



## Ferns and Lycophytes as new challenges

# Taxonomic notes on *Asplenium pseudoangustum* (Aspleniaceae): a redescription based on spore morphology and distribution novelties

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### Abstract

*Asplenium pseudoangustum* is a poorly understood species known from the Peruvian Amazon forests. Due to morphological similarities with *A. angustum* and *A. serratum*, the position of *A. pseudoangustum* among the called *A. serratum* complex was suggested. However, spore ornamentation and scales morphology indicate that *A. pseudoangustum* is more related to the species of the *A. hastatum* subclade. Here, we present a redescription for this species, including scales and spore morphology, and an updated distribution including records from Brazil and Colombia.

**Key words:** Amazon Forest, ferns, Neotropical region, South America.

### Resumo

*Asplenium pseudoangustum* é uma espécie pouco conhecida da Floresta Amazônica Peruana. Devido a similaridades morfológicas com *A. angustum* e *A. serratum*, o posicionamento de *A. pseudoangustum* no complexo *A. serratum* era sugerido. No entanto, a ornamentação dos esporos e a morfologia das escamas indicam que *A. pseudoangustum* seja mais relacionada com espécies do subclado *A. hastatum*. Aqui, apresentamos uma redescrição para esta espécie, incluindo a morfologia de escamas e esporos, e uma distribuição atualizada com registros do Brasil e da Colômbia.

**Palavras-chave:** Floresta Amazônica, samambaias, região neotropical, América do Sul.

Representing the most species-rich fern genus, *Asplenium* L. (1753: 1078) harbors more than 700 species occurring worldwide, mainly in tropical ecosystems (PPGI 2016; Xu *et al.* 2020). Although easily recognized by its unilateral sori in secondary veins and erect to ascending stems with clathrate scales, the interspecific variation related to the leaf morphology makes it a taxonomically challenging genus.

Lineages with undivided laminae evolved independently several times within the evolutionary

history of *Asplenium* (Schneider *et al.* 2004; Xu *et al.* 2020). Recent phylogenies point out the existence of simple-laminae representatives in five of the eleven clades recovered for *Asplenium s.l.* (*Phyllitis*, *Neottopteris*, *Tarachia*, *Schaffneria*, and *Asplenium s.s.*) and one within *Hymenasplenium*, the other genus of Aspleniaceae (Xu *et al.* 2020).

For the Neotropics, three monophyletic lineages presenting entire, undivided laminae are recognized in *Asplenium*: the *A. douglasii*

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complex (Sylvestre & Windisch 2002; Lino *et al.* unpublished data), the *A. serratum* complex (Reis 2022; Reis *et al.* 2022), and the *A. hastatum* subclade (Tryon & Stolze 1993; Xu *et al.* 2020). Species of those lineages exhibit undivided laminae during the entire development of the sporophyte or in part of it, with a 1-pinnate morphology in adult specimens, with lateral segments similar to the apical.

*Asplenium pseudoangustum* Stolze (1984: 79) is an epiphytic species with undivided laminae found in the Peruvian Amazon. Due to resembling morphology, it is frequently compared to *Asplenium angustum* Sw. (1817: 66) or, in some cases, with *A. serratum* L., species commonly found in Amazonian ecosystems (Stolze 1984; Tryon & Stolze 1993; Kessler & Smith 2018). However, these two latter taxa encompass a neotropical complex characterized by species with undivided laminae and free veins (Reis *et al.* 2022). Based on its described morphology and similarities with *A. angustum* and *A. serratum*, the position of *A. pseudoangustum* among the called *Asplenium serratum* complex was suggested (Stolze 1984; Tryon & Stolze 1993).

