



Original Paper

Gleicheniaceae from the Quindío Department, Colombia

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Abstract

Colombia is a tropical country with a rich fern flora. The Quindío Department is in an area which is undergoing significant environmental changes due to anthropogenic activities, such as coffee cultivation. Gleicheniaceae, a family of pioneer ferns, is known for preferentially occupying open, sunny, and disturbed habitats, such as roadsides. Our study aimed to conduct a taxonomic treatment of the Gleicheniaceae species in the Quindío Department in Colombia. Our results revealed the presence of 10 species distributed in four genera, with the *Sticherus* genus accounting for most of the species (seven in total). Notably, a new record of *Sticherus* (*S. brevitomentosus*) was found for Colombia, indicating the potential for the discovery of additional species in future studies. Furthermore, our results demonstrated that 42% of the 24 species reported in the Andean region were present in the Quindío Department, and Calarcá and Salento were the municipalities with the highest diversity. We have provided taxonomic descriptions for the genera and species, as well as an identification key, maps, images, and comments on the taxonomy and distribution of the species.

Key words: ferns, flora, Gleicheniales, taxonomic treatment.

Resumen

Colombia es un país tropical con una rica flora de helechos. El Departamento de Quindío está ubicado en una zona que sufre una importante alteración ambiental debido a actividades antropogénicas como el cultivo de café. Las Gleicheniaceae, una familia de helechos pioneros, son conocidas por ocupar preferentemente hábitats abiertos, soleados y perturbados, como los bordes de las carreteras. Nuestro estudio tuvo como objetivo realizar un tratamiento taxonómico de las especies de Gleicheniaceae en el Departamento de Quindío, Colombia. Nuestros resultados revelaron la presencia de 10 especies distribuidas en cuatro géneros, siendo el género *Sticherus* el que cuenta con la mayoría de las especies (siete en total). Notablemente, se encontró un nuevo registro de *Sticherus* (*S. brevitomentosus*) para Colombia, lo que sugiere la posible descubierta de especies adicionales en futuros estudios. Además, nuestros resultados demostraron que el 42% de las 24 especies reportadas en la región Andina estaban presentes en el Departamento de Quindío, siendo Calarcá y Salento los municipios con la mayor diversidad. Hemos proporcionado descripciones taxonómicas tanto para los géneros como para las especies, así como una clave de identificación, mapas, imágenes y comentarios sobre la taxonomía y distribución de las especies. Palabras clave: helechos, flora, Gleicheniales, tratamiento taxonómico.

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Introduction

Gleicheniaceae is an ancient lineage of leptosporangiate ferns, whose fossil evidence dates

from the beginning of the Cretaceous (Gandolfo *et al.* 1997). The family is primarily recognized for having elongated and creeping rhizomes, with

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monomorphic fronds of indeterminate growth, anywhere from 20 cm to 5 meters in length, pseudodichotomously branched several times, with latent buds, absent indusium, globose or pyriform sporangia with a transverse uninterrupted ring with or without paraphysis, and monolete or trilete spores (Holttum 1957; Mickel & Smith 2004; Gonzales & Kessler 2011; Lima & Salino 2018a, 2018b; Kessler & Smith 2018).

Gleicheniaceae has a pantropical distribution, and seven genera: *Diplopterygium*, *Dicranopteris*, *Gleichenella*, *Gleichenia*, *Rouxopteris*, *Stromatopteris*, and *Sticherus*, with an estimated 157 species (PPG I 2016; Lima & Salino 2018b; Liu *et al.* 2020). The development of these plants is favored by rocky substrates, low nutrient availability, and concentration of water in the soils where they grow, and it is also influenced by higher altitudes (Holttum 1957; Walker & Sharpe 2010).

In Colombia, the family is represented by 19 species distributed across four genera, most of them found in the Andean region, including in the departments of Antioquia, Boyacá, Cundinamarca, Norte de Santander, Santander, Quindío, and Amazonas, in the Caribbean region, and in the Orinoco River region (Ramírez *et al.* 2007; Murillo *et al.* 2008; Murillo & Murillo 2017). Despite Colombia's high levels of biodiversity and endemism, the Gleicheniaceae family remains within a significant knowledge gap in the country. To tackle this issue, additional studies are imperative to enhance our comprehension of the taxonomy, distribution, and species count within the ecosystems of the Quindío Department. This region, characterized by coffee plantations in Colombia, has historically been underrepresented in sampling efforts (Instituto Geográfico Agustín Codazzi 2001). Therefore, the present study aimed to provide a taxonomic treatment of the Gleicheniaceae family in Quindío, Colombia. The knowledge gained from this study will be crucial for informing conservation efforts aimed at preserving these species and their habitats.

Material and Methods

The Quindío Department is located between 04°04'41" and 04°43'18" North latitude, and between 75°23'41" and 75°53'56" West longitude (Fig. 1). Its surface area is 1,845 km², and its elevation ranges between 1,500–1,800 m. It is politically divided into 12 municipalities (Instituto Geográfico Agustín Codazzi 2001).

We visited six main Colombian herbaria (COL, HUQ, FAUC, MEDEL, HUA, and JAUM), and databases from virtual herbaria were also reviewed for type examination (B, BR, K, LE, and QCA) (acronyms according to Thiers, continuously updated). Six additional field trips, covering all 12 municipalities of the Quindío Department, were conducted from March 2019 to June 2021. The primary objective of these trips was to improve sampling in the study area, employing the walking method as outlined by Silva (1989). Information about the collection site, ecological data, habit, and growth zone was recorded. The collected specimens were processed and housed at the University of Quindío Herbarium (HUQ), and duplicates were deposited in FAUC.

The taxonomic identification was carried out by using the literature and making comparisons with type specimens. The morphological study involved measuring and observing different structures, and photographs were taken for identification purposes. We followed the frond terminology adopted by Østergaard Andersen & Øllgaard (1996), with modifications according to Lima & Salino (2018b). Maps were created using ArcGIS to analyze the local distribution of species, and dichotomous keys were developed for species identification.

Taxonomic treatment

Gleicheniaceae C. Presl, Reliq. Haenk. 1: 70. 1825.

Terricolous or rupicolous plants. Rhizome with hairs or scales. Fronds are erect, occasionally pendant, 2–4(–5)-bifurcate. Terete, glabrescent petiole. Accessory branches present or absent. Buds with scales or hairs, pseudostipule present or absent. Ultimate branches are pectinate or bipinnate, lanceolate, slightly asymmetric at the base, gradually reduced or truncate, with acuminate apex. Ultimate segments are lanceolate, linear or deltoid. Veins are 1–3-bifurcate. Sori paraphysis present or absent. Trilete or monolete spores.

Gleicheniaceae is a widespread family, found in tropical and subtropical regions around the world, with diversity centers in the Neotropics, Southeast Asia and Oceania. In Colombia, the family is represented by 19 species, distributed in four genera. In Quindío, 10 species are found, distributed in four genera (*Dicranopteris*, *Diplopterygium*, *Gleichenella* and *Sticherus*).

