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Ferns and Lycophytes as new challenges

Ferns and Lycophytes of Pernambuco state, Brazil: *Serpocaulon* (Polypodiaceae)

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Abstract

In order to contribute to the study of the fern flora of the state of Pernambuco, we provide a synopsis of the genus *Serpocaulon* (Polypodiaceae) for Pernambuco. The three main herbaria in the state (IPA, PEUFR, and UFP) and herbaria of national reference (BHCB, RB, and SP) were visited, and online databases were consulted. Field expeditions were carried out in the different phytogeographic zones of the state. Descriptions, diagnostic illustrations, a key to species identification, taxonomic comments, and the geographic distribution of the species in the state are presented. Five species were recorded: *Serpocaulon catharinae*, *S. menisciifolium*, *S. polystichum*, *S. richardii*, and *S. triseriale*. They occur from sea level up to 1100 m. All species were recorded in Atlantic Forest, and *S. triseriale* was also found in Caatinga. The occurrence of *S. polystichum* and *S. richardii* in Pernambuco are being confirmed in this study. Additionally, the northern distribution limit of the species *S. catharinae* and *S. menisciifolium* is recorded in this state.

Key words: Northern distribution in the Atlantic Forest, Brejos de Altitude, unprotected pteridophytes, taxonomic synopsis.

Resumo

Em adição aos estudos da flora de samambaias do estado de Pernambuco, esta contribuição tem o objetivo de apresentar a sinopse do gênero *Serpocaulon* (Polypodiaceae) para este estado. Foram visitados os três principais herbários de Pernambuco (IPA, PEUFR e UFP), além de herbários de referência nacional (BHCB, RB e SP) e fizemos consulta a bases de dados online. Também realizamos expedições de campo nas diferentes zonas fitogeográficas do estado. Apresentamos as descrições e ilustrações diagnósticas, uma chave para identificação das espécies, além de comentários taxonômicos e a distribuição geográfica das espécies no estado. Registramos cinco espécies (*Serpocaulon catharinae*, *S. menisciifolium*, *S. polystichum*, *S. richardii* e *S. triseriale*), as quais habitam ao nível do mar até 1100 m. Todas as espécies estão registradas em áreas de Floresta Atlântica, sendo *S. triseriale* também encontrada em áreas de Caatinga. Confirmamos a ocorrência de *S. polystichum* e de *S. richardii* para Pernambuco. Além disso, neste estado, registrou-se o limite norte da distribuição das espécies *S. catharinae* e *S. menisciifolium*.

Palavras-chave: Brejos de Altitude, Distribuição Norte na Mata Atlântica, samambaias desprotegidas, sinopse taxonômica.

Introduction

Biodiversity knowledge should be the main argument for land-use planning (Newbold *et al.* 2015; King *et al*. 2021), remarking that biodiversity is the result of complex historical processes that shape species interactions and ecosystem functions (Tilman *et al*. 2014). However, taxonomic, ecological, and biogeographic investigations are still necessary to understand the environmental offer (Dasgupta 2021). In this sense, an accurate

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description of the flora as a constitutive element of the landscape is fundamental (Ulloa-Ulloa *et al*. 2017).

Due to its geographic conformation, with a long and narrow shape and extending from the coast to the interior of the continent, the state of Pernambuco has an interesting vegetational diversity. The vegetation types present in the state include coastal formations (such as Mangroves and "Restingas"), areas of Atlantic Forest, and vegetation types of semi-arid regions (such as "Caatinga" and Savanna) (Andrade Lima 2007). Remnants of Atlantic Forest are the most favorable for the establishment of ferns. The Northeastern Atlantic Forest (NAF), Atlantic Forest located to the north of the São Francisco River, includes two biogeographic regions: 1.) The Pernambuco Endemism Center, comprising the coastal forests and 2) "Brejos Nordestinos" or "Brejos de Altitude", which are high elevation forests in the Northeastern region of Brazil without connection with coastal forests (Silva & Casteleti 2003). The São Francisco River has been recognized as the limit of some species' distributions: some species occur in the South and Southwest of Brazil but are absent in the NAF, and others occur in the Amazon but do not reach the south and southeast portions of the NAF. Examples of this limit in the distribution range among ferns can be found in several species of Blechnaceae (Santiago *et al.* 2014), making thus the São Francisco River a natural barrier. The Caatinga domain of the state of Piauí at the west of NAF is another natural barrier. Thus, several biogeographic patterns are likely to be revealed by thorough studies of the biodiversity in the NAF.

Although fern diversity has been extensively studied in Pernambuco (Barros & Santiago 2007, 2010; Barros & Xavier 2007, 2009; Barros *et al.* 2006; Farias *et al.* 2017; Pereira *et al*. 2007, 2011; Pietrobom & Barros 2007; Santiago *et al*. 2004, 2014; Xavier & Barros 2003), the information and records of *Serpocaulon* species are still scarce.

In the list presented by Schwartsburd (2023) in the Flora e Funga do Brasil, the author mentions only two species of *Serpocaulon* from Pernambuco, and the possible occurrence of *Serpocaulon fraxinifolium* (Jacq.) A.R. Sm. Schwartsburd (2023) recognized *S. polystichum* as a synonym of *S. fraxinifolium*. In this respect, we agree with Sanín *et al*. (2023) at recognize both as different species, the former recorded in Pernambuco, and the latter a species hitherto not recorded in Brazil. However, Santiago *et al.* (2004) had already recorded four species of *Serpocaulon* previously included in *Polypodium* for Pernambuco. This demonstrates that the information about the genus is still to be clarified in the state.

Serpocaulon is composed of 37 species (Sanín *et al*. 2023) mostly occurring in the northern Andes (Sanín 2018), with a secondary center of diversity in the Brazilian Atlantic Forest (Labiak & Prado 2008; Schwartsburd & Smith 2013; Sanín *et al*. 2023).

With the objective of consolidating the knowledge of the fern and lycophyte flora of Pernambuco (Barros & Santiago 2007, 2010; Barros & Xavier 2007, 2009), we present a synopsis of the genus *Serpocaulon* (Polypodiaceae) for this state.

Material and Methods

This study was based on specimens deposited in the three main herbaria of Pernambuco (UFP, IPA, and PEUFR) and other reference collections in Brazil (BHCB, RB, and SP) (acronyms according to Thiers, continuously updated), and data from the databases Flora e Funga do Brasil 2023 (continuously updated), Specieslink (2023), and Tropicos (2023).

