2012), sori linear with introrse indusia (rarely exindusiate), generally parallel and adjacent to midveins (Gasper *et al.* 2016; Tryon & Tryon 1982).

The family is organized in three subfamilies and 25 genera (Gasper *et al.* 2016; Molino *et al.* 2019), of which *Blechnum* L., with about 30 spp., is the third largest (Dittrich *et al.* 2015; PPG 1 2016). *Blechnum* in the restricted sense treated

by us is restricted to the Neotropics and Africa, and can be recognized by its stoloniferous rhizomes, monomorphic to subdimorphic fronds, and finely denticulate pinna margins (Gasper *et al.* 2016). The genus was taxonomically investigated in the Neotropics by Murillo (1968) and Rolleri *et al.* (2012), and in Brazil it was studied by Dittrich *et al.* (2015), who ascribed 11 species to southern and southeastern Brazil, the richest area in the country. There are some recently described endemic species in northern and central-western Brazil (Dittrich *et al.* 2012). Altogether, 13 species of *Blechnum* are known from Brazil (Dittrich & Gasper 2022).

Even though many floras give a good account of *Blechnum* in many countries (*e.g.*, Proctor 1985, for Jamaica; Mickel &

¹ Departamento de Botânica, Universidade Federal de Juiz de Fora, 36036-900, Juiz de Fora, MG, Brazil

² Programa de Pós-Graduação em Biologia Vegetal, Universidade Federal de Minas Gerais, 31270-901, Belo Horizonte, MG, Brazil

³ Departamento de Ciências Naturais, Universidade Regional de Blumenau, 89030-903, Blumenau, SC, Brazil

* Corresponding author: vinarc@gmail.com

A new species of *Blechnum* L. (Blechnaceae, Polypodiopsida) from central-western Brazil, with an updated key to the species in the country

Smith 2004, for Mexico; Ramos Giacosa 2016, for Argentina; Smith & Kessler 2018, for Bolivia), new species are still being discovered, and some species complexes (as *Blechnum occidentale* s.l.) need new study to avoid Linnean shortfalls (Hortal *et al.* 2015). Mato Grosso is not a particularly important area of endemism for ferns, but recently Matos & Vasco (2022) described an endemic species of *Elaphoglossum* from the state, *Elaphoglossum mattogrossense*. Aiming to contribute to BFG – Brazil Flora Group (BFG 2018) to achieve the Global Strategy for Plant Conservation (GSPC) established by the Conference of Parties in 2002, we describe a new *Blechnum* species, confirm the record of *Blechnum meridense* Klotzsch for Brazil, and provide an updated key to all species in the country.

Material and methods

Morphology

Herbarium specimens were consulted at BM, CESJ, BHCB, HRCB, K, and S (herbarium codes follow Thiers 2022), as well as the Virtual Herbarium INCT/HVFF (<https://specieslink.net/>)

Molecular phylogeny

Our sample (Almeida 2635) was extracted with DNeasy Plant Mini Kit (Qiagen Inc., Valencia, CA) using field-collected silica-gel-dried tissue. Amplification follows Gasper *et al.* (2017) with the same three genome regions and methods: *rbcL* (Hauffer & Ranker 1995), *rps4-trnS* (Nadot *et al.* 1995; Smith & Cranfill 2002), and *trnL-trnF* (Taberlet *et al.* 1991; Trewick *et al.* 2002). PCR products were sequenced on High Throughput Genomics (<http://www.htseq.org>). We used the same sequences from Gasper *et al.* (2017) for *Blechnum* (17 taxa), plus *Cranfillia* (two taxa) and *Austroblechnum* (two taxa) as outgroups. The sequences were aligned with MUSCLE (Edgar 2004) using MEGA XI (Tamura *et al.* 2021), with manual adjustments when necessary and no ambiguous areas excluded. We performed a maximum likelihood (ML) in IQ-TREE server with default settings (Trifinopoulos *et al.* 2016). GenBank accession number *rbcL* (ON645313), *rps4-trnS* (ON645314), and *trnL-trnF* (ON645315).

Results

Blechnum rivulorum V.A.O. Dittrich & Salino, sp. nov. (Figs. 1, 2, 3) - TYPE: BRAZIL. Mato Grosso: Chapada dos Guimarães, Parque Nacional da Chapada dos Guimarães, trilha para o Veu da Noiva, 15°24'21"S, 55°50'10"W, 28 Feb 2011, T.E. Almeida *et al.* 2635 (holotype, BHCB; isotype, CESJ).