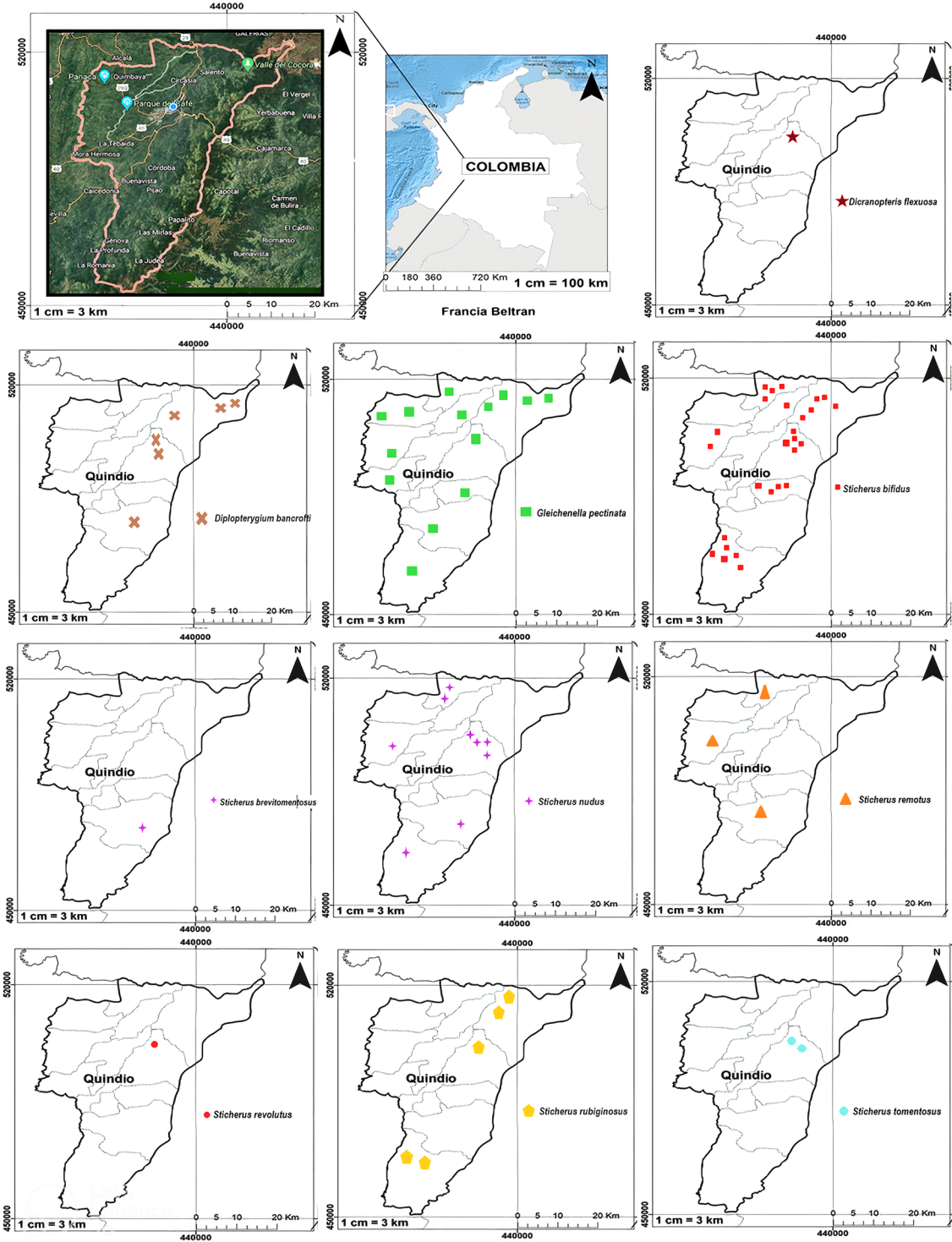


Figure 1 – Maps showing the distribution of Gleicheniaceae species in Quindío, Colombia.

Key to the Gleicheniaceae genera in Quindío

1. Rhizomes and buds covered with scales.
 2. Ultimate branches bipinnate; bud scales with entire margins; trilete spores2. *Diplopterygium*
 - 2'. Ultimate branches pectinate; bud scales with ciliate, dentate or fimbriate margins; monolete spores 4. *Sticherus*
- 1'. Rhizomes and buds covered with hairs.
 3. Fronds isotomically branched; accessory branches present; trilete spores1. *Dicranopteris*
 - 3'. Fronds anisotomically branched; accessory branches absent; monolete spores3. *Gleichenella*

1. *Dicranopteris* Bernh., Neues J. Bot. 1(2): 38–39. 1805.

Dicranopteris is a pantropical genus with approximately 20 species worldwide (PPG I 2016). In Quindío, only *Dicranopteris flexuosa* occurs.

1.1. *Dicranopteris flexuosa* (Schrad.) Underw., Bull. Torrey Bot. Club 34(5): 254. 1907. Type: BRAZIL. ESPÍRITO SANTO: Wied-Neuwied s.n. (lectotype designated by Lima & Salino 2018b, BR [BR0000006870515], photo!, isolectotypes BR [BR0000006869731]; [BR0000006869823]; [BR0000006869793]; [BR0000006869762] photos!). Fig. 2a-f

Terricolous or rupicolous plants. Rhizomes are 1.8–4.3 mm thick, with scabrous surface, glabrescent with rigid caduceous hairs. Fronds are 1–4-bifurcate. Ultimate branches are 7.4–30 × 2–7 cm, linear to lanceolate, with pinnatifid apex and attenuate base. Ultimate segments are 15–35 × 1.8–2.3 mm, linear, slightly revolute margins, green or pruinose abaxial surface, glabrous, with only globose glandular hairs on the secondary veins. Buds covered with red hairs, pseudostipule present. Accessory branches are 3–4 × 1–1.5 cm. Veins are 1–3 bifurcate. Round sori, with 6–15 sporangia per sori, paraphysis absent. Trilete, globose spores.

Selected material: QUINDÍO: Calarcá, Ruta Calarcá - Alto de La Línea, finca Villanueva, 2,110 m, 04°31'17"N, 75°36'14" W, 17.X.2019, *F. Beltrán et al. 221* (HUQ, FAUC, COL).

Additional examined material: COLOMBIA. ANTIOQUIA: Belmira, Vereda Montañita, Quebrada Montañita, 2,885 m, 06°37'18.7"N, 75°40'30"W, 17.VII.2002, *W. Rodríguez. & J.J. Colorado 3406* (COL). CAQUETÁ: Cordillera Oriental, Sucre, orillas del Río Hacha, 1,000 m, 01°47'32"N, 75°39'5"W, 3.IV.1940, *J. Cuatrecasas 9016* (COL). CHOCÓ: Municipio San José Del Palmar, 1,870 m, 04°57'01"N, 76°17'43"W, 13.II.2007, *P. Silverstone & Sopkin 1552* (COL). NARIÑO: municipio de Barbacoas, corregimiento Ortiz y Zamora, Vereda El Barro Reserva Nacional Río Nambi, 1,350–1,400 m, 01°18'00"N, 78°08'00"W, 7.XI.1997, *J.*

Pipoly et al. 21482 (JAUM). SANTANDER: municipio Suaita, carretera al frente de la fundación, 1,550 msnm, 06°10'35"N, 73°26'17"W, 20.X.2001, *A. Murillo. & J. Carmelo 3131* (COL). Municipio Los Santos, La Mesa de Los Santos, 1,500 msnm, 06°49'44"N, 73°06'01"W, 13.II.2007, *J.H. Langenheim 3064* (COL).

Dicranopteris flexuosa has been reported for southeastern United States, southern Mexico, Central America (Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica, Panama), the Caribbean, and South America (Brazil, Colombia, Venezuela, Ecuador, Peru, Bolivia, Paraguay, and northeastern Argentina) (Mickel & Smith 2004; Lima & Salino 2018b). In Colombia, it is distributed in 15 departments (Antioquia, Boyacá, Cauca, Caquetá, Cesar, Choco, Cundinamarca, Guainía, La Guajira, Meta, Putumayo, Quindío, Santander, Valle del Cauca, and Vaupés.), with a greater presence in Cundinamarca, Valle del Cauca, and Santander (Murillo *et al.* 2008). In Quindío, a single specimen was found in the municipality of Calarcá, at an altitude of 2,010 meters above sea level.

Dicranopteris flexuosa grows in exposed or shaded sites, along roadsides or forest trails, along streams, and on clay soils. Fertile individuals were found in October. It differs from the other Gleicheniaceae species in Quindío due to its buds and rhizomes covered by hairs, isotomic branch pattern, and the presence of accessory branches. Throughout all field trips, only a single population was found, but the species being highly abundant at the site.

2. *Diplopterygium* (Diels) Nakai, Bull. Natl. Sci. Mus. 29: 47. 1950.

Diplopterygium has around 25 species worldwide, of which *Diplopterygium bancroftii* is exclusively distributed in the Neotropics. They are very large ferns, and their branches can reach between 100 and 150 cm in length (Mickel & Smith 2004; Kessler & Smith 2018).