In the last decades, much effort has been made to increase the knowledge of ferns and lycophytes in Pernambuco through collections carried out in the four phytogeographic zones of the state: "Zona do Litoral", "Zona da Mata", "Zona das Caatingas", and "Zona das Savanas" (Andrade Lima 2007). In this study, we follow IBGE (2012) to describe the vegetation of the areas, namely, Mangroves and "Restinga" in the "Zona do Litoral"; variations of Seasonal and Ombrophilous Forests in the "Zona da Mata"; and variations of Steppe-Savanna in the "Zona das Caatinga" and "Zona das Savanas" (IBGE 2012; Andrade Lima 2007). We adopted the term "Brejo de Altitude" or "Brejos Nordestinos" (Andrade Lima 2007) for areas of Montane Seasonal Semideciduous Forest and of Montane Ombrophilous Dense Forest without connections with the coastal forest. This term has been widely used in the context of the northeastern Atlantic Forest and in some cases, "Brejos de Altitude" encompass areas of ecological tension (see Pôrto *et al.* 2004; Ferraz & Rodal 2006).

Morphological data from the analyzed herbarium specimens, field observations, and the literature (Rödl-Linder 1990; Lellinger 2002; Smith *et al.* 2006; Labiak & Prado 2008; Schwartsburd & Smith 2013; Sanín 2018; Sanín *et al*. 2023) were used to build an identification key with descriptions,

illustrations, field pictures, and comments for each species. Maps were prepared in ArcMAP version 10.4 (2023) using the coordinates of the collection sites of the specimens available in the data sources and when the coordinates were not available, they were inferred using the Google Maps geocoding service.

Results and Discussion

Five species of *Serpocaulon* were recorded in Pernambuco, distributed from 0 to 1,100 m in 23 (less than 12%) of the 185 municipalities of the state (Fig. 1). The genus was absent in the "Restinga" and Mangroves of the "Zona do Litoral"; was represented by only one species, *S. triseriale* (Sw.) A.R. Sm., in the "Zona das Caatingas"; and was represented by the five species in the "Zona da Mata", mostly in "Brejos de Altitude", which are therefore important areas for the study and conservation of the genus. The occurrence and comparatively high abundance of *Serpocaulon* in this phytogeographic zone is likely associated with the high number of studies conducted in the Atlantic Forest (Stehmann *et al.* 2009) and also the typically high humidity of these ecosystems (Sanín *et al*. 2023).

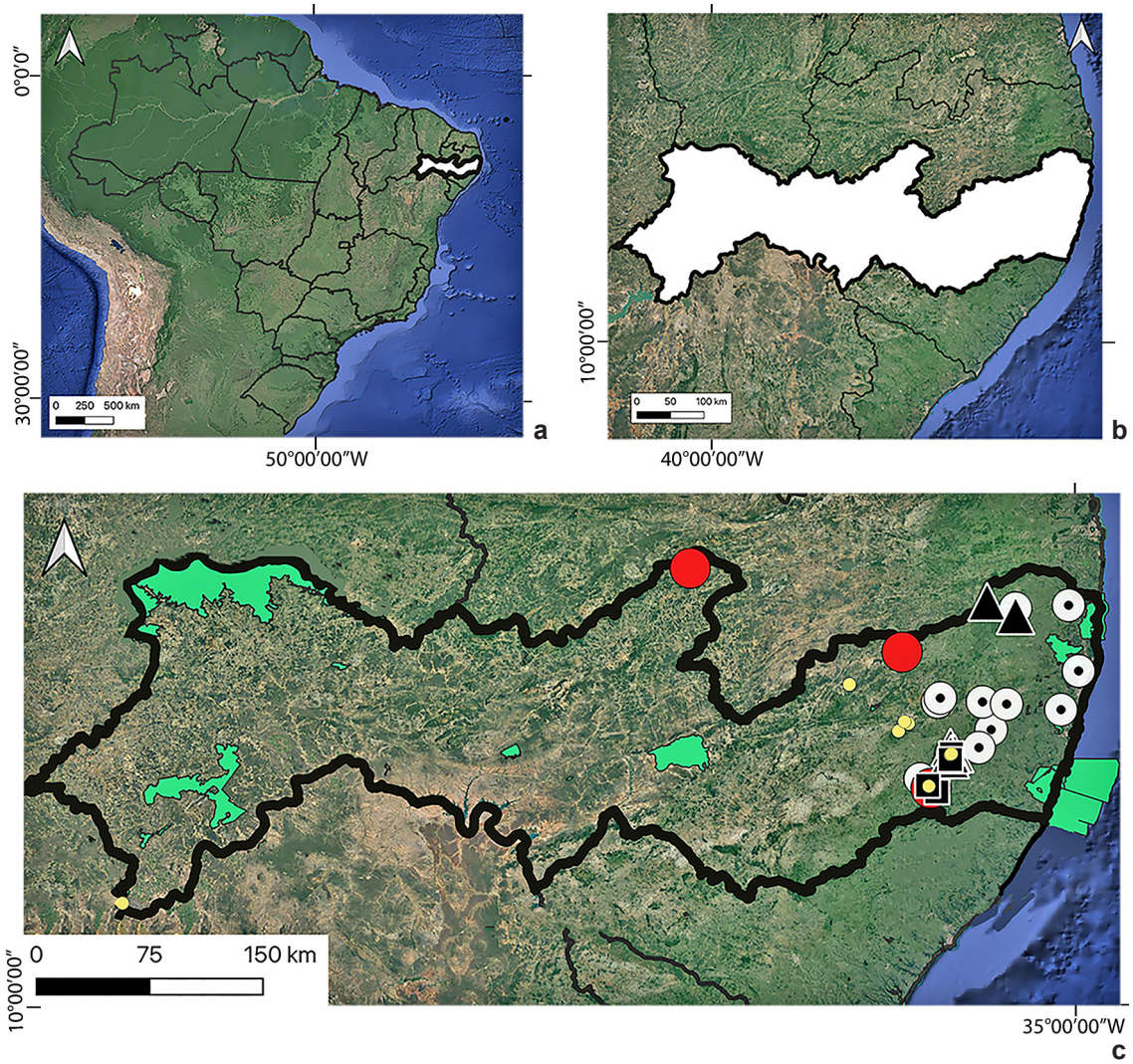

Figure 1 – Distribution of *Serpocaulon* species from Pernambuco state – a. location of Brazil in South America; b. silhouette of Pernambuco state; c. record of *Serpocaulon* species in relation to Federal protected areas (green shape). Yellow circle = *S. catharinae*; black square = *S. menisciifolium*; red circle = *S. polystichum*; full triangle = *S. richardii*; white dotted circle = *S. triseriale*.

Although *Serpocaulon triseriale* is the most widely distributed species of the genus (Smith *et al*. 2006; Sanín 2018; Sanín *et al.* 2023), it was present in only twelve of the 185 municipalities of the state and was not recorded in the west region of the state, where it was expected to occur (Xavier *et al*. 2012). The occurrence of *Serpocaulon attenuatum* (Humb. & Bonpl. *ex* Willd.) A.R. Sm. was also expected in Pernambuco state, because the species has been found in the neighboring states (Sanín *et al*. 2023).