Attempting to circumscribe the *A. serratum* complex, we perceived that *A. pseudoangustum* may not share a compatible morphology with the other species in this complex (Reis *et al.* 2022). Additionally, the morphology of the spores and scales resembles species from *A. hastatum* subclade. Here, we aim to present a redescription of *A. pseudoangustum*, with details of the scales and spores, and to report new occurrences in the territories of Brazil and Colombia. Moreover, we point out the morphological affinities with *A. hastatum* clade (Sylvestre & Windisch 2008; Xu *et al.* 2020).

Specimens of *Asplenium pseudoangustum* were examined in the following herbaria: BHCB, MO, R, RB, RBR, UPCB, USM, and US (Thiers continuously updated). The morphological characterization of digitized specimens was conducted using ImageJ 1.53a (Schneider *et al.* 2012). Spores were observed using scanning electron microscopy (SEM), with a Jeol JSM6510 or Hitachi TM4000 Plus SEM microscope. The morphological terminology of spores followed Tryon & Lugardon (1991) and Lellinger (2002). Original and inferred coordinates were obtained from examined collections and a distribution map was generated with QGIS 3.14.15-Pi (QGIS Development Team 2018).

*Asplenium pseudoangustum* Stolze. Amer. Fern J. 74: 49. 1984. Type: PERU. HUANUCO: Prov. Leoncio Prado, Tingo Maria, 09°17'34"S, 75°59'17"W, 700 m, 2.IX.1956, Tryon & Tryon 5257 (holotype GH 00020575!; isotypes, F V0075624F!, MO 1804723, U U.1003133!, US 00048739!, USM000073!). Figs. 1; 2a-c

Plant epiphytic or epipetric; stem 2.0–3.5 × 1.2–1.5 cm, short, erect to ascending, covered with 1.5–3 × 0.2–0.3 mm, lanceolate, light brown to blackish scales; leaves monomorphic, 8–28 cm long; petiole 0.5–2.2(–2.9) cm long, short to sessile, brown to dark brownish; laminae 7.1–27.2 × 1.3–2.2 cm, elliptic, chartaceous, dark green to blackish when dry, glabrous, apex acute to attenuate, margin entire to crenate; veins simple, 1- or 2-forked, spreading at a 30–45° angle with the midrib; sori linear to arcuate near margin. Indusia membranaceous, green to stramineous, elongated. Spores with major equatorial diameter 25–35 µm, with echinate, fenestrate perispore (Fig. 2).

**Examined material:** BRAZIL. ACRE: Parque Nacional da Serra do Divisor, Serra do Mõa, Mâncio Lima, trilha do Igarapé do Amor até a Cachoeira da Estátua, 07°26'01"S, 73°40'01"W, 218 m, 13.XII.2010, Almeida 2579 (BHCB). COLOMBIA. LETICIA: Parque Nacional Natural Amacayacu, Quebrada de Agua Pudre, ca. 1.5 km NE de desemboca dura sobre el río Amacayacu, 03°47'S, 70°15'W, 200–220 m, 19.XI.1991, Pipoly 16522A (MO). ECUADOR. NAPO: Estación Experimental de INIAP, San Carlos, 6 km al SE de Los Sachas, 250 m, 19.IV.1985, Baker 6081 (NY). PERU. AMAZONAS: Prov. Bagua, Imaza, camino Putuim-Shimutaz, 05°03'20"S, 78°20'23"W, 480 m, 19.VI.1996, R. Vásquez *et al.* 21248 (USM). CUSCO: Prov. La Convención, Tupitari, 2000 m, 30.VII.1943, Bües 5450 (US). HUANUCO: Prov. Leoncio Prado, Tingo Maria, 09°17'34"S, 75°59'17"W, 700 m, 2.IX.1956, Tryon & Tryon 5257 (GH, F, U, US and USM). JUNÍN: Pichis Trail, Yapas, 1350–1600 m, 28–29.VI.1929, Killip & Smith 25560 (NY, US); Puerto Bermudez, 375 m, 14–17.VII.1929, Killip & Smith 26545 (NY, US). MADRE DE DIOS: Prov. Manu, Cerro de Pantiacolla, Rio Palotoa, 12°35'S, 71°18'W, 700–1300 m, 14.XII.1985, Foster 10827 (F). PASCO: Prov. Oxapampa, Valle del Palcazú: Rio Palcazú: Cerca de Iscozacín, camino a Villa América, 09°57'04"S, 75°15'10.84"W, 400 m, 21.VIII.1985, León 715 (F, USM). UCAYALI: Prov. Padre Abad, Cuenca del Rio Aguaytía. Carretera a la quebrada Alto San Pedro, al Oeste de la Aguaytía, 09°02'S, 75°32'W, 300 m, 18.X.2004, Schunke & Graham 16470 (F). SAN MARTÍN: Tocache Nuevo, Mariscal Cáceres, Palo Blanco, al oeste del Puente, 350–700 m, 14.VI.1974, Schunke 6951 (F, US).

