

RESEARCH ARTICLE

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## NEW OCCURRENCES OF *SCHIZAEACEAE* FOR THE MARANHÃO AND BRAZILIAN CERRADO

<sup>1</sup>Domingos Lucas dos Santos-Silva,<sup>2</sup>Gustavo da Silva Gomes,<sup>3</sup>Guilherme Sousa da Silva,<sup>4</sup>Ronison Ferreira Oliveira,<sup>4</sup>Paula Regina Pereira Martins,<sup>4</sup>Dominga Hosanira Silva de Sousa,<sup>5</sup>Maria de Fátima Veras Araújo and <sup>6</sup>Gonçalo Mendes da Conceição

<sup>1</sup>Postgraduate Program in Ecology and Conservation at the State University of Mato Grosso, Campus Nova Xavantina, Brazil

<sup>2</sup>Academic of the Biological Sciences Course, State University of Maranhão/UEMA, Caxias/MA, Brazil

<sup>3</sup>Master by the Postgraduate Program in Botany of the National Institute of Research of the Amazon/INPA, Manaus/AM, Brazil

<sup>4</sup>Postgraduate Program in Biodiversity, Environment and Health / PPGBAS/UEMA, Caxias/MA, Brazil

<sup>5</sup>Doctor in Geography by UFPE, Associate Professor II of the Center for Natural Sciences/CCN of the State University of Piauí/UESPI, Brazil

<sup>6</sup>Professor Dr. State University of Maranhão/UEMA, Maranhão/Brazil; Postgraduate Program in Biodiversity, Environment and Health/PPGBAS, Caxias/MA, Brazil

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### ABSTRACT

The study record three species of Schizaeaceae (*Schizaea elegans* (Vahl) Sw., *Schizaeae stricta* Lellinger and *Actinostachys Pennula* (Sw.) Hook), distributed in two genera (*Actinostachys* and *Schizaea*). *Schizaea elegans* is considered a new record for Maranhão and *Schizaeae stricta* a new record for the Brazilian Cerrado. It presents a taxonomic key for the species, photographs based on collected material, life-form data, occurrence environments, geographic distribution and additional comments on ecology and delimitation of species.

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### INTRODUCTION

Schizaeaceae Kaulf. is an family of ferns group, composite current for two genera, *Actinostachys* Wall. and *Schizaea* Sm. (SMITH et al., 2006; PPG I 2016). Characterized as terrestrial ferns that develop in sandy soil, covered for hairs, fronds erects, linear or flabelliform, with free vein, dichotomous ramified (ALMEIDA, 2017). In the latest decades, was target of intense taxonomic investigations, in which, passed for diverse alterations, how much, that before belonged to the genera *Anemia* Sw., *Lygodium* Sw., *Schizaea* e *Mohria* Sw.

\*Corresponding author: Domingos Lucas dos Santos-Silva, Postgraduate Program in Ecology and Conservation at the State University of Mato Grosso, Campus Nova Xavantina, Brazil

(TRYON, TRYON, 1982), for present morphological characteristics shard, as the apical or subapical annulus (TRYON, TRYON, 1982; KRAMER, 1990, SMITH, 1995).

The genus *Actinostachys*, latest was considered as subgenus of *Schizaea* (TRYON; TRYON, 1982; KRAMER, 1990), but against of the anatomical differences of the frond structures, disposition of the sporangiophores and gametophytes morphological between of the two groups. (BIERHORST, 1968), Moran (1995), modified the circumscription of *Actinostachys* as subgenus of *Schizaea* and the recognized as genus, corroborating with molecular studies that evidence *Actinostachys* as lineage distinct of *Schizaea* (WIKSTRÖM et al., 2002; SMITH et al., 2006). However, the representatives of family presented great morphological diversity, anatomic and genetic, that sometimes, were classified in different

families, to known: Anemiaceae (*Anemia* and *Mohria*), Lygodiaceae (*Lygodium*) and Schizaeaceae (*Actinostachys* and *Schizaea*) (REED, 1947; SMITH *et al.*, 2006). This classification firmed itself for middle of molecular and phylogenetic studies, that showed the formation of an monophyletic group, to order Schizaeales (HASEBE *et al.*, 1994; PRYER *et al.*, 1995; PPG I, 2016). Schizaeaceae occur in Pantropical region and in seasoned area of New and Old World (SMITH *et al.*, 2006), in this area are registered between 32 to 40 species (KESSLER, SMITH, 2017). Among these, 11 species occur in Brazil and five for Northeast region (SANTIAGO, ALMEIDA, 2019). For the Maranhão are registered only the species *Actinostachys pennula* (Sw.) Hook and *Schizaea stricta* Lellinger (CRIA, 2019). The study presents species of Schizaeaceae, in the State of Maranhão, which description detailed of the taxa, taxonomic keys, photos based in collect material, data about habit of life-form, occurrence environment, geographical distribution and comments about and delimitation of the species.