In this study, we confirm the presence of *S. polystichum* in Pernambuco. This species was not reported from Brazil according to Smith *et al*. (2006). Schwartsburd (2023) considered *S. polystichum* as a synonym of *S. fraxinifolium*, but we agree with Smith *et al*. (2006) and Sanín *et al*. (2023) who consider them as two distinct species. Sanín *et al*. (2023) supported that specimens identified as *S. fraxinifolium* must represents *S. polystichum* in Brazil. Additionally, we report the occurrence of *S. richardii* in the state of Pernambuco. This species has been frequently identified in Brazil as *S. adnatum* (Kunze *ex* Klotzsch) A.R. Sm. (*e.g.*, Zuquim *et al*. 2008, 2009; Góes- Neto & Pietrobom 2012; Schwartsburd & Smith 2013). *S. adnatum* is an Andean species that also has a long-creeping rhizome, pinnate laminae, and adnate pinnae at the apex (Sanín *et al*. 2023).

The species *Serpocaulon catharinae* and *S. menisciifolium* presents their northernmost distribution limit in Pernambuco (Fig. 1). This information is important for the conservation of these species because specimens at the boundaries of the species distribution range are key for population genetic studies (Barbosa *et al*. 2012).

None of the five species of *Serpocaulon* found in Pernambuco occur within sustainable use or integral protection federal conservation units (CUs). However, they occur in privately managed areas, such the Frei Caneca Private Natural Heritage Reserve (RPPN) (in the municipality of Jaqueira) and Pedra D'antas RPP (Lagoa dos Gatos) both sustainable use CUs; state-managed areas such as the Matas do Siriji Wildlife Refuge (RVS) (São Vicente Férrer) and Dois Irmãos State Park (Recife), both integral protection CUs and the Serras e Brejos do Capibaribe Environmental Protection Area (APA) (Brejo da Madre de Deus and Taquaritinga do Norte) a sustainable use CU. The Atlantic Forest in Pernambuco has been currently reduced to less than 2% of its original cover (Capobianco 2001) and most of the remnants are still vulnerable to anthropic pressure (Santiago, personal observation).

Serpocaulon A.R. Sm. Taxon 55(4): 928. 2006. Figs. 1-4

Epiphytic and terrestrial, rhizomes short (phyllopodia < 2 times the rhizome width apart) to long-creeping (phyllopodia 2 or more times the rhizome width apart), pruinose or not, rhizome scales clathrate, dense or scattered, patent, lanceolate to subulate, bicolorous or concolorous, dark brown to reddish, pale or iridescent, rounded base and acuminate to long tapering apex. Laminae pinnate or pinnatisect, when pinnate 5–15 pairs of pinnae, when pinnatisect 28–44 pairs of segments, linear to ovate-lanceolate, papyraceous to coriaceous, proximally reflexed, distally gradually tapering (*S. catharinae*) or with a conform pinna apex, base of the pinna or segments decurrent, sessile to adnate (*S. richardii* and rarely *S. triseriale*), glabrous to densely pubescent (in juvenile specimens of *S. menisciifolium* and *S. richardii*), venation regularly anastomosing (goniophlebioid) with individual chevron-shaped areoles and each with a single, free, included excurrent veinlet, 1–5 rows of sori between the costa and the pinnae or segments margins.

Key for species of *Serpocaulon* in Pernambuco

1. Laminae pinnatisect ..... 1. *Serpocaulon catharinae*
1'. Laminae pinnate 2
2. Rhizome scales subulate with reflexed apex ..... 4. *Serpocaulon richardii*
2'. Rhizome scales lanceolate with straight apex 3
3. Rhizome long-creeping ..... 3. *Serpocaulon polystichum*
3'. Rhizome short-creeping 4
4. Rhizome scales bicolorous, middle pinnae adnate ..... 2. *Serpocaulon menisciifolium*
4'. Rhizome scales concolorous, middle pinnae sessile ..... 5. *Serpocaulon triseriale*

1. *Serpocaulon catharinae* (Langsd. & Fisch.) A.R. Sm. Taxon 55(4): 928. 2006. *Polypodium catharinae* Langsd. & Fisch. Pl. Voy. Russes Monde 9, pl. 9. 1810. Type: BRAZIL. Insula Catharinae, *G.H. Langsdorff 12* (lectotype, designated by Hensen [1990: 292], LE [bc] 00000033 image!).

Figs. 1, 2a, 3a, 4a

Epiphytic, rhizome short-creeping, pruinose; scales patent, subulate, disperse, bicolorous, brown whitish to the margin, dark brown to the center, opaque, base rounded, apex long acuminate and reflexed. Laminae pinnatisect, linear, base truncate, apex gradually tapering; segments 28–44 pairs, chartaceous, glabrous, base decurrent, apex rounded; sori 1 row between the costa and the segment margin.

Examined material: Amaraji, Engenho Animoso, 25.VI.1999, *I. Fernandes 1451* (JPB). Bonito, Mata da Reserva Biológica Municipal, 08º30'30.5"S, 35º43'18.2"W, 750–800 m, 11.VII.2000, *A. Santiago 222* (PEUFR). Caruaru, aprox. 450 m, 10.IX.1971, *Andrade-Lima 71-6724* (IPA); Mata do Brejo dos Cavalos, 16.VII.1988, *I.C.L. Barros 1988* (PEUFR); Brejo dos Cavalos, 1,100 m, 08º18'36"S, 36º00'00"W, 3.VIII.1995, *M.R.C. Sales de Melo 143* (PEUFR). Jaqueira/Lagoa dos Gatos, Serra do Urubu, trilha do Mosquito, 672 m, 08º42'2"S, 35º51'10"W, 3.XII.2014, *L.S.B. Calazans 467* (BHCB); Mata da Colônia, 800 m, 08º30'14"S, 35º42'56"W, 800 m, 29.XI.2000, *A. Santiago & M. Pietrobom-Silva 343* (PEUFR). Maraial/Lagoa dos Gatos, Serra do Urubú, 19.IV.1994, *A.M. Miranda 1538* (PEUFR). Tapera, Mata do Toró, 3.III.1974, 50 m, *I. Pontual 74-1271* (PACA-AGP).

The species is registered in Lowland Semideciduous Seasonal Forest; Lowland, Submontane, and Montane Ombrophilous Dense Forest; "Brejos de Altitude", 50–1,100 m.