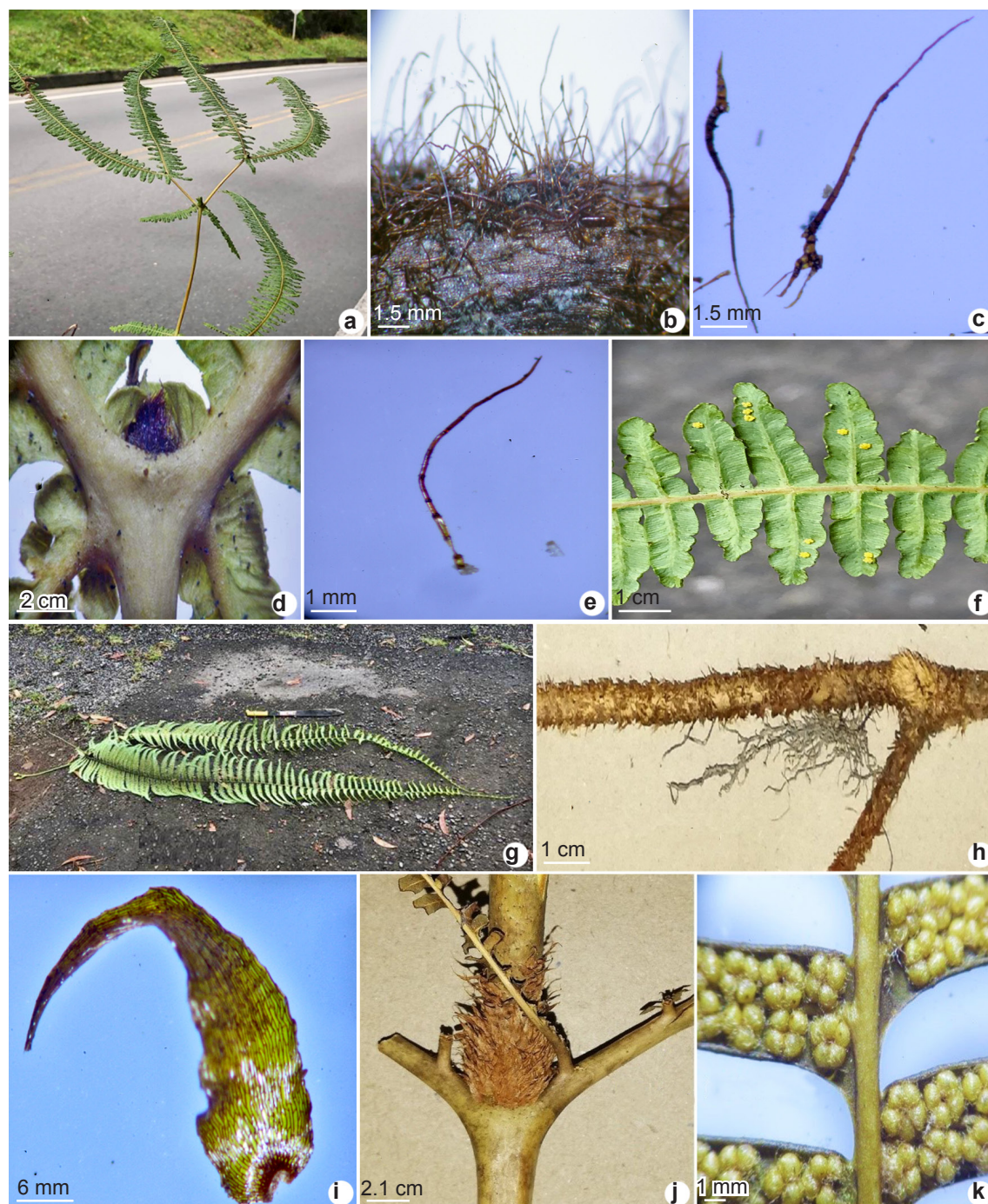


Figure 2 – a-f. *Dicranopteris flexuosa* – a. frond; b. rhizome covered with hairs; c. details of rhizome hairs; d. bud; e. bud hairs; f. abaxial surface. g-k. *Diplopterygium bancroftii* – g. frond; h. rhizome detail; i. rhizome scale; j. frond pseudodichotomy; k. abaxial surface.

2.1. *Diplopterygium bancroftii* (Hook.) A.R. Sm., Amer. Fern J. 70:26.1980. Type: JAMAICA (lectotype designated by Mickel & Smith 2004 K! [K000589313], isolectotype BM). Fig. 2g-k

Rhizomes are 2–5 mm thick, with pale-brown, adpressed to ascendant scales. Fronds are bipinnate, 1-bifurcate. Ultimate branches are 5–15 × 0.8–3.5 cm, with scales and hairs. Ultimate segments are 7–20 × 2–6 mm, linear, with usually plane margins, abaxial surface covered by scales and hairs on the midrib and secondary veins. Buds with lanceolate, yellow to light-brown scales, pseudostipule present. Veins are 1-bifurcate. Round sori, with 5–6 sporangia per sori, paraphysis present. Trilete spores.

Examined material: QUINDÍO: Calarcá, Vía Calarcá - La Sonadora, finca Maracaibo, 2,900 m, 04°26'34"N, 75°37'17"W, 1.II.2020, *F. Beltrán & C.A. Agudelo 247* (HUQ); Vía Calarcá - La Sonadora, finca Maracaibo, 2,460 m, 04°28'07"N, 75°37'20"W, 1.II.2020, *F. Beltrán & C.A. Agudelo 252* (HUQ). Pijao, vereda La Quamba, cerca del puente La Quamba, 1,950 m, 04°21'54"N, 75°41'06"W, 15.IX.2020, *F. Beltrán & C.A. Agudelo 292* (HUQ). Salento carretera de la autopista del café que conduce hasta Boquía, vía a Salento, 1 km adelante, 2,000 m, 04°39'14"N, 75°35'54"W, 25.II.2020, *F. Beltrán et al. 254* (HUQ). Carretera de la autopista del café que conduce hasta Boquía, vía a Salento, 1 km adelante, 1,980 m, 04°39'28"N, 75°35'49"W, 25.II.2020, *F. Beltrán et al. 259* (HUQ). Vía a La Ceja y volcán machín, finca Las Mercedes, 2,170 m, 04°37'29"N, 75°33'22"W, 21.IX.2020, *F. Beltrán & C.A. Agudelo 307* (HUQ).

Diplopterygium bancroftii has a wide distribution throughout the Neotropic region, ranging from Mexico, to Central America (Guatemala, Honduras, El Salvador, Costa Rica, Jamaica, Haiti, Santo Domingo, Lesser Antilles), to South America (Colombia, Venezuela, Ecuador, Peru, Bolivia) (Mickel & Smith 2004; Kessler & Smith 2018). In Colombia, it is found in six departments (Antioquia, Caldas, Cundinamarca, Putumayo, Quindío, Santander), being more present in Cundinamarca and Santander (Murillo *et al.* 2008). In Quindío, six populations were found, distributed in three municipalities (Calarcá, Pijao, and Salento), at an altitude of 1,950 to 2,900 m.

Diplopterygium bancroftii is rarely found in areas highly exposed to sunlight, and primarily grows under the shade of trees and bushes along the edges of forests and roads. In Colombia, it grows on slopes along roads on clay soils and along creek banks, in both exposed and shaded locations. Fertile individuals have been observed in January. It is readily recognized in Quindío by its scale-covered rhizome and buds, and its bipinnate branches.

3. *Gleichenella* Ching, Sunyatsenia 5: 276. 1940.

Gleichenella is a monotypic genus with neotropical distribution (PPG I 2016).

3.1. *Gleichenella pectinata* (Willd.) Ching, Sunyatsenia 5: 276. 1940. Type: VENEZUELA. Distrito Federal. Caracas, Bredemeyer s.n. (holotype B [B-W 19465] photo!). Fig. 3a-f

Terricolous plants. Rhizomes are 3.5–4.3 mm thick, with red to brown hairs. Fronds are 1–4 bifurcate. Ultimate branches are 10.2–22.5 × 1.8–2.8 cm, linear to lanceolate, with pinnatifid apex and attenuate base. Ultimate segments are 10–15 × 3.5–4.5 mm, linear, abaxial surface with stellate red hairs, glabrous adaxial surface. Buds with red hairs, pseudostipule present. Accessory branches absent. Veins are 2–3(–4) bifurcate. Round sori, with 4–11 sporangia per sori, paraphysis absent. Monolete, ellipsoid spores with rugose surface.