The species was found in Brazil, Colombia, Ecuador, and Peru (Fig. 3). Epiphytic on tree



Figure 1 – Holotype of *Asplenium pseudoangustum* (Tryon 5257, GH).

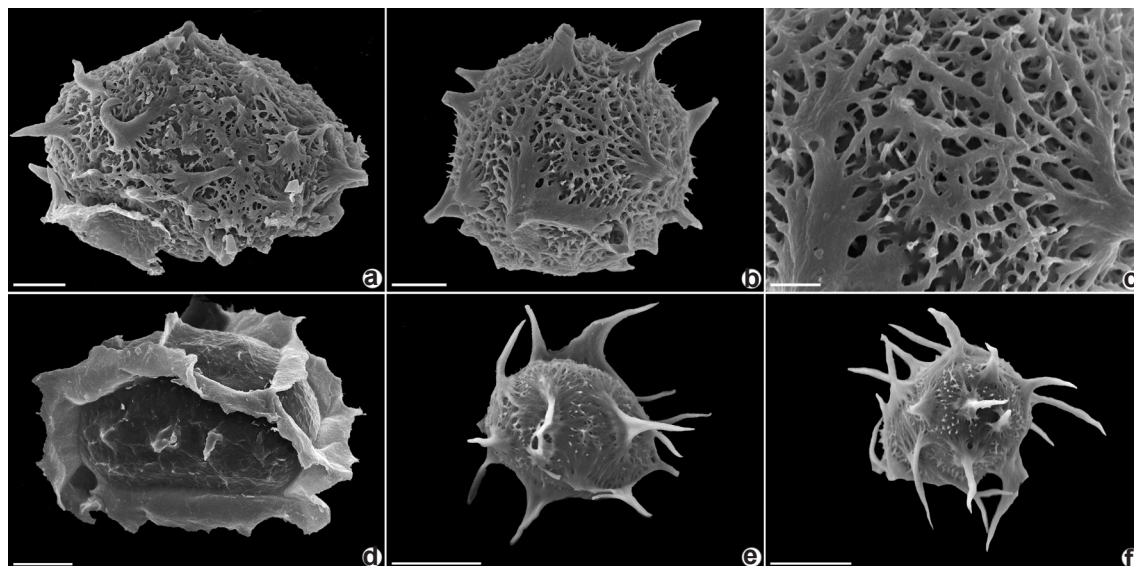
trunks or branches, or rarely growing on rocks, occurring in shaded and humid places at 200–2,000 m elevation. *Asplenium pseudoangustum* is found primarily in dense forests in Peru, but few specimens are recorded from Brazil, Colombia, and Ecuador, all within the Amazon basin. The records of *Asplenium pseudoangustum* from Brazil (Parque Nacional da Serra do Divisor, Acre) and Colombia (Parque Nacional Natural Amacayacu, Leticia) are near the border of Peru.