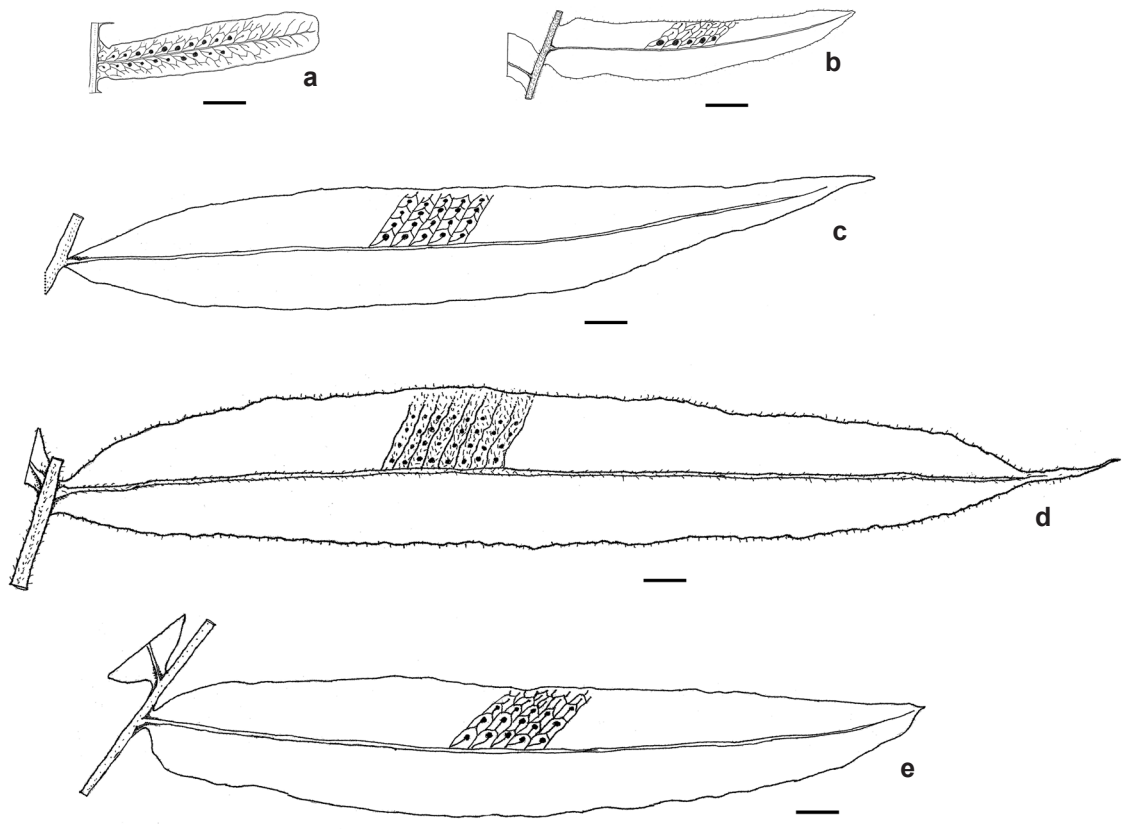

Figure 2 – Pinnae/segments of *Serpocaulon* species from Pernambuco state – a. segment of *S. catharinae* with rounded/truncate apex; b. pinna of *S. menisciifolium* showing pubescence and one row of sori; c. segment of *S. polystichum* with four rows of areoles and sori; d. pinna of *S. richardii* showing pubescence and four rows of sori; e. pinna of *S. triseriale* with four rows of areoles and tree of sori. [a. *D. Sanín & A. Santiago 4194* (BHCB); b. *I.C.L. Barros 36 et al.* (PEUFR); c. *D. Sanín & A. Santiago 4197* (BHCB); d. *D. Sanín & Santiago 7267* (BHCB); e. *D. Sanín & A. Santiago 4195* (BHCB)]. Scale bars = 1 cm.

Serpocaulon catharinae is widely distributed species in Brazil (Labiak & Prado 2008). Specimens from the NAF present narrow laminae with several segments.

Hensen (1990) designate a lectotype from LE without link to any specific herbarium specimen. After revising the protologue (Langsdorff & Fisch 1810, Fig. 9) and comparing the digital specimens at LE, where three plants are found in the same sheet, Sanín *et al*. (2023) found that the line drawing in the protologue matches the right-corner plant of the specimen *L. Langsdorff 12* (LE) in size, shape, number of segments, and sori in the middle pinna. Since Langsdorff & Fisch (1810) did not associate this name with any specific collection, Sanín *et al*. (2023) designate the specimen *L. Langsdorff 12* (LE) as the lectotype of this species.

2. *Serpocaulon menisciifolium* (Langsd. & Fisch.) A.R. Sm. Taxon 55(4): 928. 2006. *Polypodium menisciifolium* Langsd. & Fisch. Pl. Voy. Russes Monde 11, pl. 12. 1810. Type: BRAZIL. "Insula St. Catharina", *G.H. Langsdorff 15* (lectotype, designated by Hensen [1990: 304], LE [bc] 00000044 image!).

Serpocaulon hirsutulum (T. Moore) Schwartsb. & A.R. Sm., J. Bot. Res. Ins. Texas 7(1): 90. 2013. *Polypodium hirsutulum* T. Moore, Index. Fil. (T. Moore) 390. 1862, *nom. nov.* for *Polypodium hirsutulum* Raddi, Pl. Bras. Nov. Gen. 21, t 29, fig 2. 1825, *nom. illeg.* (non G. Forst 1786). Type: BRAZIL. "Super palmarum annosarum truncus inviciniis Urbis Rio-Janeiro" [On trunk of aged palms in the vicinity of the city of Rio de Janeiro], Nov 1817-May 1818, *Raddi* s.n. (lectotype, designated by Schwartsburd & Smith, [2013: 88], PI [bc] 010870 image!). Figs. 1, 2b, 3b, 4b

Epiphytic, rhizome short-creeping; scales patent, ovate-lanceolate, densely covering the rhizome, bicolorous, reddish, iridescent, brown to the center and dark brown to the margin, base rounded, apex acute-acuminate. Laminae pinnate, lanceolate, base truncate, apex conform; pinnae 12–13 pairs, chartaceous, rarely coriaceous, densely pubescent, base adnate, acroscopically softly auriculate, apex acute; sori 1–2 rows between the costa and pinna margin.

Examined material: Bonito, Mata da Colonia, 800 m, 08º30'14"S, 35º42'56"W, 19.VI.1998, *I.C.L. Barros et al.* (PEUFR); Mata da Chuva, 750 m, 08º32'20.8"S, 35º43'22.3"W, 7.V.1999, *I.C.L. Barros et al.* (PEUFR). Jaqueira, Usina Colônia, Mata do Ageró, 415 m, 18.X.2001, *M.S. Lopes & M.R.S. Pietrobom 404* (RB). Lagoa dos Gatos, RPPN Pedra D'antas, *R.P. Farias et al. 150* (UFP). Maraial/Lagoa dos Gatos, Serra do Urubu, 22.V.1998, *I.C.L. Barros 36 et al.* (PEUFR).

These records represent the northernmost limit of the species distribution range. The species is registered in Submontane and Montane Ombrophilous Dense Forest, and "Brejos de Altitude", 415–800 m.

Serpocaulon hirsutulum (Raddi) Schwartsb. & A.R. Sm. was segregated from *S. menisciifolium* by Schwartsburd & Smith (2013) suggesting that small plants with densely pubescent laminae characterize this taxon. However, we agree with Brade (1951) and Hensen (1990) that proposed *P. hirsutulum* Raddi as a synonym of *P. meniscifolium* (= *S. menisciifolium*) by observed that the presence of pubescence is related with the age of the plants.