Plants epipetric; rhizomes erect, stoloniferous, the scales narrowly triangular, light to dark tan, concolorous, 1 × 0.2 mm at the base, margins entire or with few teeth; fronds monomorphic, 2.9–13.4 cm long; stipes filiform, paleaceous to almost black, 1.1–3.9 cm long, 0.3–0.4 mm diam. at the base with scales similar to those on the rhizome; blades linear, elliptic, ovate or oblanceolate, 1.9–8.8 × 0.5–1.8 cm, glabrous, papyraceous, pinnatisect (sometimes pinnate between the two proximal pinnae pairs), at the apex with a more or less caudate segment 1–4 cm long, lobed at the base or not, longer than lateral pinnae, or rarely subconform, abruptly reduced toward the base to a vestigial pinna pair or to an ordinary, smaller pinna, or not reduced at all; rachises glabrous or with scattered multicellular hairs on both faces; pinnae (1)3–7(11) pairs, 0.4–1.2 × 0.3–0.7 cm at the base, sometimes broader than long, slightly (mainly the basal ones) to strongly (mainly the middle and distal ones) ascending, generally sursumcurrent (all ordinary pinnae and auricles) or just adnate to rachis (auricles), triangular, margins finely denticulate, apex rounded, acute, or mucronate; veins free, simple to bifurcate, small pinnae of small specimens sometimes lacking a clear midrib (pinnae dimidiate), with clavate ends before reaching the margin. Spores monolete, 48–55 µm in equatorial view, granulate or rugulate with low folds.

Comments: *Blechnum rivulorum* is closely related to *Blechnum polypodioides* Raddi and *B. asplenioides* Sw. From the first it can be distinguished by the pinnae more strongly ascending, generally more than 45° (when ascending, in *B. polypodioides*, generally not more than 30°), distinct spores (perispore with low folds vs. perispore without folds in *B. polypodioides*) and stipe diameter (filiform, not more than 0.4 mm diam. vs. stouter stipes 0.9–1.1 mm diam. in *B. polypodioides*). From *B. asplenioides* it can be distinguished by the blades abruptly reduced proximally to a vestigial pinna pair or to a smaller pinna (gradually reduced proximally in *B. asplenioides*, generally to semicircular lobes), by the sinuses (wide in *B. rivulorum* vs. narrow in *B. asplenioides*) and by the linear, elliptic or oblanceolate blades (vs. linear-lanceolate in *B. asplenioides*). Furthermore, *B. asplenioides* tends to be a more robust plant (fronds 5.7–30 cm long vs. 2.9–13.4 cm long in *B. rivulorum*) with more pinnae (6–32 pairs) than *B. rivulorum* ((1)3–7(11) pairs).

Blechnum rivulorum forms a clade with *Blechnum asplenioides* and *Blechnum polypodioides* in the maximum likelihood analysis, with high support, in the *Blechnum polypodioides* clade (Fig. 4, indicated by an asterisk). Despite our goal was not to provide a new phylogeny of *Blechnum* s.s., we can identify *B. rivulorum* affinities. This is a well-supported clade composed by small plants (when compared to the *Blechnum occidentale* clade), with areolate-veined species (Dittrich *et al.* 2012) as sister to *Blechnum rivulorum*+*asplenioides*+*polypodioides*.

At least one specimen has some dimidiate pinnae. Those pinnae are very small in this specimen, but this may be result





Figure 1. *Blechnum rivulorum*. A. Habit. B. Rhizome scales. C. Proximal pinna pair, showing venation. D. Median pinna pair. All from Pivetta 1497, a paratype (HRCB). Drawn by Samyra Gomes Furtado.

