

Flora of Viçosa, Minas Gerais State, Brazil: the ancient fern orders Gleicheniales and Osmundales (Polypodiopsida)

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ABSTRACT – (Flora of Viçosa, Minas Gerais State, Brazil: the ancient fern orders Gleicheniales and Osmundales (Polypodiopsida)). In the Municipality of Viçosa, one family, three genera, and five species of Gleicheniales occur: *Dicranopteris flexuosa*, *Gleichenella pectinata*, *Sticherus bifidus*, *S. lanuginosus*, and *S. nigropaleaceus* (Gleicheniaceae). All these species are very common in the area, forming dense thickets (“gleiquenais”) in disturbed areas, and co-occurring in these thickets. *Dicranopteris flexuosa*, *G. pectinata*, and *S. bifidus* are widespread in the Neotropics; *Sticherus lanuginosus* is widespread in South America and Costa Rica; and *S. nigropaleaceus* is endemic to the Brazilian Atlantic Forest. We provide nomenclatural corrections for *S. lanuginosus*. In Osmundales, only one species is found in Viçosa, occurring in marshes: *Osmunda palustris* (Osmundaceae). The taxonomy of *Osmunda* is still controversial, with the main Brazilian taxon named as *O. palustris*, *O. regalis*, *O. regalis* subsp. *palustris*, *O. regalis* var. *spectabilis*, *O. spectabilis*, or *O. spectabilis* var. *palustris*. In our view, the best name for the taxon occurring in Viçosa is *O. palustris*, a taxon likely with a Neotropical distribution. Our taxonomic judgment is based on the re-interpretation of recent phylogenetic works, together with populational and morphological studies comparing Brazilian specimens with specimens from the U.S.A. We present descriptions, illustrations, examined specimens, taxonomic comments, and keys to identification.

Keywords: gleiquenal, gleiquênia, *Osmunda palustris*, *Osmunda regalis*, *Osmunda spectabilis*, *Sticherus*

RESUMO – (Flora de Viçosa, Estado de Minas Gerais, Brasil: as ordens de samambaias anciãs Gleicheniales e Osmundales (Polypodiopsida)). No município de Viçosa, uma família, três gêneros e cinco espécies de Gleicheniales ocorrem: *Dicranopteris flexuosa*, *Gleichenella pectinata*, *Sticherus bifidus*, *S. lanuginosus* e *S. nigropaleaceus* (Gleicheniaceae). Todas estas espécies são extremamente comuns na região, formando densos gleiquenais em áreas alteradas, e co-ocorrendo nestes gleiquenais. *Dicranopteris flexuosa*, *G. pectinata* e *S. bifidus* são amplamente distribuídos na região neotropical; *Sticherus lanuginosus* é amplamente distribuído na América do Sul e Costa Rica; e *S. nigropaleaceus* é endêmico à Floresta Atlântica brasileira. São providas correções nomenclaturais em *S. lanuginosus*. Em Osmundales, apenas uma espécie é encontrada em Viçosa, em ambientes paludosos: *Osmunda palustris* (Osmundaceae). A taxonomia de *Osmunda* é ainda controversa, na qual o principal táxon brasileiro vem sendo identificado como *O. palustris*, *O. regalis*, *O. regalis* subsp. *palustris*, *O. regalis* var. *spectabilis*, *O. spectabilis*, ou *O. spectabilis* var. *palustris*. Aqui, sugere-se que o melhor nome a ser adotado ao táxon ocorrente em Viçosa seja *O. palustris*, e ele provavelmente tenha distribuição neotropical. A decisão taxonômica foi baseada na re-interpretação de estudos filogenéticos recentes e em estudos populacionais e morfológicos, comparando espécimes brasileiros e norte-americanos. São apresentadas descrições, ilustrações, lista de material examinado, comentários taxonômicos e chaves de identificação.

Palavras-chave: gleiquenal, gleiquênia, *Osmunda palustris*, *Osmunda regalis*, *Osmunda spectabilis*, *Sticherus*

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Introduction

Gleicheniales and Osmundales are two ancient orders of ferns that arouse in the *second radiation of the filicaleans*, much before the modern Polypodiales. Both orders have fossils records starting on the Permian, between 250 and 300 million years ago (Rothwell & Stockey 2008; Smith *et al.* 2008). Gleicheniales is characterized by its species having generally long-creeping, underground rhizomes, which are protostelic or solenostelic, pseudo-dichotomous leaves, and sporangia with oblique annulus that are not very distinguishable from the capsule cells (Tryon & Tryon 1982; Smith *et al.* 2008). Osmundales is characterized by massive stems with unique ectophloic solenosteles with rings of discrete xylem strands, hemi-dimorphic or dimorphic leaves, and large sporangia with lateral annulus (Tryon & Tryon 1982; Smith *et al.* 2008).