3. *Serpocaulon polystichum* (Link) A.R. Sm. Taxon 55(4): 928. 2006. *Polypodium polystichum* Link, Hort. Berol. 2: 101. 1833. Type: BRAZIL. (Cult. in bot. gard. at Berlin), *J.H.F. Link s.n.* (Lectotype, designated by Hensen [1990: 297], B [bc] 200163713 image!). Figs. 1, 2c, 3c, 4c

Epiphytic or terrestrial, rhizome long-creeping; scales patent, ovate-lanceolate, scarcely covering the rhizome, bicolorous, brown to the margin, dark brown to the center, opaque, base rounded, apex acuminate to long acuminate and patent to rarely reflexed. Laminae pinnate, ovate-lanceolate, base truncate, apex conform; pinnae 9–10 pairs, chartaceous, glabrous, proximally sessile to softly adnate apically, base decurrent, apex acuminate; sori 2–4 rows between the costa and pinna margin, non-impressed.

Examined material: Jaqueira, Usina Colônia, Serra do Quengo, 713 m, 08º42'50.4"S, 35º50'25.8"W, 3.IV.2002, *M.S. Lopes & M.R.S. Pietrobom 529* (UFP). Taquaritinga do Norte, Sítio Cafundó, 10.I.1977, *I. Pontal 77-1438* (PEUFR); alto da serra ou Engenho Brejinho, 21.XI.1977, *Andrade-Lima 77-8321* (IPA).

The species is registered in Montane Ombrophilous Dense Forest and "Brejos de Altitude", at 713 m.

Serpocaulon polystichum has been frequently confounded in Brazil with *S. fraxinifolium* (Labiak & Prado 2008; Schwartsburd & Smith 2013; Sanín *et al.* 2023), an Andean species described based on a cultivated specimen from Schönbrunn, Austria, but collected in Venezuela (Hensen 1990). Like *S. polystichum*, *S. fraxinifolium* has long-creeping rhizomes and pinnate laminae. However, *S. polystichum* can be distinguished from *S. fraxinifolium* by its patent rhizome scales (*vs.*

appressed) and non-impressed sori at the adaxial surface of the pinnae (*vs.* impressed).

4. *Serpocaulon richardii* (Klotzsch) A.R. Sm. Taxon 55(4): 929. 2006. *Polypodium richardii* Klotzsch, Linnaea 20: 394. 1847. Type: ENGLISH GUYANA. *R. Schomburgk 1651* (lectotype, designated by Hensen [1990: 306], B, isotype frag. NY).

Figs. 1, 2d, 3d-f, 4d

Epiphytic or terrestrial, rhizome long-creeping; scales patent, subulate, scarcely covering the rhizome, bicolorous, brown to the margin, reddish to the center, opaque, base rounded, apex long linear tapering, reflexed. Laminae pinnate, ovate-lanceolate, base truncate, apex conform; pinnae 4–7(–9) pairs, papyraceous to rarely chartaceous, densely pubescent, base barely sessile to completely adnate, apex long acuminate; sori (1–)3–5 rows between the costa and pinna margin.

Examined material: Bonito, margem estrada para Camocim, 21.I.1970, *Andrade-Lima 70-5657* (IPA); Reserva Biológica, 21.XI.1994, *L.P. Felix 7003* (PEUFR);

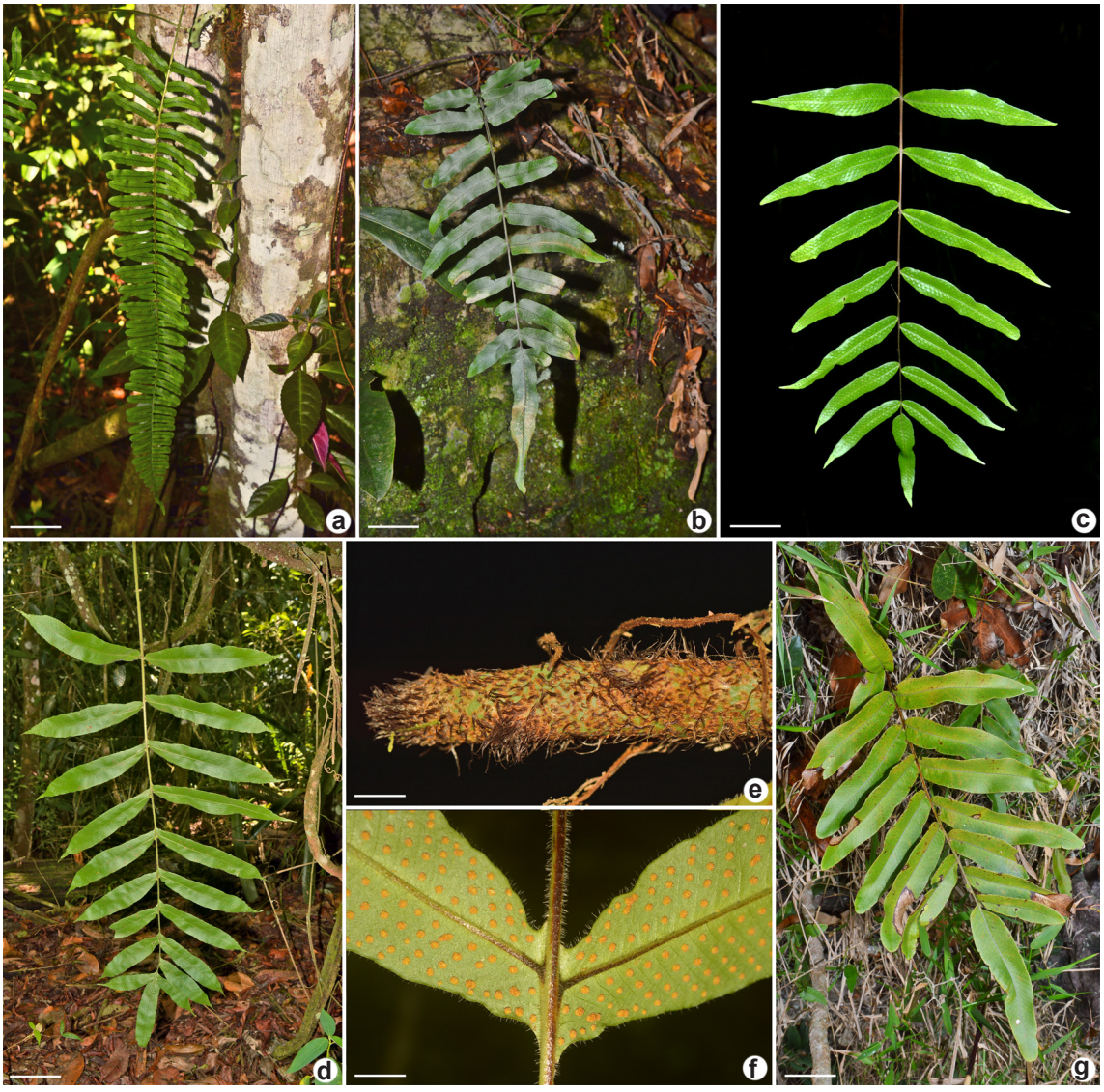

Figure 3 – a-g. Field pictures of *Serpocaulon* species from Pernambuco state – a. *S. catharinae*; b. *S. menisciifolium*; c. *S. polystichum*; d-f. *S. richardii* – d. lamina; e. apex rhizome; f. adnate pinna; g. *S. triseriale*. [a. *D. Sanín & A. Santiago 4194* (BHCB); b. *D. Sanín & A. Santiago* (BHCB); c. *D. Sanín & A. Santiago 4197* (BHCB); d-f. *D. Sanín & A. Santiago 7267* (BHCB); g. *D. Sanín & A. Santiago 7267* (BHCB)].