## MATERIAL AND METHODS

The State of Maranhão, with an extension of 333,365.6 km<sup>2</sup>, is located in a transition area between three Brazilian macro regions (North, Northeast and Midwest), with especially typical climatic and phytogeographic characteristics where it covers the phytogeographical domains of the Amazon, Cerrado and Caatinga, in an area considered ecotonal (GALINKIN *et al.*, 2004, IMESC, 2008 and IBGE, 2014). The climate is characterized transitional between wet and semi-humid climate, with an annual average temperature of 26.2 °C, and rainfall between 800 mm and 2800 mm, with a rainy period between October and May, and the dry season from June to September (MARANHÃO, 2011). The species of Schizaeaceae were collected in the Municipality Environmental Protection Area of Inhamum, located in the municipality of Caxias/MA (-04°53'30 "S; -43°24'53" W), in the Eastern region of the State and in the National Park of Chapada das Mesas, in the municipality of Carolina/MA (7°02'39.6 "S; 047°26'28.0" W), in the Southern region of the State, in Cerradão area. The specimens were collected following the techniques of Góes-Neto and Pietrobom (2012). For the determination of the taxa, the works of Bierhorst (1971), Silva *et al.* (2015), Prado (2005). The classification system adopted was PPG I (2016). The species life-form was observed following the terms proposed by Lellinger (2002), Xavier and Barros (2003) and Zuquin *et al.* (2008). For the representativeness of genera in Brazil and geographic distribution of species, were consulted in the Flora do Brasil 2020 under construction (floradobrasil.jbrj.gov.br), MOBOT/Tropicos (www.tropicos.org), NYBG (sweetgum.nybg.org/science/vh) and *SpeciesLink* (inct.splink.org.br). World Ferns (worldplants.webarchiv. kit.edu/ferns/) has been consulted for the world. The material was examined with the aid of a stereoscopic microscope and light microscope, at the Laboratory of Plant Biology /LABIVE, at State University of Maranhão/UEMA. After the identification of the botanical material, the samples were incorporated into the Herbarium Prof. Aluizio Bittencourt (HABIT), of CESC/UEMA.

## RESULTS AND DISCUSSION

Were identified three species, distributed in two genera of Schizaeaceae for the State of Maranhão. Among botanical collections, that have collections of Schizaeaceae with

specimens of Maranhão, were the herbaria: CEN (Herbarium of Embrapa Genetic Resources and Biotechnology), CESJ (Herbarium Leopoldo Krieger), HSTM (Herbarium of the Federal University of Western Pará), HUEFS (Herbarium of the State University of Feira de Santana) e HABIT (Herbário Prof. Aluizio Bittencourt). It was observed that in these collections, that the genus most representative was *Schizaea*, with two species, to know: *S. elegans* (Vahl) Sw. e *S. stricta* Lellinger., while that *Actinostachys* is represented for a species, *Actinostachys pennula* (Sw.) Hook. Of these, *Schizaea elegans* is registered as a new occurrence for the Maranhão, the that represent an addition to number of the species ferns to the State. Of the different biomes (Amazon, Cerrado and Caatinga) that the State of Maranhão have, the species of Schizaeaceae presents a greater diversity in Cerrado (Figure 2). For the Brazilian Cerrado was registered only the species *Actinostachys pennula*, *Schizaea elegans* and *Schizaea poeppigiana* J.W. Sturm (SANTIAGO, ALMEIDA, 2019). Thus, the new record of *Schizaea stricta* in Cerrado Maranhense, enlarge their areas of occurrence in this biome.

The lack of registration in the other phytogeographical domains within the state of Maranhão can be caused by the lack of collection effort in the State. For Maranhão, the municipalities with the largest number of Schizaeaceae were Carolina (five specimens), Caxias (three specimens) and Barreirinhas (one specimen). In these municipalities, the species were collected in conservation units, respectively in the National Park Chapada das Mesas, Municipal Environmental Protection Area Inhamum and National Park Lençóis Maranhenses (Figure 1). Of the taxa registered for Maranhão, *S. elegans* is under threat, according to Santiago and Almeida (2019). Due to the rarity of samples in botanical collections of Schizaeaceae and the constant loss of habitats of the Cerrado and other domains in Maranhão, floristic, taxonomic and population studies are of extreme importance to indicate the degree of threat of other species to Schizaeaceae in Maranhão, since, for the State, there is still no list of endangered flora species. The occurrence of the new records are extremely important for the realization of new studies for the Brazilian Cerradão and Maranhão, for expanding the taxonomic, ecological, life form and geographic distribution of the species.