Stolze (1984) described *Asplenium pseudoangustum* based on depauperated specimens from Ecuador and Peru that were initially identified as *A. angustum*. *Asplenium pseudoangustum* is similar to *A. angustum* because of its simple, undivided laminae, with secondary veins spreading at 30–45° from the midrib, and epiphytic habit. However, these two species can be distinguished by the thicker, chartaceous laminae, absence of leaf scales and deltoid non-glandular stem scales in *A. pseudoangustum* (vs. membranaceous laminae, with scales in the midrib, and linear-lanceolate glandular stem scales in *A. angustum*).

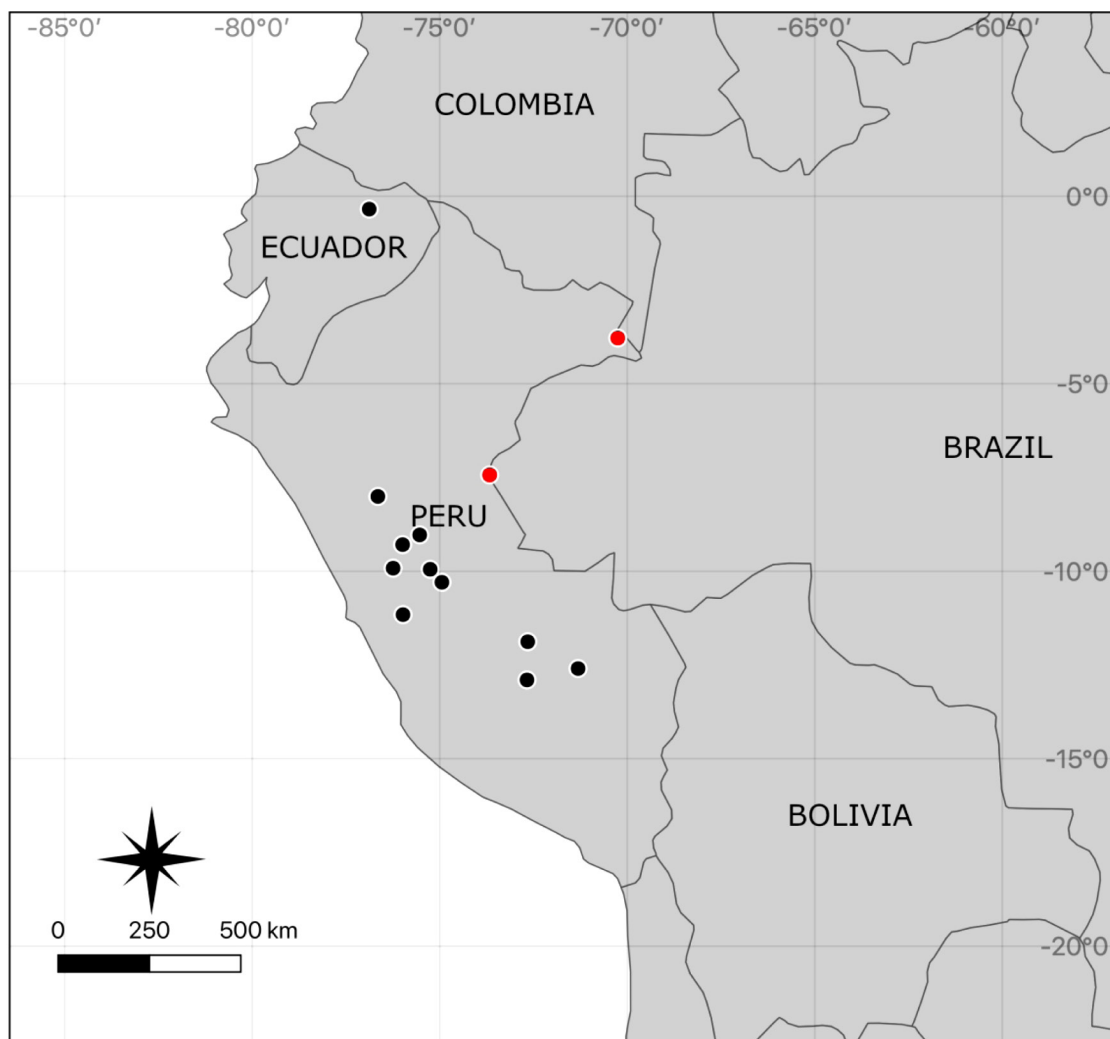
The fenestrate and echinate perispore ornamentation exhibited in *A. pseudoangustum* (Fig. 2a–c) is an informative character and indicates it is not related to *A. angustum*. The latter species