Examine Material: QUINDÍO: Calarcá, Ruta Calarcá - Alto de La Línea, Finca Villanueva, 1,890 m, 04°31'36"N, 76°36'40"W, 17.X.2019, *W.F. Beltrán et al. 217* (HUQ). Circasia, Vía a Armenia, escuela de Hojas Anchas, cerca del puente de Hojas Anchas, 1,470 m, 04°33'17"N, 75°40'25"W, 14.IX.2020, *F. Beltrán & C.A. Agudelo 285* (HUQ). Córdoba, 200 metros delante de la finca La Estrella, 1,790 m, 04°22'22"N, 75°41'01"W, 15.IX.2020, *F. Beltrán & C.A. Agudelo 290* (HUQ). FILANDIA: Vereda El Paraíso, por el vivero El Paraíso, 1,830 m, 04°39'26"N, 75°40'26"W, 27.II.2020, *F. Beltrán et al. 261* (HUQ). GÉNOVA: Vereda Cumaral Bajo, finca Picaragua, 1,617 m, 04°12'13"N, 75°50'35"W, 14.XI.2019 *F. Beltrán et al. 231* (HUQ). MONTENEGRO: Vía a Circasia, finca Montebello, cerca de la torre de antenas roja, 1,620 m, 04°35'36"N, 75°40'53"W, 14.IX.2020, *F. Beltrán & C.A. Agudelo 278* (HUQ). Pijao, Vía al páramo de Chili, adelante del río Gris, 1,720 m, 04°20'49"N, 75°42'03"W, 15.IX.2020, *F. Beltrán & C.A. Agudelo 296* (HUQ). Quimbaya Motel Acuarios, restaurante El Silo, 1,310 m, 04°37'27"N, 75°45'49"W, 27.II.2020 *F. Beltrán et al. 271* (HUQ); vía Quimbaya a Montenegro, a 100 m del puente del río Roble cerca de Montenegro, 1,320 m, 04°37'19"N, 75°45'42"W, 27.II.2020, *F. Beltrán et al. 272*, (HUQ). Salento, Carretera de la autopista del Café que conduce hasta Boquía, vía a Salento, 1 km adelante, 2,000 m, 04°39'14"N, 75°35'54"W, 25.II.2020, *F. Beltrán 255* (HUQ); Carretera de la autopista del Café que conduce hasta Boquía, vía a Salento, 1 km adelante, 2,000 m, 04°39'14"N, 75°35'54"W, 25.II.2020, *F. Beltrán et al. 256* (HUQ); Vía a La Ceja y Volcán Machín, Finca Cardonales, 2,040 m, 04°38'16"N, 75°33'55"W, 21.IX.2020, *F. Beltrán & C.A. Agudelo 302* (HUQ); Vía a La Ceja y Volcán Machín, Finca Gran Azul, 2,081 m, 04°38'03"N, 75°33'36"W, 21.IX.2020, *F. Beltrán & C.A. Agudelo 303* (HUQ). TEBAIDA: Río

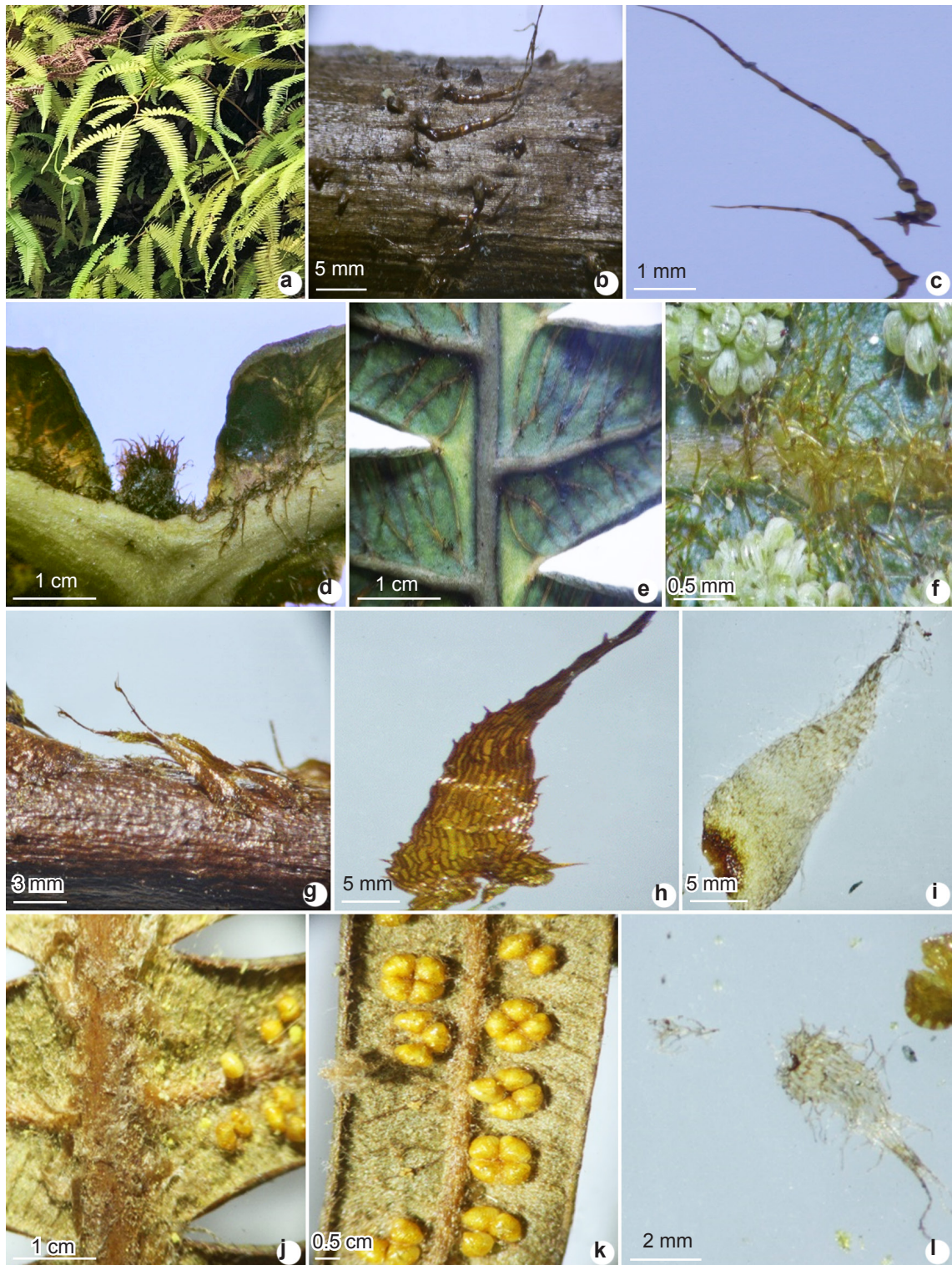


Figure 3 – a-f. *Gleichenella pectinata* – a. habit; b. rhizome detail; c. rhizome hairs; d. bud; e. abaxial surface; f. abaxial surface hairs. g-l. *Sticherus bifidus* – g. rhizome detail; h. rhizome scale; i. bud scale; j. abaxial surface; k. segment of abaxial surface showing the sori; l. rachis and midrib scales.

Espejo, hacia Pueblo Tapado, 1,150 m, 04°27'50"N, 75°48'24"W, 14.IX.2020, F. Beltrán & C.A. Agudelo 274 (HUQ).

Gleichenella pectinata is widely distributed through the Neotropic region, ranging from Mexico, to Central America (Antilles, Trinidad and Tobago, Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica, Panama), to South America (Brazil, Bolivia, Colombia, Ecuador, Peru, Venezuela) (Mickel & Smith 2004; Kessler & Smith 2018; Lima & Salino 2018b). In Colombia, it is found in ten departments (Antioquia, Córdoba, Cundinamarca, Huila Nariño, Putumayo, Quindío, Santander, Vaupés, Valle de Cauca), with greater presence in Cundinamarca, Valle del Cauca, and Santander. This species grows at altitudes of 460 to 1,400 meters above sea level (Murillo *et al.* 2008). In Quindío, 14 populations were found, distributed in 10 municipalities (Calarcá, Circasia, Córdoba, Filandia, Génova, Montenegro, Pijao, Quimbaya, Salento, and Tebaida), with a greater presence in Salento and Quimbaya, at an altitude of 1,150–2,081 meters above sea level. It is a species with a wide range of distribution and abundance, as it was collected in most of the municipalities of the Quindío Department. In the municipality of

Salento, it was very abundant at altitudes greater than 2,000 meters above sea level.