A new species of *Blechnum* L. (Blechnaceae, Polypodiopsida)
from central-western Brazil, with an updated key to the species in the country

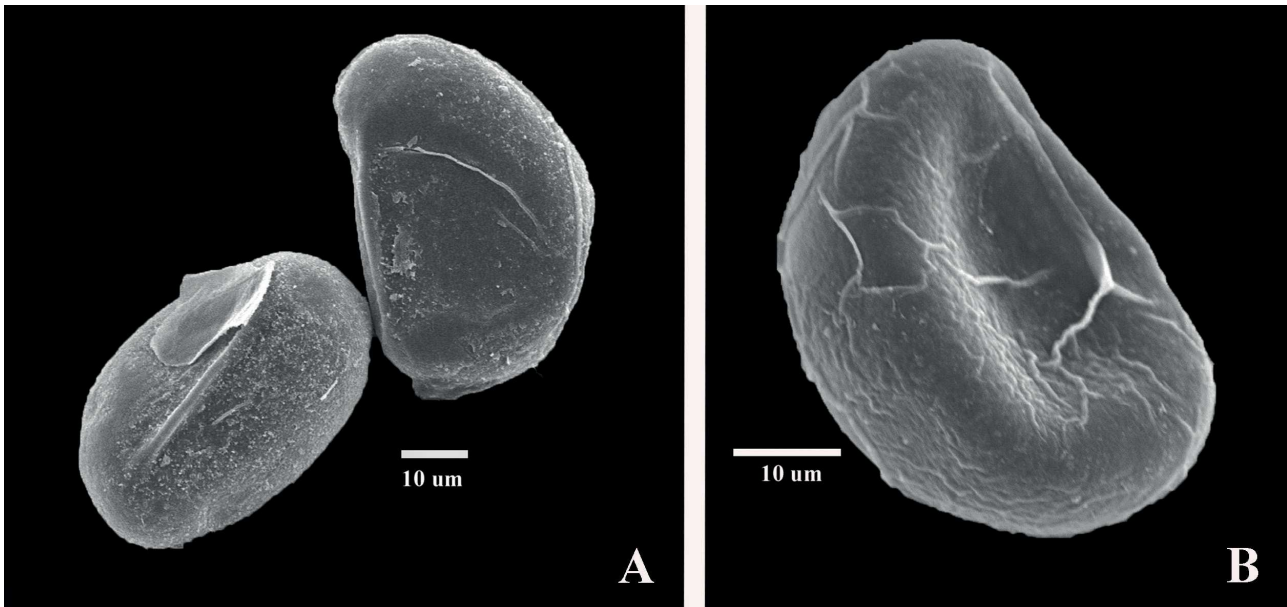


Figure 2. Spores of *Blechnum rivulorum*, from T.E. Almeida *et al.* 2635 (BHCB).