Gleicheniales embraces three families (*sensu* PPG I, 2016): Dipteridaceae, with two genera, and 11 species; Gleicheniaceae, with six genera, and ca. 160 species; and Matoniaceae, with two genera, and four species. Among these families, only Gleicheniaceae occurs in Brazil, represented by *Dicranopteris* (with three species), *Gleichenella* (one sp.), and *Sticherus* (10-15 spp.) (Gonzales & Kessler 2011; Lima & Salino 2018, 2020). The genus name *Gleichenia* has been and is sometimes applied to Brazilian plants (*e.g.*, Lisboa 1956; Sehnem 1970), but this genus is Paleotropical. On the other hand, common names in Portuguese, such as “*gleiquênia*” and “*gleiquenal*” (= Gleicheniaceae thickets), are correctly used for these plants. In Brazil, such plants are very common, forming dense thickets in disturbed, open areas (*e.g.*, Sehnem 1970; Windisch 1994; Prado 2004a; Schwartsburd & Labiak 2007; Lima & Salino 2018). The ecological niche of pioneer plants occurring in disturbed, sunny areas with poor soils, is common across the family (Kessler & Smith 2018), and it is resulted from their habit allied to phytotoxic compounds they produce (Østergaard-Andersen & Ølgaard, 2001). *Gleichenella pectinata*, for example, produces compounds that are allelopathic to many other plants (Muller *et al.* 2007), and with insecticide action (Moliterno & Abreu 2016).

Gleicheniaceae, as currently circumscribed (*e.g.*, PPG I 2016) is monophyletic, but some genera still require new and modern circumscriptions: the Old World genus *Gleichenia* has shown to be polyphyletic (Perrin *et al.* 2007; Li *et al.* 2010; Wei *et al.* 2021), and the Pantropical *Sticherus* has shown to be paraphyletic (Lima *et al.* 2023). According to Lima *et al.* (2023), *Dicranopteris* and *Gleichenella* are monophyletic, and the Brazilian species of *Sticherus* form a phylogenetic group along with the Neotropical remaining species of *Sticherus*. Further studies should review whether the Brazilian species should be kept in *Sticherus s. str.*, or if they should be combined into another genus name.

The number of Brazilian species of *Sticherus* is still controversial, due to two conflicting revisionary works on

the genus: while Gonzales & Kessler (2011) recognized 12 species in Brazil (four of which occurring in Minas Gerais), Lima & Salino (2018) recognized 11 species (seven in Minas Gerais). At first sight, 11 and 12 species seem similar, but a detailed look at their works shows there are many differences on which species names are accepted and which are synonymized. Later, Lima & Salino (2020) also recognized 12 species.

Osmundales comprises solely family Osmundaceae, with four extant genera and about 20 extant species (PPG I 2016): *Claytosmunda* (one species), *Leptopteris* (six spp.), *Osmunda* (ca. four spp.), *Osmundastrum* (one sp.), *Plenasium* (ca. four spp.), and *Todea* (two spp.). Phylogenetically, Osmundales plays an important role as a link between the eusporangiate and the leptosporangiate ferns: they have leptoesporangia, but formed by more than one initial cell, and enormous in size, when compared to other leptoesporangia (Tryon & Tryon 1982; Smith *et al.* 2008).