### Key of identification for the species of Schizaeaceae

1. Fronds linear and undivided, no laminar expansion, digitates sporangiophores in two or more rows on each side of the costae.....1. *Actinostachys pennula*
- 1'. Fronds with expansion laminar or, if linear, with dichotomic division, sporangiophores pinnatifid to pinnate; sporangiophores in an only row on side of the costae.....2
2. Frond with laminar tissue developed, flabelliform.....2. *Schizaea elegans*
- 2'. Frond with laminar tissue absent or greatly reduced laminar tissue, linear.....3. *Schizaea stricta*

**1. *Actinostachys pennula* (Sw.) Hook. Genera Filicum t. 111A. 1842. Synonyms: *Schizaea pennula* Sw. Synopsis Filicum 150, 379. 1806**

**Description:** Terrestrial. Short, tuberous rhizome with brown trichomes. Fronds cespitoses, erects, linear, dimorphs, 10-39 cm leghth; petiole short, triangular, ca. 1 cm. and 0.1 cm diameter; lamina simple, undivided linear, triangular in cross

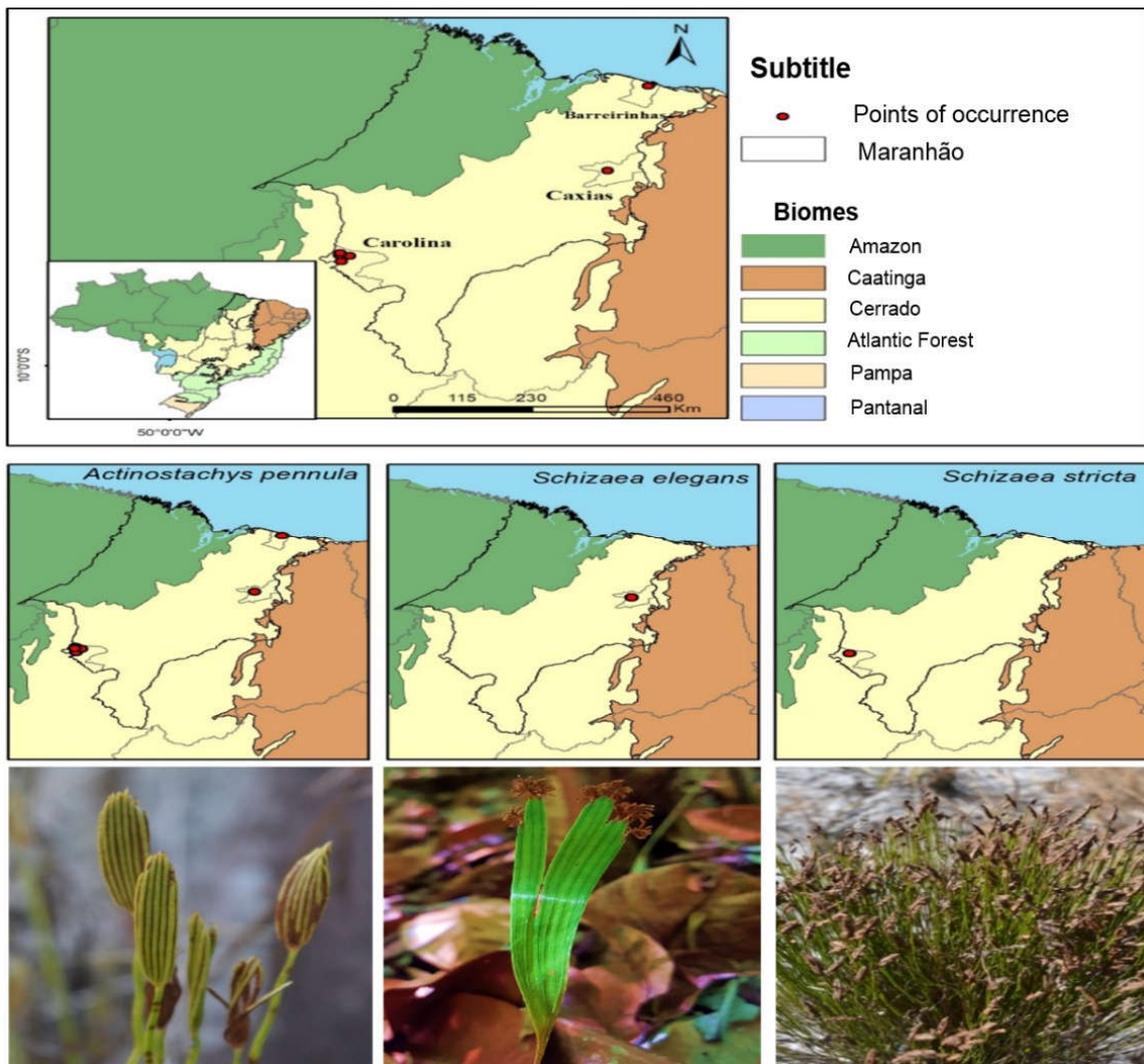


Figure 1. Points of occurrence and distribution of Schizaeaceae species in the biomes and municipalities of Maranhão/Brazil

section, glabrous or little pubescent, apex acute, fronds sterile with apex acute; fronds fertile ending in digitized sporangiophores. Sporangioophores with 6-10 (14) linear segments, with reduced lamellar tissue, margin entire, 1-4 (5) cm. and 0.1-0.3cm wide, with light brown, tortuous trichomes on the abaxial face between the sporangia; undeveloped plant tissue, with clear and filiform paraphrases on the abaxial face, adaxial glabrous face and smooth margin. Sporangia in 2-4 rows on each side of the coast.