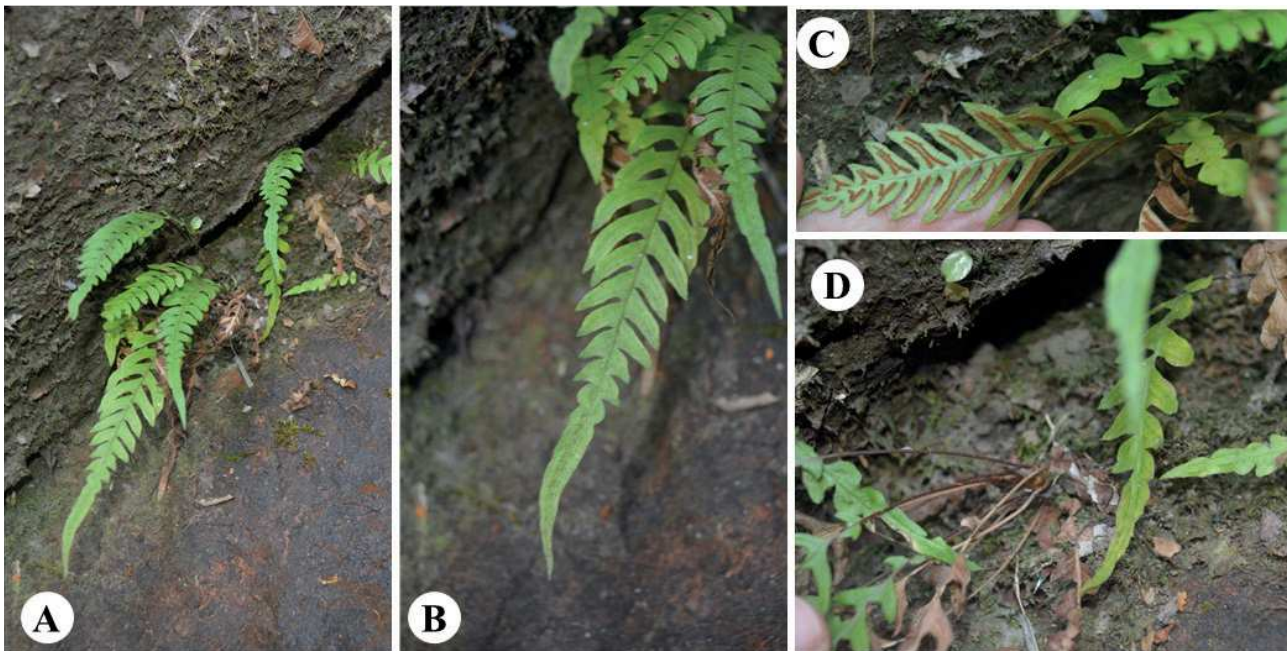


Figure 3. Photos of *Blechnum rivulorum* in nature, taken at Cachoeira do Relógio, border of Cuiabá and Santo Antônio do Leverger municipalities, Chapada dos Guimarães, Mato Grosso, Brazil (15°36'55.7"S, 55°28'45.8"W, 695 m). A. Habit. B. Fronds. C. Sori. D. Stipes. (Photos: V.A.O. Dittrich).