This species grows in exposed or shaded sites, on road edges or in wooded paths in Colombia. Fertile individuals were found from November to May. *Gleichenella pectinata* is recognized by the rhizome and buds covered with hairs and by its anisotomic branch pattern.

4. *Sticherus* C. Presl, Tent. Pterid. 51–52. 1836.

Terricolous plants. Rhizomes with red to brown peltate scales. Fronds are erect or pendant, 2–4-bifurcate. Petiole is round, glabrescent or with scales at the base and apex. Accessory branches absent. Buds covered with scales, pseudostipule present or absent. Ultimate branches are pectinate, linear to lanceolate, with reduced or truncate base, and pinnatifid apex. Ultimate segments are linear, lanceolate, or deltoid. Veins are 1-bifurcate. Sori paraphysis present or absent. Monolete, elliptic spores.

Sticherus has about 95 species, around 54 of which occur in the Neotropics (PPG I 2016). In Colombia, it is represented by 19 species (Murillo *et al.* 2008). In Quindío, the genus is represented by seven species.

Key to the *Sticherus* species in Quindío

1. Deltoid ultimate segments..... 4.5. *Sticherus revolutus*
- 1'. Linear ultimate segments.
 2. Ultimate branches with remote segments, more than one segment length of distance..... 4.4. *Sticherus remotus*
 - 2'. Ultimate branches with close segments, less than half one segment length of distance..... 3
 3. Ultimate segments glabrescent abaxially, at least on the apex; ovate bud scales 4.3. *Sticherus nudus*
 - 3'. Ultimate segments sparsely to densely covered by arachnoid scales abaxially; triangular to lanceolate bud scales.
 4. Ultimate branches with truncate base; segments present only at the ultimate branches. 4.2. *Sticherus brevitomentosus*
 - 4'. Ultimate branches with gradually reduced base; segments present at the first ramifications.
 5. Ultimate branches more than 25 cm long, abaxial surface densely covered by arachnoid scales; coriaceous segments 4.7. *Sticherus tomentosus*
 - 5'. Ultimate branches less than 25 cm long, abaxial surface sparsely to moderately covered by arachnoid scales; papyraceous segments.
 6. Reddish bud scales, with short ciliate margins; abaxial surface of the segments sparsely covered by arachnoid scales 4.6. *Sticherus rubiginosus*
 - 6'. Light to dark-brown bud scales, with occasionally central darkening; abaxial surface of the segments moderately covered by arachnoid scales 4.1. *Sticherus bifidus*

4.1. *Sticherus bifidus* (Willd.) Ching, Sunyatsenia 5(4): 282. 1940. Type: VENEZUELA. DISTRITO FEDERAL: Caracas, Bredemeyer s.n. (lectotype B [B-W-19468-01 0] photo!, designated by Proctor 1985, isolectotype S [S-R-3496] photo!).

Fig. 3g-l

Rhizomes are 2–4 mm thick, with dark-brown, triangular scales, with ciliate margins. Fronds are 2–3-bifurcate. Ultimate branches are 19–25 × 3.2–4.8 cm, lanceolate, with pinnatifid apex and reduced base. Ultimate segments are 14.5–27 × 2.5–3.5 mm, linear, its margins plane or slightly revolute, abaxial surface moderately covered with arachnoid scales in the laminar tissue and veins. Buds with triangular, brown scales, with occasionally central darkening and fimbriate margins; pseudostipule present or absent. Veins are 1-bifurcate. Round sori, 4–6 sporangia per sori, paraphysis absent.

Examined material: QUINDÍO: Calarcá: Ruta Calarcá - Alto de La Línea, Finca Villanueva, 1,870 m, 04°31'43"N, 76°36'48"W, 17.X.2019, *F. Beltrán et al.* 216 (HUQ). CIRCASIA: Vía a Armenia, escuela de Hojas Anchas, cerca del puente de Hojas Anchas, 1,470 m, 04°33'17"N, 75°40'25"W, 14.IX.2020, *F. Beltrán & C.A. Agudelo* 284 (HUQ). CÓRDOBA: 500 metros delante del pueblo por la vía hacia la vereda Carniceros, 1,590 m, 04°23'08"N, 75°41'15"W, 15.IX.2020, *F. Beltrán M. & C.A. Agudelo* 287 (HUQ); 200 metros delante de la Finca La estrella, abundante, 1,790 m, 04°22'22"N, 75°41'01"W, 15.IX.2020, *F. Beltrán M. & C.A. Agudelo* H 291 (HUQ). FILANDIA: Vereda El paraíso, por el vivero El Paraíso, vía a Quimbaya, 1,850 m, 04°39'53"N, 75°40'10"W, 27.II.2020, *F. Beltrán et al.* 260 (HUQ); Finca hotel Paisaje Cafetero, vía a Quimbaya, 1,640 m, 04°38'03"N, 75°41'19"W, 27.II.2020, *F. Beltrán et al.* 264 (HUQ); zona cafetera, fonda Patio Bonito, Nuevo Paraíso, vía a Quimbaya, 1,510 m, 04°37'50"N, 75°43'22"W, 27.II.2020, *F. Beltrán et al.* 265 (HUQ). GÉNOVA: carretera de Génova, Vereda Cumaral Bajo, Finca Picaragua, 1,617 m, 04°12'13"N, 75°50'35"W, 14.XI.2019, *F. Beltrán et al.* 232 (HUQ); Vereda Cumaral Alto, Finca La Miranda, 1,625 m, 04°11'32"N, 75°49'19"W, 14.XI.2019, *F. Beltrán et al.* 234 (HUQ). MONTENEGRO: Río La Viaje, hacienda San Pablo, 1,000 m, 04°22'10"N, 75°31'44"W, 14.IX.2020, *F. Beltrán M. & C.A. Agudelo* H 276 (HUQ); Vía a Circasia, Finca Montebello, cerca de la torre de antenas roja, 1,620 m, 04°35'36"N, 75°40'53"W, 14.IX.2020, *F. Beltrán M. & C.A. Agudelo* H. 277 (HUQ). SALENTO: carretera de la autopista del café que conduce hacia Boquía, vía a Salento, 1 km adelante, 1,980 m, 04°39'28"N, 75°35'49"W, 25.II.2020, *F. Beltrán et al.* 257 (HUQ); Vía a La Ceja y volcán Machín, finca Las Margaritas, a 200 m del hostel El Mocambo, 2,080 m, 04°38'03"N, 75°33'36"W,

21.IX.2020, *F. Beltrán M. & C.A. Agudelo* H. 304 (HUQ); Finca Sestillal, vía a La Ceja y volcán Machín, adelante de la vereda Barcinales, 2,440 m, 04°36'41"N, 75°32'51"W, 21.IX.2020, *F. Beltrán M. & C.A. Agudelo* H. 312 (HUQ).

Sticherus bifidus occurs in South America (Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Venezuela) and Central America (Costa Rica, Cuba, Guyana Panama, Trinidad and Tobago) (Mickel & Smith 2004; Lima & Salino 2018b). In Colombia, it is found in 12 departments (Antioquia, Boyacá, Caldas, Cauca, Chocó, Cundinamarca, Meta, Nariño, Putumayo, Quindío, Santander, Valle del Cauca) (Murillo *et al.* 2008). In the Quindío Department, it is distributed in seven municipalities (Calarcá, Circasia, Córdoba, Filandia, Génova, Montenegro, and Salento), with the greatest presence in Salento and Génova.

Sticherus bifidus can be found along roads and paths in disturbed, exposed, and sunny forest edges, forming large populations that mix with the existing vegetation. They grow at altitudes of 150 to 3,000 meters above sea level, being more abundant at 1,500 meters above sea level. It differs from the other species of the genus due to its linear ultimate segments, and its triangular and brown bud scales, usually with central darkening and fimbriated margins.