belongs to *A. serratum* complex, a monophyletic neotropical lineage characterized by its undivided laminae, stem scales with marginal glandular cells, laminar scales along the midrib, and veins free ending near margins (Reis 2022; Reis *et al.* 2022). Further, the cristate-alate perispore ornamentation is a conserved character, occurring in all species from this complex (Fig. 2d). Thus, by presenting a different perispore ornamentation pattern and for not sharesharing other morphological characters, *A. pseudoangustum* belongs to a distinctive lineage than that of *A. angustum*.

Only one known group of neotropical *Asplenium* has spores with echinate, fenestrate perispore (Fig. 2e,f), corresponding to species from the *Asplenium hastatum* subclade (Xu *et al.* 2020). Although there are no species with undivided laminae currently reported for this lineage, some pinnate species can have young sporophytes with undivided laminae, such as *A. juglandifolium* Lam. (1786: 307), *A. pearcei* Baker (1874: 483), and *A. tricholepis* Rosenst. (1913: 468). Therefore, this group are remarkably diverse in the Amazon Forest. Based on this and the perispore ornamentation, we suggest that *A. pseudoangustum* is probably more related to this lineage than to species in the *A. serratum* complex.



**Figure 2** – a–f. Perispore ornamentation of *Asplenium pseudoangustum* and related species. – a–c. *Asplenium pseudoangustum*, with an echinate-fenestrate perispore (Almeida 2579, BHCB); d. *Asplenium angustum*, with a cristate-alate perispore (Hoffman 4, R); e–f. *Asplenium pearcei*, with an echinate-fenestrate perispore (Pietrobon 7135, RBR). a, d, e. Major equatorial view; b, f. Minor equatorial view; c. Details of perispore (photos by Atiles Reis). Scale bars: a–b, e–f = 5 µm; c = 2 µm; d = 10 µm.



**Figure 3** – Distribution map of *Asplenium pseudoangustum*. New records are represented by red dots.

Furthermore, due to the rates of phenolics concentrated in the leaves and the difficulties in obtaining fresh samples, molecular studies encompassing *A. pseudoangustum* are challenging. Thus, as far as we are concerned, this species is not included in any published phylogenetic analysis or has its sequences deposited in databases. Nevertheless, we believe that these morphological characters indicate different position and affinities for *A. pseudoangustum*, clarifying the relations of this undivided laminae neotropical *Asplenium*.

### Acknowledgments

This study was funded in part by the Coordenação de Aperfeiçoamento de Pessoal

de Nível Superior - Brasil (CAPES) - Finance Code 001. The authors thank the following: FAPERJ, for APQ-1 E-26/211.521/2021 (granted to LSS); Museu Nacional/UFRJ and Instituto de Pesquisas Jardim Botânico do Rio de Janeiro, for the resources and infrastructure used in this study; the curators and staff of the consulted herbaria, especially those at R, RBR, and BHCB, for providing sample fragments for the morphological analysis, and GH for image usage permission; Nathan Smith, Thais Almeida and two anonymous reviewers for constructive suggestions; and Raquel Rachid (dpUnion) and Ricardo Louro (UFRJ), for helping with the SEM micrographs while using the Hitachi TM4000 Plus.

## Data availability statement

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

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Area Editor: Dra. Thaís Almeida

Received on March 31, 2023. Accepted on May 30, 2023.



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