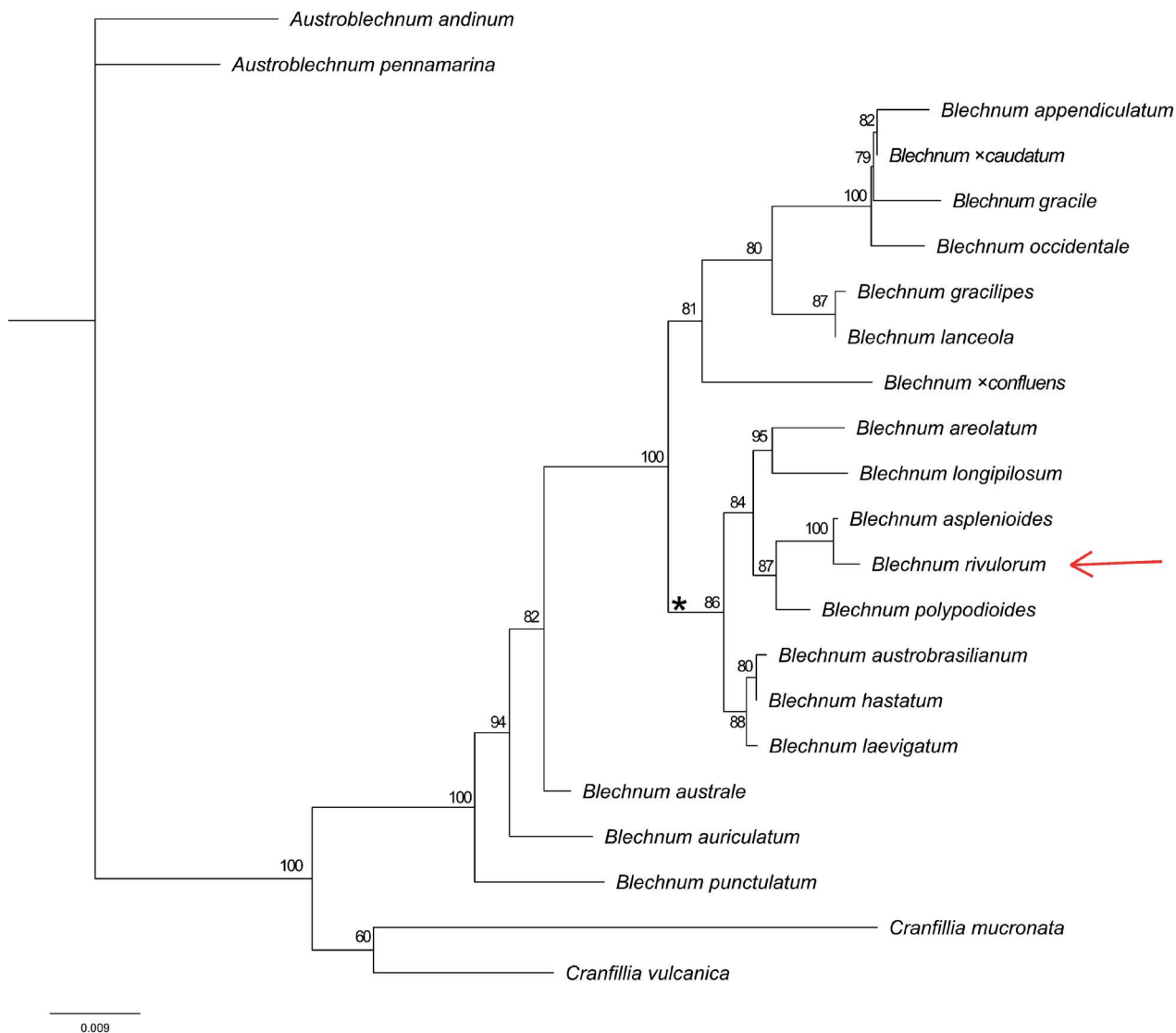


Figure 4. Maximum likelihood phylogeny of *Blechnum* L. based on three chloroplast regions (*rbcL*, *rps4*, *trnL-trnF*). Maximum likelihood bootstrap support values are indicated near nodes; *Blechnum rivulorum* is shown by an arrow.

of their size. Fertile dimidiate pinnae have sori not following any vein, but instead at the base of a few veins. Variation in frond shape is striking, even at the same individual (e.g., Salino 380, UEC).

This species grows on sandstone rocks, generally along rivers or close to them. Their habitat and morphology suggest that they may be rheophytes. The species name (latin *rivulorum* = from the rivers) indicates their preferred habitat.

Additional specimens examined (paratypes): Brazil, Mato Grosso: Barra do Garças, 9 km NE of Barra do Garças, 450-500 m, 5 May 1973, W.R. Anderson 9761 (K, P, UB - photo, US - photo); idem, ca. 5 km N of Barra do Garças, at base of

south face of mountain, 500 m, 24 Feb 1982, W.R. Anderson 12441 (MBM - photo, NY - photo); Chapada dos Guimarães, perto do arroio que forma o Véu da Noiva, 15 Jul 1991, J. Pivetta 1497 (HRCB, SJRP - photo); ibidem, 16 Feb 1988, A. Salino 380 (UEC - photo); ibidem, Rio Coxipozinho, 28 Jan 1989, R.F. Novelino 613 (CESJ); ibidem, Salgadeira, 28 Jan 1989, R.F. Novelino 610 (CESJ); Cuiabá, Rodovia MT-351, Balneário Salgadeira, próximo ao limite com o município de Chapada dos Guimarães, 17 Apr 2003, F.P.F. Athayde & D.F. Peralta 1211 (HBRA - photo); idem, Parque Nacional da Chapada dos Guimarães, Trilha para a base da cachoeira Véu de Noiva, parte alta da trilha, 15°24'21"S, 55°50'11"W, 553 m, 15 Jul 2018, B. Canestraro 1252 (CESJ).

**A new species of *Blechnum* L. (Blechnaceae, Polypodiopsida)
from central-western Brazil, with an updated key to the species in the country**