In Brazil, Osmundaceae is represented by *Osmunda* and *Osmundastrum* (Sylvestre *et al.* 2020, 2022). *Osmundastrum* is represented solely by the sub-comopolitan *Osmundastrum cinnamomeum* (L.) C. Presl. The species of *Osmunda*, on the other hand, are still debatable. Many authors considered two species in Brazil: one widespread and another endemic to the *Cerrado* region and southern Brazil. The endemic species has been commonly named as *Osmunda gracilis* Link (by Sturm 1859; Fée 1869; Sehnem 1967; Arana & Ponce 2015; Sylvestre *et al.* 2020), but recently as *Osmunda piresii* Brade (Sylvestre *et al.* 2022). The widespread taxon has been treated either as a cosmopolitan species, *Osmunda regalis* L. (*e.g.*, Lisboa 1956; Tryon & Tryon 1982; Schwartsburd & Labiak 2007), as an American variety, *Osmunda regalis* var. *spectabilis* (Willd.) A. Gray (*e.g.*, Prado 2004b), as an American species, *Osmunda spectabilis* Willd. (*e.g.*, Fée 1869; Arana & Ponce 2015; Sylvestre *et al.* 2020, 2022), as a Neotropical variety, *Osmunda spectabilis* var. *palustris* (Schrad.) C. Presl (*e.g.*, Presl 1845), as a Brazilian subspecies, *Osmunda regalis* subsp. *palustris* (Schrad.) Á. Löve & D. Löve (*e.g.*, Löve & Löve 1977), or as a Brazilian species, *Osmunda palustris* Schrad. (*e.g.*, Sturm 1859; Sehnem 1967).

Phylogenetic studies show that *Osmunda regalis s.l.*, considered as a cosmopolitan species, is artificial, rendering a paraphyletic species (Metzgar *et al.* 2008; Tsutsumi *et al.* 2021). Rather, there are several monophyletic clades within *Osmunda*, including cryptic species of the *Osmunda regalis*-complex, well-defined species, as well as hybrids. Seven clades were presented by Tsutsumi *et al.* (2021): 1. Containing *O. japonica* Thunb. And *O. lancea* Thunb.; 2. Containing only *O. lancea*; 3. Containing “*O. regalis*” from the Americas; 4. Containing *O. regalis* from Europe; 5. Containing “*O. regalis*” from Cameroon; 6. Containing “*O. regalis*” from Madagascar; and 7. Containing “*O. regalis*” from India and *O. hybrida* Tsutsumi, S. Matsumoto, Y. Yatabe, Y. Hiray. & M. Kato. The type of *O. regalis* is European, therefore the

European clade retains the name *O. regalis* s. str. Judging the American clade as a monophyletic species, Sylvestre *et al.* (2022) adopted the name *O. spectabilis* for the species widespread in the Americas.

Continuing the papers on the Fern Flora of Viçosa, in which Medeiros & Schwartzburd (in press) presented the Blechnaceae, Pena & Schwartzburd (2022), the Dennstaedtiaceae, Lindsaeaceae and Saccolomataceae, Matos & Schwartzburd (2022), the Dryopteridaceae, Gonçalves da Silva & Schwartzburd (2017), the Polypodiaceae, Miranda & Schwartzburd (2017), the Salviniaceae (Marsileaceae and Salviniaceae), and Rabelo & Schwartzburd (2016), the Schizaeales (Anemiaceae and Lygodiaceae), we here present the taxonomic treatment for Gleicheniales (Gleicheniaceae) and Osmundales (Osmundaceae). So far, these publications have unveiled the occurrence of 64 species and seven hybrids for the local Flora. Among these taxa, 25 are endemic to the Brazilian Atlantic Forest, and among them, one species, one variety and three hybrids have been described as new to science. In addition, six names have been rescued from recent synonymy (including the proposal of one new combination), and three hybrids have been newly recorded for the Brazilian territory.

Material and methods

We have been collecting ferns in Viçosa since July of 2012, especially in the protected areas, such as *Estação Mata do Paraíso*, *Recanto das Cigarras*, *Mata do Seu Nico*, and smaller forest fragments. In the case of Gleicheniales, on the other hand, the disturbed areas are the best place to find them. And so, our main collections are from disturbed areas, alongside roads, and forest clearings. The forest fragments of Viçosa are considered Semi-Deciduous Seasonal Forest (IBGE 2012), and they range from around 600 to 900 m altitude (Gonçalves da Silva & Schwartzburd 2017). We collected specimens following usual procedures for ferns (e.g., Fidalgo & Bononi 1989).