4.2. *Sticherus brevitomentosus* Østergaard & Øllgaard, Fl. Ecuador 66: 132, f. 37. 2001. Type: ECUADOR, PROV. ZAMORA-CHINCHIPE, Yangana-Valladolid, km 29, 2,580 m, Østergaard Andersen 10728 (holotype QCA [QCA113182] photo!; isotypes AAU, QCNE). Fig. 4a-f

Rhizome is 2–5 mm thick, covered with triangular to lanceolate, brown to orange, scales, with ciliate margins. Fronds are 2–3-bifurcate. Ultimate branches are 8–12 × 2.4–3.2 cm, lanceolate, with pinnatifid apex and truncate base. Ultimate segments are 18–40 × 4–6 mm, linear, its margins slightly revolute, abaxial surface with short arachnoid scales on the laminar tissue, midrib, and secondary veins. Buds with triangular light-brown scales, with short ciliate margins, pseudoestipule absent. Veins are 1-bifurcate. Sori with 3–4 sporangia per sori, paraphysis absent.

Examined material: QUINDÍO: Pijao, Vereda La Quamba, cerca del puente La Quamba, 1,950 m, 04°21'54"N, 75°41'06"W, 15.IX.2020, *F. Beltrán M. & C.A. Agudelo* H. 294 (HUQ).

Sticherus brevitomentosus is endemic of South America, and it is present especially throughout the Andes region of Colombia, Venezuela, Ecuador,

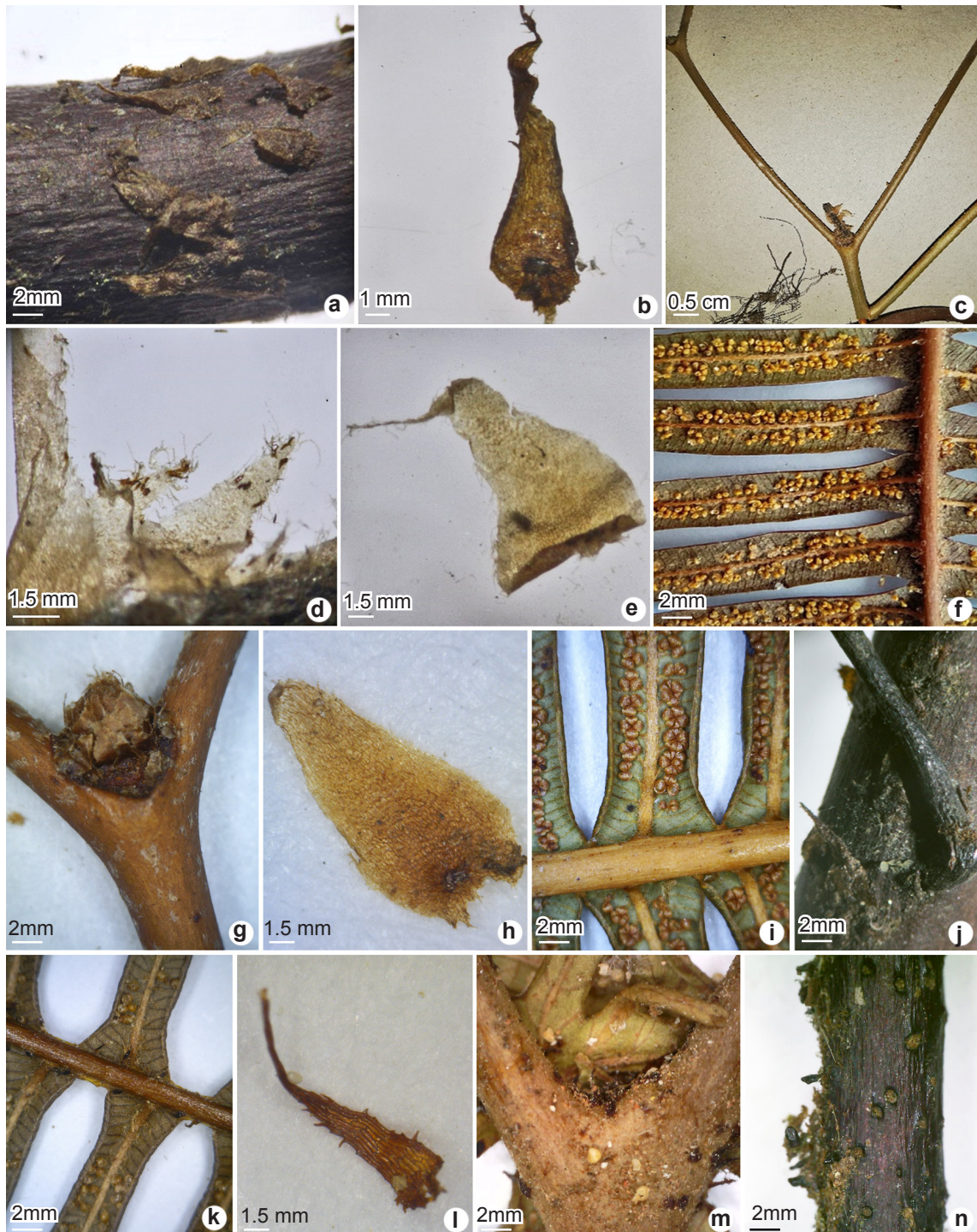


Figure 4 – a-f. *Sticherus brevitomentosus* – a. rhizome detail; b. rhizome scale; c. frond pseudodichotomy; d. bud scales; e. bud scale details; f. abaxial surface. g-j. *Sticherus nudus* – g. bud; h. bud scale detail; i. abaxial surface; j. rhizome detail. k-n. *Sticherus remotus* – k. abaxial surface detail; l. bud scale; m. bud; n. rhizome detail.

and up to Bolivia. In Brazil, this species has only been reported in the Amazonas region in montane moist forest between 2,000–2,200 m above sea level (Østergaard Andersen & Øllgaard 2001; Lima & Salino 2018b). This is the first record of this species for Colombia. In Quindío, it was only found in the municipality of Pijao, at an average altitude of 1,950 m above sea level.

Apparently uncommon, it lives on the edges of moist mountain forest roads and roadways. In Colombia, it was found at 1,950 meters above sea level. This species is morphologically closely related to *S. bifidus* and *S. nudus*, but it is recognized for having pale brown, lance-shaped and rigid rhizome scales, and buds with many triangular scales with entire margins and ciliate tips.

4.3. *Sticherus nudus* (Moritz) Nakai, Bull. Natl. Sci. Mus. 29: 23. 1950. Type: VENEZUELA. Caracas, 1856, Moritz 452 (B! photo). Fig. 4g-j

Rhizomes are 3–5 mm thick, with brown to dark-brown triangular scales, with cartilaginous margins. Fronds are 2–3-bifurcate. Ultimate branches are 7.8–11.9 cm long \times 2.1–3.2 cm wide, lanceolate, with pinnatifid apex and truncate base. Ultimate segments are 15–27 \times 2.4–3.6 cm, linear, with midrib sparsely covered with ovate scales, laminar tissue and secondary veins are glabrescent. Buds covered with light-brown, oval to round scales. Veins are 1-bifurcate. Sori with 4–5 sporangia per sori, paraphysis absent.

Examined material: QUINDÍO: Calarcá, Ruta Calarcá-Alto de La Línea, Finca Villanueva, 1,770 m, 04°31'32"N, 76°37'01"W, 17.X.2019, *F. Beltrán et al.* 215 (HUQ); Ruta Calarcá-Alto de La Línea, Comunidad El Destapado, 2,160 m, 04°31'28"N, 75°36'10"W, 31.X.2019, *F. Beltrán & C.A. Agudelo H.* 223 (HUQ); Ruta Calarcá-Alto de La Línea, Comunidad El Destapado, 2,270 msnm, 04°31'46"N, 75°35'40"W, 31.X.2019, *F. Beltrán & C.A. Agudelo H.* 227 (HUQ). FILANDIA: Finca hotel Paisaje Cafetero, vía a Quimbaya, 1,640 m, 04°38'03"N, 75°41'19", 27.II.2020, *F. Beltrán et al.* 262 (HUQ); Zona cafetera, fonda Patio Bonito, Nuevo Paraíso, vía a Quimbaya, 1,400 m, 04°37'37"N, 75°44'17"W, 27.II.2020, *F. Beltrán et al.* 269 (HUQ). GÉNOVA: Vereda Cumaral Alto, Finca Monasterio, 1,830 m, 04°09'34"N, 75°50'01"W, 14.XI.2019, *F. Beltrán et al.* 239 (HUQ). MONTENEGRO: Vía a Círcasia, finca Montebello, cerca de la Fonda Zulia, 1,620 m, 04°35'36"N, 75°40'53"W, 4.IX.2020, *F. Beltrán M. & C.A. Agudelo H.* 280 (HUQ). PIJAO: Vereda La Quamba, cerca del puente La Quamba, 1,950 m, 04°21'54"N, 75°41'06"W, 15.IX.2020, *F. Beltrán M. & C.A. Agudelo H.* 293 (HUQ).