Updated key to Blechnum in Brazil

- 1. Fronds subdimorphic, the fertile ones slightly contracted 2
- Fronds monomorphic, the fertile ones not contracted 4
- 2. Veins partially anastomosing *B. heringeri*
- Veins free 3
- 3. Sterile blades at most 6.1 cm wide; sori continuous, rarely some interrupted; proximal pinnae of sterile fronds gradually reduced, 2.5–5 × shorter than the longest pinnae *B. auriculatum*
- Sterile blades at least 8 cm wide; sori generally, at least partially, interrupted; proximal pinnae of sterile fronds slightly reduced, 1.2–2(3) × shorter than the longest pinnae *B. × leopoldense*
- 4. Veins partially anastomosing 5
- Veins free 6
- 5. Pinnae 1–2 pairs; blades truncate at base *B. areolatum*
- Pinnae (4–)5–7(–11) pairs; base of blades with one to three reduced pinnae *B. longipilosum*
- 6. Blades simple, entire *B. lanceola*
- Blades pinnatisect or pinnate 7
- 7. Blades gradually reduced to semicircular lobes or to auricles at the base..... 8
- Blades not reduced or reduced at the base, if so never gradually reduced to semicircular lobes or to auricles 9
- 8. Median pinnae deltate, strongly ascending; basal pinnae semicircular *B. asplenoides*
- Median pinnae narrowly triangular, patent or slightly ascending; basal pinnae surcurrent *B. polypodioides*
- 9. Lamina apex a conform or subconform terminal pinna, 1.1–3.2 times longer than the longest lateral pinna 10
- Lamina apex pinnatifid or with a more or less caudate segment, not conform or subconform 13
- 10. Lamina apex subconform; distal pinnae surcurrent 11
- Lamina apex conform; distal pinnae not surcurrent 12
- 11. Proximal pinna pair free from the rachis *B. × caudatum*
- Proximal pinna pair adnate to the rachis *B. rivulorum*
- 12. Fertile terminal pinnae cuneate and symmetric at the base, very rarely lobed; pinna pairs 2(3) *B. meridense*
- Fertile terminal pinnae lobed and/or asymmetric at the base; pinna pairs (2)3–5(–8) *B. gracile*
- 13. Acroscopic side of the proximal pair of pinnae partially or completely adnate to the rachis 14
- Acroscopic side of the proximal pair of pinnae totally free from the rachis 17
- 14. Basisopic side of the proximal pair of pinnae totally adnate to the rachis 15
- Basisopic side of the proximal pair of pinnae completely or partially free from the rachis 16
- 15. Medial pinnae ascending, generally not more than 30°; stipes 0.9–1.1 mm diam. *B. polypodioides*
- Medial pinnae strongly ascending, generally more than 45°; stipes filiform, less than 0.4 mm diam. *B. rivulorum*
- 16. Hairs generally abundant on rachis and blade (at the margins, on or between veins, at both sides) *B. laevigatum*
- Hairs, when present, only on rachis, rarely on veins, never at the margins or between veins *B. austrobrasillianum*
- 17. Basal pinnae proximally without auricles at the acroscopic side *B. occidentale*
- Basal pinnae proximally auriculate acroscopically *B. × leopoldense*



New record for Brazil:

Blechnum meridense Klotzsch. BRAZIL: Rio de Janeiro, Corcovado, 1894, *Herter s.n.* (S). According to Rolleri *et al.* (2012), this species was previously recorded in Brazil. They cite the voucher *Albricht 165* (LP) and state that the specimen on the left is *B. meridense*. Unfortunately, there is no photo of it, and we were unable to see any image (according to Laura Iharlegui from LP, *pers. com.*, the specimen *Albricht 165* could not be found in the collection). This is the only specimen seen by the authors in Brazil, and since this specimen was collected more than 120 years ago amid an urban area that is one of the main centers of research in Botany in the country, we believe it is probably locally extinct.

Acknowledgments

The senior author acknowledges CNPq/Reflora program for financial support and the fern curator at K for loan specimens of Blechnaceae. All authors acknowledge Samyra Gomes Furtado for the drawing. ALG and AS thanks CNPq for the productivity grants (311303/2020-0 and 313981/2020-5, respectively).