We observed the ferns under magnifying glass to see hairs, scales, grooves, and veins, and prepared specimens and incorporated them into herbarium VIC, with duplicates sent to UCS (and others to be sent to RB and SP). We contributed with 73 herbarium specimens. We analyzed the fern collection of VIC, in which another 25 specimens were studied. We also consulted herbaria online, to search for additional specimens from Viçosa, especially those collected by Y. Mexia and J.G. Kuhlmann, from the following websites: SpeciesLink (<http://www.splink.org.br/>), ReFlora (<http://floradobrasil.jbrj.gov.br/reflora/herbarioVirtual/>), Jstor Global Plants (<https://plants.jstor.org/>), and the Pteridophyte Collections Consortium (<http://www.pteridportal.org/portal/collections/>). Another 24 specimens were studied online. Morphological terms follow Lellinger (2002). The illustrations were prepared by Reinaldo Pinto.

Specifically, for Osmundaceae, one of us (Schwartzburd) have collected and studied populations in the field in many

places in Brazil (in the States of Minas Gerais, Espírito Santo, and Paraná), in the USA (State of Vermont), and in Italy.

Results and discussion

Diversity and Distribution – From Viçosa and surroundings, we report the occurrence of one family, three genera, and five species of Gleicheniales: *Dicranopteris flexuosa*, *Gleichenella pectinata*, *Sticherus bifidus*, *S. lanuginosus*, and *S. nigropaleaceus* (Gleicheniaceae). All these species are extremely common in the area, forming dense thickets (“gleiquenais”) in disturbed areas, and co-occurring in these thickets. The slopes (“barrancos”) around Viçosa are either tamed by the Gleicheniaceae, either by exotic grasses (“braquiária”, “capim-gordura”, etc.). There is an apparent competition between the group that will form the thicket.

Dicranopteris flexuosa, *Gleichenella pectinata*, and *Sticherus bifidus* are widespread in the Neotropics; *Sticherus lanuginosus* is widespread in South America; and *S. nigropaleaceus* is endemic to the Brazilian Atlantic Forest. The three *Sticherus* spp. from Viçosa are considered valid by both the treatments of Gonzales & Kessler (2011) and Lima & Salino (2018, 2020).

For Osmundales, only one species is found in Viçosa, occurring exclusively on marshes, on flooded soils: *Osmunda palustris* (Osmundaceae). The taxonomy of *Osmunda* is still controversial, with the main Brazilian taxon identified as either *O. palustris* (e.g., Sturm 1859; Sehnem 1967), *O. regalis* (e.g., Lisbôa 1956; Tryon & Tryon 1982; Schwartzburd & Labiak 2007), *O. regalis* var. *spectabilis* (e.g., Prado 2004b), *O. regalis* subsp. *palustris* (e.g., Löve & Löve 1977), *O. spectabilis* (e.g., Fée 1869; Arana & Ponce 2015; Sylvestre *et al.* 2020, 2022), or *O. spectabilis* var. *palustris* (e.g., Presl 1845). Tsutsumi *et al.* (2021) clearly showed that *Osmunda regalis*, considered as a subcosmopolitan species, is paraphyletic. Rather, to reach a monophyletic classification, the geographical clades of *O. regalis* s.l. should be regarded as different species. *Osmunda regalis* s. str. is kept for the European species, since its type is European. Tsutsumi *et al.* (2021: Figure 5) presented a clade formed by populations from the Americas, which they named as the “American lineage” – this led Sylvestre *et al.* (2022), for example, to name the widespread “species” from the Americas as *O. spectabilis*, whose type is from the USA. On the other hand, the lack of samples from the Neotropics masked the formation of two sub-clades clearly segregated within the American clade: one formed by the five samples of *Osmunda* from the USA, and another formed by a sample from Mexico and a sample from Misiones, Argentina, in the border with Brazil and Paraguay.

After our studies on living populations and morphological comparisons between *Osmunda* populations from Brazil (from Minas Gerais, Espírito Santo, and Paraná) and two populations from the USA (Vermont), we reached the

conclusion that they represent two very distinct entities that we would regard as two different species: *Osmunda palustris* from Brazil (whose type is from Brazil), probably occurring in the whole Neotropics, and *O. spectabilis* s. str. occurring in the USA (and possibly in Canada). This conception is similar to those of Sturm (1859) and Sehnem (1967) for the adoption of the species level to the Brazilian (Neotropical) taxon, and also especially similar to that of Presl (1845), who pointed out differences between the US/Canadian *O. spectabilis* var. *spectabilis* and the Neotropical *O. spectabilis* var. *palustris* (for which he cited specimens from Mexico and Brazil). Our judgment is based on a different interpretation of the phylogenetic hypothesis presented by Tsutsumi *et al.* (2021), on the field studies and collections of populations of *Osmunda* spp. in several places in Brazil, in the USA, and in Italy, and in detailed morphological comparisons between them. This is a primary hypothesis, which, may be further investigate in the future with the addition of Brazilian samples (and other Neotropical as well) to the global phylogeny of *Osmunda* – which, in fact, we are starting to perform.