Mata da Azuada, relitos a mao dereita deçendo, 709 m, 08º30'8.6"S, 35º41'49.9"W, 16.III.2019, *D. Sanín & A. Santiago 7267* (BHCB); Mata da Colônia, 800 m, 08º30'14"S, 35º42'56"W, 14.VII.2000, *A. Santiago 218* (PEUFR); Mata da Chuva, 750 m, 08º32'20"S, 35º43'22"W, 8.V.2001, *A. Santiago & M.R. Pietrobom-Silva 453* (PEUFR); Mata da Reserva Biológica municipal de Bonito, 750-800 m, 08º30'30"S, 35º43'18"W, 19.V.2000, *A. Santiago et al. 149* (PEUFR). São Vicente Ferrer, Complexo do Maciço Serra do Mascarcenhas, Mata do Estado, 640 m, 07º35'00"S, 35º30'00"W, 20.IV.1998, *M.R. Pietrobom-Silva 4229* (PEUFR). Vicência, 8.VII.1974, *I. Pontual* (PEUFR).

The species is registered mainly in "Brejos de Altitude", but it is also recorded in Submontane Ombrophilous Dense Forest, 480–800 m.

This species has been frequently misidentified in Brazil as *S. adnatum* (Smith *et al*. 2006; Zuquim *et al*. 2008, 2009; Coelho & Esteves 2011; Góes-Neto & Pietrobom 2012; Schwartsburd 2023), an Andean species distributed from Colombia and Venezuela to Peru (Sanín *et al*. 2023). Smith *et al*. (2006) suggested the occurrence of *S. richardii* in Brazil. In a later work, Brazil was not mentioned by Smith *et al*. (2018) in the distribution range of the species. By his part, Schwartsburd & Smith (2013) suggested that Brazilian plants identified as *S. adnatum* should be better referred to as *S. richardii*, but they did not cite any specific collection to exemplify this assertion. Later, Schwartsburd (2023) reinforced the occurrence of *S. richardii* in Brazil, but did not cite specimens from Pernambuco.

Serpocaulon richardii has long-creeping rhizomes and pinnate laminae with distally adnate pinnae, as does *S. adnatum*. However, it can be distinguished from *S. adnatum* by the subulate rhizome scales with reflexed apex (*vs*. ovate rhizome scales and appressed apex), and densely pubescent laminae (*vs*. glabrous). *Serpocaulon richardii* can also be confounded with *S. psychotrium* Mostacero, D. Sanín & A.R. Sm. because they share long-creeping rhizomes with subulate scales and pinnate laminae with distally adnate pinnae, but *S. richardii* can be distinguished from *S. psychotrium* by the densely pubescent laminae (*vs.* glabrous laminae) and the papyraceous to chartaceous laminae with non-impressed sori (*vs.* chartaceous laminae with impressed sori).

Serpocaulon richardii presents its southernmost distribution in Pernambuco and Bahia states (Sanín *et al*. 2023).

5. *Serpocaulon triseriale* (Sw.) A.R. Sm., Taxon 55(4): 929. 2006. *Polypodium triseriale* Sw. J. Bot. (Schrader) 2: 26. 1800 [1801]. *Goniophlebium triseriale* (Sw.) Wherry. Amer. Fern. J. 54(3): 144. 1964. Type: WEST INDIES. *Anonym s.n.* (lectotype designated by Sanín *et al.* [2023: 432], UPS [bc] 24589 image!). Figs. 1; 2e; 3g; 4e

Figure 4 – a-e. Rhizome scales from *Serpocaulon* species from Pernambuco state – a. subulate scale of *S. catharinae*; b. wide ovate-lanceolate scale of *S. menisciifolium*; c. narrow ovate-lanceolate scale of *S. polystichum*; d. subulate scale of *S. richardii*; e. lanceolate scale of *S. triseriale*. [a. *D. Sanín & A. Santiago 4194* (BHCB); b. *I.C.L. Barros 36 et al.* (PEUFR); c. *D. Sanín & A. Santiago 4197* (BHCB); d. *D. Sanín & Santiago 7267* (BHCB); e. *D. Sanín & A. Santiago 7267* (BHCB)].

Epiphytic or terrestrial, rhizome short-creeping; scales patent, lanceolate, densely covering the rhizome, concolorous, light brown, opaque, base rounded, apex narrowly acute-acuminate. Laminae pinnate, ovate-lanceolate, base truncate, apex conform; pinnae (5–)7–9(–15) pairs, coriaceous to rarely chartaceous, glabrous, base barely sessile to barely adnate, apex acute to acuminate; sori (1–)2–3(–5) rows between the costa and pinna margin.

Examined material: Amaraji, Matas do Engenho Animoso, 2.XII.1999, *C.P.L. Luna et al. 21* (UFP). Bezerros, Parque Municipal de Serra Negra, 2.VI.1995, *M.R.C. Sales de Melo 63* (PEUFR); Pedra Pintada, Serra Negra de Bezerros, 800 m, 08º10'S, 35º47'W, 13.VIII.1999, *L. Krause & A. Liebig 33* (PEUFR). Bonito, Mata da Chuva, 750 m, 08º32'20"S, 35º43'22"W, 19.V.2000, *A. Santiago et al. 166* (PEUFR); Mata da Reserva Biológica Municipal de Bonito, 750-800 m, 08º30'30"S, 35º43'18"W, 10.V.2000, *A. Santiago et al. 149* (PEUFR); Mata da Colônia, 800 m, 08º30'14"S, 35º42'56"W, 19.V.2000, *A. Santiago et al. 148* (PEUFR). Cabo de Santo Agostinho, Reserva de Gurjaú, VIII.1991, *K. Duarte* (UFP). Cortez, 10.XI.1974, *Andrade-Lima* (IPA). Goiana, Eng. Itapirema do Meio, 12.X.1966, *Andrade-Lima 66-4728* (IPA). Gravatá, Fazenda Harmonia, 10.X.1970, *Andrade-Lima 70-6043* (IPA). Jaqueira, Usina, Colônia (Ageró), 415 m, 08º44'27"S, 35º50'37"W, 20.V.2002, *M.S. Lopes & M.R.S. Pietrobom 613* (UFP). Brejo da Madre de Deus, Biruti Grande, Mata do Biturizinho, 1,000 m, 15.IX.1992, *K.M.R. Santos* (PEUFR). Maraial, Lagoa dos Gatos, Serra do Urubú, 22.V.1998, *I.C.L. Barros 34* (PEUFR). Recife, Várzea, mata de São João, 11.V.2001, *M.D. Santos et al. 5* (PEUFR); Dois Irmãos, área do Açude do Prata, Jardim Zoobotânico, 1983, 20 m, *A Souto 04* (UFP). Vicência, Engenho Jundiá, Mata do Engenho Jundiá, 487 m, 07º37'20"S, 35º19'40"W, 5.III.2002, *A.M.R. Carvalho et al. 55* (UFP). Tacaratu, Serra do Morcego, 835 m, 04º18'80"S, 38º7'35"W, 15.III.2011, *J.A. Siqueira-Filho 2468* (HVASF).