Sticherus nudus occurs in South America, in the Andean region of Colombia and Venezuela (Gonzales & Kessler 2011). In Colombia, it has been found in eight departments (Boyacá, Cundinamarca, Caldas, Cauca, Huila, Magdalena, Putumayo, and Quindío) with a greater presence in Cundinamarca, Boyacá, and Cauca (Murillo *et al.* 2008). In Quindío, eight populations were found, distributed across five municipalities (Calarcá, Filandia, Génova, Montenegro, and Pijao),

Sticherus nudus form very dense colonies in open habitats, in montane forests, between 1,400–2,700 m above sea level, being more abundant at 2,000 m above sea level. It is primarily recognized because the first branches are longer than the second, and the branches are curved. *Sticherus nudus* can be confused with *S. brevitomentosus*, due to not having pectinate segments on the proximal branches, generally flat segments, with little scaly branches, oval-lanceolate to oval, papery and whitish scales, which are opaque to brown when dried. However, *S. nudus* differs from *S. brevitomentosus* due to the glabrescent abaxial surface of the ultimate branches, while *S. brevitomentosus* has a pubescent abaxial surface.

4.4. *Sticherus remotus* (Kaulf.) Chrysler, Amer. J. Bot. 31: 483. 1944. Type: BRAZIL. undated, Chamisso s.n. (holotype LZ destroyed; lectotype LE [LE00000264], photo!, chosen by Lellingner 1989: 232). Fig. 4k-n

Rhizomes are 3.5–4.3 mm thick, with brown, rigid, narrow-triangular scales, with dentate margins. Fronds are 2–3-bifurcate. Ultimate branches are 25–33 cm long \times 4–5 cm wide, linear, with pinnatifid apex and reduced base. Ultimate segments are 2.5–4.5 \times 0.4 cm, linear and remote, with brown to dark scales in the abaxial surface. Buds with dark, linear to lanceolate scales, pseudostipule present. Veins are 1-bifurcate. Sori with 4–6 sporangia per sori, paraphysis absent.

Examined material: QUINDÍO: Filandia, Zona cafetera, fonda Patio Bonito, Nuevo Paraíso, vía a Quimbaya, 1,520 m, 04°37'51"N, 75°43'18"W, 27.II.2020, *F. Beltrán et al.* 268 (HUQ). MONTENEGRO: Sector La Soledad, 1,270 m, 04°33'33"N, 75°44'54"W, 27.II.2020, *F. Beltrán et al.* 273 (HUQ). PIJAO: Vía al páramo de Chili, 1,980 m, 04°18'27"N, 75°42'09"W, 15.IX.2020, *F. Beltrán M. & C.A. Agudelo H.* 298 (HUQ).

Sticherus remotus occurs in lowlands and low mountainous areas of Bolivia, Brazil, Colombia, Costa Rica (Cocos Island), Cuba, Ecuador, French Guiana, Grenada, Guyana, Panama, Peru,

Puerto Rico, Surinam, Trinidad, and Venezuela (Gonzales & Kessler 2011; Lima & Salino 2018b). In Colombia, it is found in seven departments (Amazonas, Caquetá, Cundinamarca, Nariño, Quindío, Valle de Cauca, and Vaupés), with a higher presence in Cundinamarca and Valle de Cauca. In Quindío, it is found in Filandia, Montenegro and Pijao, at altitudes of 1,270–1,980 m, with an average altitude range of 1,520 m.

Sticherus ramotus is widely distributed in moist forests, often near road edges, landslides, exposed grassy slopes, rocky habitats, and along the edges of moist roads. It is readily recognized by the remote segments in the ultimate branches.

4.5. *Sticherus revolutus* (Kunth) Ching, Sunyatsenia 5(4): 285. 1940. Type: ECUADOR. LOJA: Saraguro, Humboldt & Bonpland s.n. (holotype P, isotypes B, US). Fig. 5a-f

Rhizomes are 2.5–3.6 mm thick, with dark-brown triangular scales with dentate margins. Fronds are 3–5 bifurcate. Ultimate branches are 8–12 cm long \times 1–2.2 cm wide, linear, with pinnatifid apex and reduced base. Ultimate segments are 1–1.5 \times 0.5–1 cm, deltoid to triangular, abaxial surface with pale to brown triangular scales with ciliate margins on the rachis, glabrous on the midrib and laminar tissue. Buds with light-brown triangular scales with ciliate margins, pseudostipule present. Veins are 1-bifurcate. Sori with 4–6 sporangia per sori, paraphysis absent.

Examined material: QUINDÍO: Calarcá La Sonadora, finca Maracaibo, 2,810 m, 04°27'12"N, 75°37'17"W, 1.II.2020, *F. Beltrán & C.A. Agudelo H. 250* (HUQ).

Sticherus revolutus is very common in high-altitude mountains such as those in Bolivia, Colombia, Costa Rica, Ecuador, Guyana, Mexico, Panama, Peru, and Venezuela (Gonzales & Kessler 2011). In Colombia, it is recorded in ten departments (Antioquia, Boyacá, Caldas, Cauca, Cundinamarca, Nariño, Norte Santander, Putumayo, Quindío, and Santander), with a higher presence in Cundinamarca and Antioquia. This species grows at altitudes between 1,400–3,300 m above sea level. In Quindío, only one population was found in the municipality of Calarcá, at 2,810 m.

It can be found along roadsides, accompanied by grassy edges, open habitats, humid mountain forests, and shrubby páramos. Although only found in one location, its presence could be expected at similar altitudes in the municipalities of Pijao, Génova, and Salento. *Sticherus revolutus* can be distinguished from the other *Sticherus*

species in Quindío by its deltoid segments, prominent squamophores in the rhizome and 4–5-bifurcate fronds.

4.6. *Sticherus rubiginosus* (Mett.) Nakai, Bull. Natl. Sci. Mus. 29: 28. 1950. Type: COLOMBIA. Puente Nacional, 1650m, Lindig 71 (holotype B!, photo). Fig. 5g-i

Rhizome is 2.3–3.7 mm thick, with orange to brown lanceolate scales, with ciliate margins. Fronds are (1–)2–3 bifurcate. Ultimate branches are 7.5–12 \times 2.5–3.5 cm, lanceolate, with pinnatifid apex and reduced base. Ultimate segments are 15–30 \times 3–5 mm, linear, its margins usually revolute, pruinose abaxial surface, with red triangular scales with ciliate margins in the midrib and secondary veins. Buds with orange to red, triangular scales, with ciliate margins; pseudostipule usually present. Veins are 1-bifurcate. Sori with 5–6 sporangia per sori, paraphysis absent.

Examined material: QUINDÍO. Calarcá: vía Calarcá - La Sonadora, finca Maracaibo, 2,860 m, 04°26'41"N, 75°37'16"W, 1.II.2020, *F. Beltrán & C.A. Agudelo H. 249* (HUQ). GÉNOVA: Vereda Cumaral Alto, Finca Monasterio, adelante de la escuela, 1,885 m, 04°08'59"N, 75°50'29"W, 14.XI.2019, *F. Beltrán et al. 240*, (HUQ); Vereda Cumaral Alto, Finca Monasterio, adelante de la escuela, 1,885 m, 04°08'59"N, 75°50'29"W, 14.XI.2019, *F. Beltrán et al. 241* (HUQ). Salento, carretera de la autopista del café que conduce hasta Boquía, vía a Salento, 1 km adelante, 1,980 m, 04°39'28"N, 75°35'49"W, 25.II.2020, *F. Beltrán et al. 258*, (HUQ); Vía a La Ceja y volcán Machín, finca Sestillal, 2,300 m, 04°36'60"N, 75°33'11"W, 21.IX.2020, *F. Beltrán & C.A. Agudelo H. 310* (HUQ).