Regarding the habit and habitat differences, *Osmunda palustris* differs from *O. spectabilis* by living in tropical to sub-tropical habitats and being evergreen, whereas *O. spectabilis* lives on temperate habitats, commonly under the snow in some months, in which they loose all their leaves. The leaves of both species are different in size as well, with those of *O. palustris* reaching only 70-100 cm long (to 120 cm maximum, in exceptional cases – Figure 4 a), whereas *O. spectabilis* has longer leaves, commonly 100-150 cm long.

Morphologically, in addition to the differences in leaf sizes, *Osmunda palustris* further differs from *O. spectabilis* by

the chartaceous to coriaceous laminae (*vs.* membranaceous), by the pinnae tapering at the apexes, producing apical pinnules ca. 1/3 the length of the lateral pinnules (*vs.* pinnae with conform apexes; the apical pinnules about the same length of the lateral ones), by the opposite to sub-opposite lateral pinnules (*vs.* alternate), and by the strongly raised veins (*vs.* immersed to slightly raised) (Figures 4 a-c *vs.* Figures 4 f-g). Some of these differences have already been pointed out by Tryon & Tryon (1982), but they did not consider the two taxa as distinct, and by Presl (1845), who considered them as two different varieties.

Taxonomic Treatment

Gleicheniales

Rhizomes protostelic, solenostelic, or with dicyclic solenosteles; leaves monomorphic or dimorphic; sporangia generally with oblique annuli, or rarely sub-vertical (Tryon & Tryon 1982; Kramer & Green 1990; Smith *et al.* 2006).

Gleicheniaceae C. Presl

Plants terrestrial or epipetric, commonly forming thickets. Rhizomes long-creeping, protostelic or rarely solenostelic; leaves monomorphic, indeterminate, generally pseudo-dichotomous, with buds at the furcations; veins free; sori abaxial, exsindusiate; sporangia with oblique annuli; spores trilete or monolete (Tryon & Tryon 1982; Kramer & Green 1990; Smith *et al.* 2006; Lima & Salino 2018).

Six genera: *Dicranopteris*, *Diplopterygium* (not occurring in Brazil), *Gleichenella*, *Gleichenia* (not occurring in Brazil), *Sticherus*, and *Stromatopteris* (not occurring in Brazil).

Key to genera of Gleicheniaceae from Viçosa

- 1. Rhizomes and laminar buds with scales *Sticherus*
- 1. Rhizomes and laminar buds with hairs
 - 2. Laminae isotomically branched; aplebioid pinnules present at the base of furcations *Dicranopteris*
 - 2. Laminae anisotomically branched; aplebioid pinnules absent *Gleichenella*

Dicranopteris Bernh.

Plants terrestrial or epipetric; rhizomes with hairs; leaves scandent; laminae isotomically branched; aplebioid pinnules present at the base of furcations; buds at the base of furcations covered with hairs; segments abaxially glabrous or with hairs; spores trilete (Tryon & Tryon 1982; Kramer & Green 1990; Lima & Salino 2018).

Dicranopteris flexuosa (Schrad.) Underw., Bull. Torrey Bot. Club 34(5): 254. 1907. *Mertensia flexuosa* Schrad.,

Gött. Gel. Anz. 863. 1824. *Gleichenia flexuosa* (Schrad.) Mett., Ann. Mus. Bot. Lugduno-Batavi 1: 50. 1863.