**Material Examined:** BRAZIL, MARANHÃO: Caxias, Municipality Environmental Protection Area of Inhamum, 06.XII.2018, G.M. Conceição (HABIT 3407); Barreirinhas, Village Mata Fome, National Park Lençóis Maranhenses, 19.V.2015, N.F.O. Mota; A.K. Kock.; M.N.C. Bastos (HSTM 9830); Carolina, National Park Chapada das Mesas, 12.IV.2016, M.F. Simon (CEN 95530); Carolina, Morro do Chapéu, 29.XII.2011, V.A.O. Dittrich; A.A. Vale (CESJ 70515); Carolina, Balneário Chico de Dodó, 29.I.2012, R.M. Harley (HUEFS 179409).

**Geographical Distribution:** Belize, Guatemala, Costa Rica, Colombia, Guadalupe, Cuba, Trindade, Venezuela, Equador, Peru, Porto Rico, Suriname, French Guiana, Guiana, Bolívia, Mexico, Nicaragua. For Brazil, occur in the North (Amazonas, Amapá, Pará, Rondônia, Roraima, Tocantins), Northeast regions (Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Rio

Grande do Norte, Sergipe, Mato Grosso), Southeast (Espírito Santo, Rio de Janeiro, São Paulo) South (Paraná, Santa Catarina).

**Phytogeographical Domains:** Amazon, Cerrado, Atlantic Forest.

**Collect Data:** All the material examined resembles in physiognomies and collects local, characterized for collects in sandy soil, on edge or on the shade of gallery forest, with lots of burlap, next to water courses. It can also be found in Cerradão.

**Taxonomic Comment:** *A. pennula* difference of *A. subtrijuga* (Mart.) C. Presl that is the only other congeneric species occurrent in Brazil, for have triangular frond in transversal section and spores foveolados (ALMEIDA, 2017). *A. pennula*, when sterile can be confused with grasses and Cyperaceae (Góes-Neto et al., 2014). According to Prado (2005), this species has been treated by several authors such as *Schizaea*, characterized by sporangiophores with 6-4 (14) segments, ranging from 1-3 (5) cm in length.

**Ecological Comment:** They are terrestrial, frequent in forested areas (Cerradão and Ciliary Forest), grows in small clumps in sandy soils, with litter presence and/or in soggy soils.