This is the most widely distributed species of the genus (Smith *et al*. 2006; Sanín *et al.* 2023). It is recorded in all forest formations and "Caatinga" (Steppe-Savanna) of Pernambuco, 0–1,000 m.

Serpocaulon triseriale is found in several herbaria of Brazil as *Polypodium brasiliense* Poir., a synonym of *S. triseriale* (Smith *et al*. 2006; Sanín *et al.* 2023).

Serpocaulon triseriale can be confused with *S. rex* Schwartsb. & A.R. Sm. and *S. attenuatum* due to the impressed venation and lanceolate and patent rhizome scales. However, it is distinguished from *S. rex* by its short-creeping rhizome, 1–4 rows of sori between the costa and the margin, smooth margin of the pinnae, and flat and connected verrucae ornamentation of the spore (*vs.* long-creeping rhizome, 4–6 rows of sori between the costa and the margin, crenate margin of the pinnae, and prominent and not connected verrucae ornamentation of the spore) (Sanín *et al*. 2019). On the other hand, *S. triseriale* can be distinguished from *S. attenuatum* by its pinnate laminae with 1–4 rows of sori between the costa and the margin (vs. pinnatisect laminae and 1–2 rows of sori between the costa and the margin) (Sanín *et al*. 2019).

Serpocaulon triseriale has been registered in Pernambuco around roots of *Vriesea procera* Mez (*Andrade-Lima 66-4728*, IPA), and as an epiphyte on palm trees (*E.S. Santana 87*, PEUFR).

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Data availability statement

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

References

Andrade Lima D (2007) Estudos fitogeográficos de Pernambuco. Anais da Academia Pernambucana de Ciência Agronômica 4: 243-274.

ArcMAP version 10.4 (2023) ArcGis 10.4, Release 10. Environmental Systems Research Institute, Redlands. Available at <https://www.arcgis.com/index.html>. Access on 01 Jun 2023.

Barbosa AR, Fiorini CF, Silva-Pereira V, Mello-Silva R & Borba EL (2012) Geographical genetic structuring and phenotypic variation in the *Vellozia hirsuta* (Velloziaceae) ochlospecies complex. American Journal of Botany 99: 1477-1488.

Barros ICL & Santiago ACP (2007) Samambaias e licófitas do estado de Pernambuco, Brasil: Psilotaceae. Bradea 12: 17-23.

Barros ICL & Santiago ACP (2010) Samambaias e licófitas do estado de Pernambuco, Brasil: Metaxyaceae. Biotemas 23: 215-218.

Barros ICL & Xavier SRS (2007) Samambaias e licófitas do estado de Pernambuco, Brasil: Salviniaceae. Revista Brasileira de Biociências 5: 246-248.

Barros ICL & Xavier SRS (2009) Samambaias e licófitas do estado de Pernambuco, Brasil: Gleicheniaceae. Bradea 14: 11-20.

Barros ICL, Santiago ACP, Pereira AFN & Pietrobom MR (2006) Pteridófitas. *In*: Pôrto K, Almeida-Cortez J & Tabarelli M (orgs.) Diversidade biológica e conservação da Floresta Atlântica ao Norte do Rio São Francisco. Ministério do Meio Ambiente, Brasília. Pp. 147-171.

Brade AC (1951) Filices novae Brasilienses VII. Arquivos do Jardim Botánico do Rio de Janeiro 11: 21-36.

Capobianco JPR (2001) Dossiê Mata Atlântica 2001: Projeto Monitoramento Participativo da Mata Atlântica. Instituto Socioambiental, Rede de ONGs da Mata Atlântica, Sociedade Nordestina de Ecologia. São Paulo. 407p.

Coelho CB & Esteves LM (2011) Spore morphology of *Serpocaulon* A.R. Sm. and related taxa from Brazil (Polypodiaceae). Grana 50: 165-18.

Dasgupta P (2021) The economics of biodiversity: the Dasgupta review. HM Treasury, London. 604p.

Farias R, Silva I, Pereira AF, Santiago A & Barros I (2017) Inventory of Ferns and Lycophytes of the RPPN Pedra D'Antas, Pernambuco state, northeastern Brazil. Biota Neotropica 17: e20170364.

Ferraz EMN & Rodal MJN (2006) Caracterização fisionômica - estrutural de um remanescente de floresta ombrófila montana de Pernambuco, Brasil. Acta Botanica Brasilica 20: 911-926.

Flora e Funga do Brasil 2023 (continuously updated) Jardim Botânico do Rio de Janeiro. Available at <http://floradobrasil.jbrj.gov.br/>. Access on 19 May 2023.

Góes-Neto LAA & Pietrobom MR (2012) Novos registros de samambaias para a Amazônia Brasileira. Rodriguésia 63: 1151-1155.

Hensen RV (1990) Revision of the *Polypodium loriceum*-complex. Nova Hedwigia 50: 279-236.

IBGE (2012) Manual técnico da vegetação brasileira. Manuais técnicos em geociências. Instituto Brasileiro de Geografia e Estatística - IBGE, Rio de Janeiro. 78p.

King S, Vardon M, Grantham H, Eigenraam M, Ferrier S, Juhn D, Larsen T, Brown C & Turner K (2021) Linking biodiversity into national economic accounting. Environmental Science & Policy 116: 20-29.

Klotzsch JF (1847) Flora der Aequinoctial-Gegenden der neuen Welt. FIlices. Linnaea 20: 394-445.

Labiak P & Prado J (2008) New combinations in *Serpocaulon* and a provisional key for the Atlantic Rain Forest species. American Fern Journal 98: 139-159.

Langsdorff L & Fisch F (1810) Plantes recueillies pendant le voyage des Russes autor do monde. Expédition dirigée par M. de Krusenstern. A Tubingue & Chez J.G. Cotta, Libraire. Tübingen. 26p.