References

- BFG - The Brazil Flora Group. 2018. Brazilian Flora 2020: Innovation and collaboration to meet Target 1 of the Global Strategy for Plant Conservation (GSPC). *Rodriguésia* 69: 1513-1527.
- Dittrich VAO, Gasper AL. 2022. *Blechnum* L. In: *Flora e Funga do Brasil*. Rio de Janeiro, Jardim Botânico do Rio de Janeiro. <https://floradobrasil.jbrj.gov.br/FB90785>
- Dittrich VAO, Salino A, Almeida, TE. 2012. Two new species of the fern genus *Blechnum* with partially anastomosing veins from Northern Brazil. *Systematic Botany* 37: 38-42.
- Dittrich VAO, Salino A, Monteiro R. 2015. The *Blechnum occidentale* (Blechnaceae, Polypodiopsida) species group in southern and southeastern Brazil. *Phytotaxa* 231: 201-229.
- Edgar RC. 2004. MUSCLE: Multiple sequence alignment with high accuracy and high throughput. *Nucleic Acids Research* 32: 1792-1797.
- Gasper AL, Dittrich VAO, Smith AR, Salino A. 2016. A classification for Blechnaceae (Polypodiales: Polypodiopsida): New genera, resurrected names, and combinations. *Phytotaxa* 275: 191-227.
- Gasper AL, Almeida TE, Dittrich VAO, Smith AR, Salino A. 2017. Molecular phylogeny of the fern family Blechnaceae (Polypodiales) with a revised genus-level treatment. *Cladistics* 33: 429-446.
- Haufler CH, Ranker TA. 1995. rbcL sequences provide phylogenetic insights among sister species of the fern genus *Polypodium*. *American Fern Journal* 85: 361-374.
- Hortal J, de Bello F, Diniz-Filho JAF, Lewinsohn TM, Lobo JM, Ladle RJ. 2015. Seven shortfalls that beset large-scale knowledge of biodiversity. *Annual Review of Ecology, Evolution, and Systematics* 46: 523-549.
- Matos FB, Vasco A. 2022. *Elaphoglossum matogrossense* (Dryopteridaceae), a new and threatened species from Chapada dos Guimarães, Mato Grosso, Brazil. *Kew Bulletin*: 77: 721-728. doi: 10.1007/s12225-022-10043-2
- Mickel JT, Smith AR. 2004. *The pteridophytes of Mexico*. New York, The New York Botanical Garden.
- Molino S, Gabriel y Galán JM, Wasowicz P, Fuente P, Sessa EB. 2019. The *Struthiopteris spicant* (Blechnaceae, Polypodiopsida) complex in Western Europe, with proposals for taxonomic and nomenclatural changes. *Plant Systematics and Evolution* 305: 255-268.
- Murillo MT. 1968. *Blechnum* subgénero *Blechnum* en Sur América, con especial referencia a las especies de Colombia. *Nova Hedwigia* 16: 329-366.
- Nadot S, Bittar G, Carter L, Lacroix R, Lejeune B. 1995. A phylogenetic analysis of monocotyledons based on the chloroplast gene *rps4*, using parsimony and a new numerical phenetics method. *Molecular Phylogenetics and Evolution* 4: 257-282.
- PPG 1 - The Pteridophyte Phylogeny Group. 2016. A community-derived classification for extant lycophytes and ferns. *Journal of Systematics and Evolution* 54: 563-603.
- Proctor GR. 1985. *Ferns of Jamaica*. London, British Museum.
- Ramos Giacosa JP. 2016. Familia Blechnaceae Newman. In: Zuloaga FO, Belgrano MJ (eds.) *Flora Vascular de la República Argentina*. Vol II. Buenos Aires, Instituto de Botánica Darwiniana. p. 86-104.
- Rolleri CH, Prada C, Passarelli LM, Gabriel y Galán JM, Ciciarelli MM. 2012. Revisión de especies monomorfas y subdimorfas del género *Blechnum* (Blechnaceae-Pteridophyta). *Botanica Complutensis* 36: 51-77.
- Rothfels CJ, Sundue MA, Kuo LY, Larsson A, Kato M, Schuettpelz E, Pryer KM. 2012. A revised family-level classification for eupolypod II ferns (Polypodiidae: Polypodiales). *Taxon* 61: 515-533.
- Smith AR, Cranfill RB. 2002. Intrafamilial relationships of the thelypteroid ferns (Thelypteridaceae). *American Fern Journal* 92: 131-149.
- Smith AR, Kessler M. 2018. Prodrómus of a fern flora for Bolivia. XXXIII. Blechnaceae. *Phytotaxa* 334: 99-117.
- Taberlet P, Gielly L, Pautou G, Bouvet J. 1991. Universal primers for amplification of three non-coding regions of chloroplast DNA. *Plant Molecular Biology* 17: 1105-1109.
- Tamura K, Stecher G, Kumar S. 2021. MEGA11: Molecular evolutionary genetics analysis version 11. *Molecular Biology and Evolution* 38: 3022-3027.
- Thiers BM. 2022. Index Herbariorum: A global directory of public herbaria and associated staff. <http://sweetgum.nybg.org/science/ih/>
- Trewick SA, Morgan-Richards M, Russell S, Henderson S, Rumsey FJ, Pintér I, Barrett JA, Gibby M, Vogel JC. 2002. Polyploidy, phylogeography and Pleistocene refugia of the rockfern *Asplenium ceterach*: evidence from chloroplast DNA. *Molecular Ecology* 11: 2003-2012.
- Trifinopoulos J, Nguyen L-T, von Haeseler A, Minh BQ. 2016. W-IQ-TREE: a fast online phylogenetic tool for maximum likelihood analysis. *Nucleic Acids Research* 44: W232-W235.
- Tryon RM, Tryon AF. 1982. *Ferns and allied plants, with special reference to tropical America*. New York, Springer-Verlag.