Figure 2. A) Collection local of *Schizaea elegans* in the Municipal Environmental Protection Area of Inhamum, Caxias/MA; B) *Schizaea elegans* in their natural habitat; C) Fertile blade bearing several sporangiophores at the apical margin

**2. *Schizaea elegans* (Vahl) Sw. Journal für die Botanik. (Schrader) 1800 (2): 103. 1801. Synonyms: *Acrostichum elegans* Vahl. Symbolae Botanicae. 2: 104, pl. 50. 1791. *Lophidium lalifolium* L. C. Rich., Act. Soc. Hist. Nat. Paris 1: 114. 1792.**

**Description:** Terrestrial plants, rhizome vertical, pilose, trichomes, light with septa black, acute apex. Fronds 39,5 cm length x 1,7 cm wide, monomorphic, petiole 17 cm length x 0,2 cm wide. green, yellow or brown, brown in base, sulcate, glabrous or little pilose; glabrous lamina, flabelliform, entire or divided in segments more narrow of 0.4-5cm wide, deltoids, with expansion laminar, apical margin sterile 9 cm of length x 1,1 cm wide; free veins, furcates, fertile lamina carrying several sporangiophores in apical margin; sporangiophores 0,4-1 x 0,4-0,6 cm, pinnate; sporangia sessile, arranged in two rows, apical annulus; paraphysis on central vein, filiform, obtuse apex, spores reniform, surface smooth with deposit of bodies spherical.

**Material Examined:** BRAZIL, MARANHÃO: Caxias, Municipality Environmental Protection Area of Inhamum, 06.XII.2018, G.M. Conceição (HABIT – 3408).

**Geographical Distribution:** Nicaragua, Costa Rica, Mexico, Belize, Guatemala, Honduras, Panama, Colombia, Venezuela, Ecuador, Peru, Bolivia, Jamaica, Trindade, Guiana, Suriname, French Guiana. For Brazil, occur in the North regions (Acre, Amazonas, Pará, Rondônia, Roraima, Tocantins), Northeast (Alagoas, Bahia, Pernambuco), Midwest (Mato Grosso), Southeast (Espírito Santo, Minas Gerais, Rio de Janeiro, São Paulo), South (Paraná, Rio Grande do Sul, Santa Catarina). Its distribution area extends to the state of Maranhão (Northeast of Brazil).

**Phytogeographical domain:** Amazon, Cerrado, Atlantic forest

**Collect data:** In Maranhão was observed for first time in ciliary forest with tree great port, in soggy soils and near the river bank (Figure 2).

**Taxonomic Comments:** However, *S. elegans* differs from the other species of the genus by the laminar tissue developed, flabella and widely furcated, in addition to being a much larger species, with specimens reaching more than 1 m in length (Góes-Neto, Pietrobom, 2012). The species is characterized by the presence of broad fronds, with leaves usually flabby,

furrowed two to four times, margins of the toothed leaves, long margin sporophore.

***Schizaea stricta* Lellinger, Mem.NewYork Bot. Gard. 18: 8, 1969**

**Description:** Stem erect or ascending, ca. 0.5-1 cm wide., covered by light-brown, light-colored trichomes. Fronds cespitose, erect, dichotomous or dimorphic in the median portion, with laminar tissue almost absent or very reduced, 14-40 cm length; petiole 8-15cm length. and 0.1-0.2cm wide, about the same length of the lamina, furrowed adaxially, with sparse trichomes or slightly pubescent light brown. Fruit linear, glabrous or with sparse light brown trichomes, 12-15 cm wide. and ca. 0.2 cm wide, 4-5 times dichotomous, apex of segments ending in sporangiophores, margin of both cartilaginous blades. pinnatifid sporangiophore to pinnate, 1.5-2.3 cm length, and 0.1-0.2 cm wide, with 20-30 segments/pinnas, glabrous on the adaxial and pubescent face on the abaxial face, flexed trichomes, light brown; sporangia in 1 row on each side of the coast.

**Material Examined:** BRAZIL, MARANHÃO: Carolina, National Park Chapada das Mesas, 12.IV.2016, M.F. Simon (CEN 95529) HABIT (3409).

**Geographical Distribution:** Venezuela, Colombia and Guyana. For Brazil, they occur in the North (Amazonas, Pará and Roraima), Central-West (Mato Grosso) regions. With addition to the Northeast region.

**Phytogeographical Domains:** Amazon, with extension to the Maranhense Cerrado domain.

**Collection Data:** Material was collected on edge of gallery forest, smooth undulating relief, sandy soil with lots of litter. It forms very frequent clumps at the collection site, similar to the collection environment of the other species described here, making evident a unique environment for the presence of Schizaeaceae species.

**Taxonomic Comments:** Difference of the other species presented here, as it presents approximately 30 pinnas per sporangiophore, besides the petiole measure the same length of the blade, besides the blade is 4 to 5 times furcate (PRADO, 2005).

**Ecological Commentary:** Terrestrial, frequent in forested areas. It grows in small clumps.

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