Lellinger DB (2002) A modern multilingual glossary for taxonomic pteridology. Pteridologia 3. American Fern Society, Washington. 264p.

Link HF (1833) Hortus regius botanicus Berolinensis. Tomus II. G. Reimer, Berlin. 376p.

Newbold T, Hudson LN, Hill SLL, Contu S, Lysenko I, Senior RA, Börger L, Bennett DJ, Choimes A, Collen B, Day J, De Palma A, Díaz S, Echeverria-Londoño S, Edgar MJ, Feldman A, Garon M, Harrison MLK, Alhusseini T, Ingram DJ, Itescu Y, Kattge J, Kemp V, Kirkpatrick L, Kleyer M, Laginha Pinto Correia D, Martin CD, Meiri S, Novosolov M, Pan Y, Phillips HRP, Purves DW, Robinson A, Simpson J, Tuck SL, Weiher E, White HJ, Ewers RM, Mace GM, Scharlemann JPW & Purvis A (2015) Global effects of land use on local terrestrial biodiversity. Nature 520: 45-50.

Pereira AFN, Barros ICL, Xavier SRS & Santiago ACP (2007) Composição florística e ecologia da pteridoflora de fragmentos de Floresta Atlântica (Reserva Ecológica de Gurjaú, Cabo de Santo Agostinho, Pernambuco, Brasil). Revista Brasileira de Biociências 5: 489-491.

Pereira AFN, Barros ICL, Santiago ACP & Silva IAA (2011) Florística e distribuição geográfica das samambaias e licófitas da Reserva Ecológica de Gurjaú, Pernambuco, Brasil. Rodriguésia 62: 1-10.

Pietrobom MR & Barros ICL (2007) Pteridoflora do Engenho Água Azul, município de Timbaúba, Pernambuco, Brasil. Rodriguésia 58: 85-94.

Pôrto KC, Cabral JJP & Tabarelli M (2004) Brejos de Altitude em Pernambuco e Paraíba, História. Natural, Ecologia e Conservação, Ministério do Meio Ambiente, Brasília. 324p.

Raddi G (1825) Plantarum brasiliensium nova genera et species novae, vel minus cognitae. Pars I / collegit, et descripsit Iosephus Raddius. A. Pezzati, Florence. 101p.

Rödl-Linder G (1990) Monograph of the genus *Goniophlebium*. Blumea 34: 277-423.

Sanín D (2018) *Serpocaulon* (Polypodiaceae), Flora de Colombia. Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogotá. 135p.

Sanín D, Martínez OG & Salino A (2019) New record of *Serpocaulon triseriale* (Sw.) A.R. Sm. (Polypodiaceae) in Argentina, with morphological comparison of relatives. Check List 15: 175-180.

Sanín D, Salino A & Smith AR (2023) Taxonomic revision of *Serpocaulon* (Polypodiaceae). Annals of the Missouri Botanical Garden 108: 288-464.

Santiago ACP, Barros ICL & Sylvestre LS (2004) Pteridófitas ocorrentes em três fragmentos florestais de um brejo de altitude (Bonito, Pernambuco, Brasil). Acta Botanica Brasilica 18: 781-792.

Santiago ACP, Barros ICL & Dittrich VAO (2014) Samambaias e licófitas do estado de Pernambuco, Brasil: Blechnaceae. Rodriguésia 65: 861-869.

Schwartsburd PB (2023) *Serpocaulon* in Flora e Funga do Brasil. Jardim Botânico do Rio de Janeiro. Available at <https://floradobrasil.jbrj.gov.br/FB91745>. Access on 10 October 2023.

Schwartsburd P & Smith AR (2013) Novelties in *Serpocaulon* (Polypodiaceae). Journal of the Botanic Research Institute of Texas 7: 85-93.

Silva JMC & Casteleti CHM (2003) Status of the biodiversity of the Atlantic Forest of Brazil. Pp. 22-28. *In*: In Galindo-Leal C & Câmara IG (eds.) The Atlantic Forest of South America: biodiversity status, trends, and outlook. Center for Applied Biodiversity Science and Island Press, Washington D.C. Pp. 43-59.

Smith AR, Kreier HP, Haulfler CH, Ranker TA & Schneider H (2006) *Serpocaulon*, a new genus segregated from *Polypodium*. Taxon 55: 919-930.

Smith AR, Kessler M, León B, Almeida TE, Jiménez-Perez I & Lehnert M (2018) Prodromus of a fern flora for Bolivia. XL. Polypodiaceae. Phytotaxa 354: 1-67.

SpeciesLink network (2023)Available at <https://specieslink.net>. Access on 19 May 2023.

Stehmann K, Forzza RC, Salino A, Sobral M, Costa DP & Kamino LHY (2009) Diversidade taxonômica na Floresta Atlântica. Plantas da Floresta Atlântica. Jardim Botânico do Rio de Janeiro, Rio de Janeiro. Pp. 3-12.

Swartz OP (1800) Genera et species filicum ordine systematico redactarum. Journal für die Botanik 2: 1-136.

Thiers B (continuously updated) Index Herbariorum: a global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. Available at <http://sweetgum.nybg.org/science/ih/>. Access on 28 January 2023.

Tilman D, Isbell F & Cowles JM (2014) Biodiversity and ecosystem functioning. Annual Review of Ecology, Evolution and Systematics 45: 471-493.

Tropicos (2023) Missouri Botanical Garden. Available at <https://tropicos.org/name/100527987>. Access on 19 May 2023.

Ulloa-Ulloa C, Acevedo-Rodríguez P, Beck S, Belgrano MJ, Bernal R, Berry PE, Brako L, Celis M, Davidse G, Forzza RC, Gradstein SR, Hokche O, León B, León-Yánez S, Magill RE, Neill DA, Nee M, Raven PH, Stimmel H, Strong MT, Villaseñor JL, Zarucchi JL, Zuloaga FO & Jørgensen PM (2017) An integrated assessment of vascular plant species of the Americas. Science 358: 1614-1617.

Wherry ET (1964) Some new combinations for Southeaster ferns. American Fern Journal 54: 143-146.

Xavier SRS & Barros ICL (2003) Pteridófitas ocorrentes em fragmentos de floresta serrana no estado de Pernambuco, Brasil. Rodriguésia 54: 13-21.

Xavier SRS, Barros ICL & Santiago ACP (2012) Ferns and lycophytes in Brazil's semi-arid region. Rodriguésia 63: 483-488.

Zuquim G, Costa FRC, Prado J & Tuomisto H (2008) Ferns and lycophytes of Rebio Uatumá, Central Amazonia. Áttema Design Ed. Ltda, Manaus. 316p.

Zuquim G, Costa FRC & Prado J (2009) An annotated checklist of ferns and lycophytes from the Biological Reserve of Uatuma, an area with patches of rich-soils in central Amazonia, Brazil. Fern Gazette 18: 286-30.

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