Sticherus rubiginosus is common in the mountains of Bolivia, Colombia, Costa Rica, Ecuador, Peru, Puerto Rico, Trinidad, and Venezuela (Gonzales & Kessler 2011). In Colombia, it is widely distributed throughout the Andes Mountain range in 12 departments (Antioquia, Boyacá, Caldas, Cauca, Cundinamarca, Huila, Magdalena, Norte Santander, Putumayo, Quindío, Santander, Valle del Cauca), with a greater presence in Cundinamarca and Antioquia (Murillo *et al.* 2008). In Quindío, five populations were found, distributed in three municipalities, at an altitude of 1,885–2,860 meters above sea level. In the municipality of Salento, it was very abundant at altitudes greater than 2,000 meters above sea level.

Sticherus rubiginosus grows in a variety of habitats, especially in open areas near roadsides,

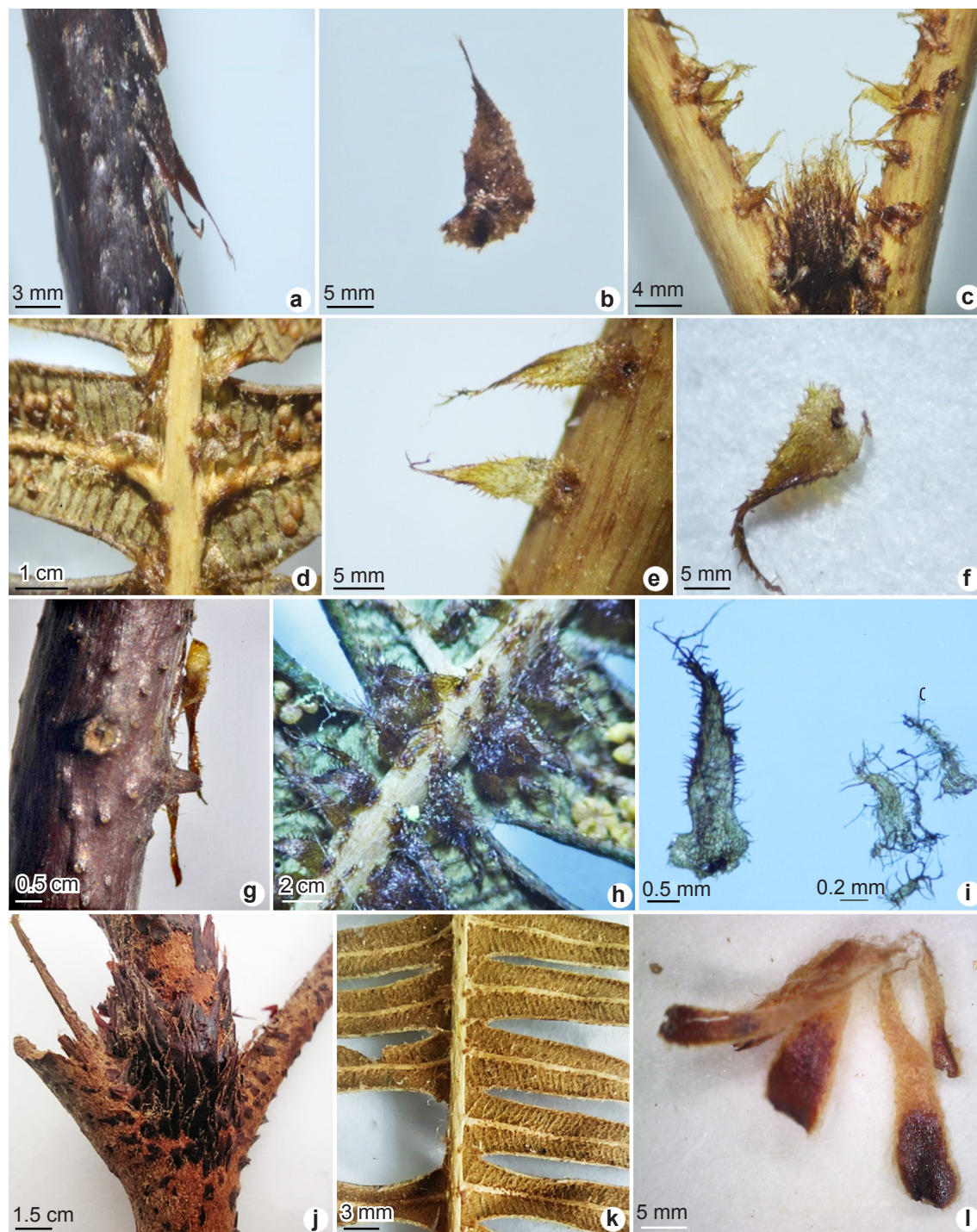


Figure 5 – a-f. *Sticherus revolutus* – a. rhizome detail; b. rhizome scale; c. bud; d. abaxial surface; e. rachis scale; f. bud scale. g-i. *Sticherus rubiginosus* – g. rhizome detail; h. abaxial surface; i. bud scale and rachis scales. j-l. *Sticherus tomentosus* – j. frond pseudodichotomy; k. abaxial surface; l. bud scales.

and in heavily disturbed mountain moist forests, such as on exposed slopes and landslide areas near streams. It is considered a pioneer species that grows in open soils, rapidly growing, forming dense shrubbery in road edges and slopes. It may be recognized and differs from the other *Sticherus* species in Quindío due to the presence of reddish to orange bud scales.

4.7. *Sticherus tomentosus* (Cav. ex Sw.) A. R. Sm., Ann. Missouri Bot. Gard. 77: 255. 1990. Type: PERU. Collector unknown, “Herb. Cavanille” (holotype S!, photo). Fig. 5j-l

Rhizome is 3.4–4.8 mm thick, with dark-brown to reddish lanceolate scales, with ciliated margins. Fronds are 2–3-bifurcate. Ultimate branches are 30–60 × 3.4–4.44 cm, linear to lanceolate, with pinnatifid apex and reduced base. Ultimate segments are 2.2–3.5 × 0.5–0.8 cm, linear, with usually plane margins, tomentose abaxial surface, covered by arachnoid scales on the midrib, secondary veins and laminar tissue, triangular red to brown scales with ciliate margins at the midrib. Buds with dark-brown lanceolate scales with ciliate margins. Veins are 1-bifurcate. Sori with 3–5 sporangia per sori, paraphysis absent.

Selected material: QUINDÍO: Calarcá, Via Calarcá - La Sonadora, finca Maracaibo, 2,880 m, 04°26'38"N, 75°37'17"W, 1.II.2020, F. Beltrán & C.A. Agudelo H. 248 (HUQ). Via Calarcá - La Sonadora, finca Maracaibo, 2,460 m, 04°28'07"N, 75°37'20"W, 1.II.2020, F. Beltrán C.A. Agudelo H. 251 (HUQ).

Sticherus tomentosus is found in the mountains of Guatemala, the highlands of Guayana in southeastern Venezuela (expected in adjacent Guyana), and in the Andes, in northwestern Colombia, Ecuador, Peru, and Venezuela (Gonzales & Kessler 2011). In Colombia, it is found in seven departments (Antioquia, Choco, Santander, Putumayo, Boyacá, Caldas, and Quindío), with a greater presence in Antioquia and Santander (Murillo *et al.* 2008). In Quindío, only two populations were found in the municipality of Calarcá, at an altitude of 2,460–2,880 meters above sea level.

Sticherus tomentosus is commonly found along the edges of humid forests and roads, on landslides, and along streams. *Sticherus tomentosus* may be distinguished from the other *Sticherus* species in Quindío by its large and robust ultimate branches, with densely tomentose abaxial surface, and coriaceous fronds.

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Data availability statement

In accordance with Open Science communication practices, the authors inform that there is no data sharing of this manuscript.

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