Figures 1 a-f

Plants terrestrial or rupestral, thicket-forming. Rhizomes stramineous, 2.5-3.6 mm diam.; hairs reddish-brown. Leaves scrambling, to 3 m long; stipes to 1 m long, 2.5-3.1 mm diam., greenish to stramineous, glabrous; laminae 1-5-furcate, isotomically divided; rachises glabrous; accessory leaflets present at pinnae bases and subsequent divisions; buds with stiff, reddish-brown hairs; ultimate

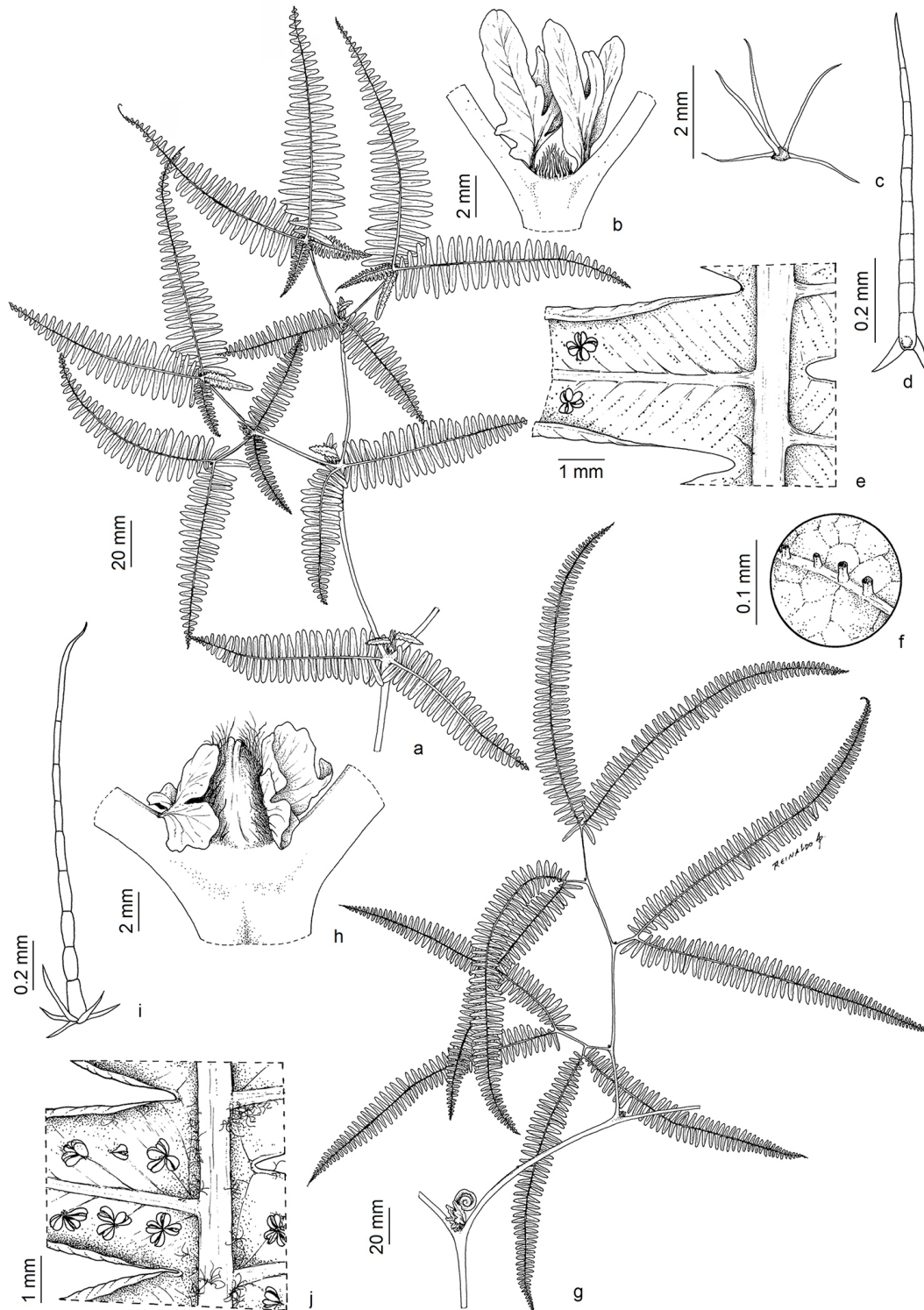


Figure 1. a-f. *Dicranopteris flexuosa*. (Schwartzburd 2827) a. Pinna. b. Bud, showing hairs. c. Laminar hair. d. Laminar hair. e. Segment, abaxially. f. Glandular hairs from veins. g-j. *Gleichenella pectinata*. (Miranda 59) g. Pinna. h. Bud, showing hairs. i. Laminar hair. j. Segment, abaxially.

segments linear; midveins abaxially with sparse, reddish-brown hairs, adaxially glabrous; veins 1-2-furcate, abaxially with globose, orange, glandular hairs, adaxially glabrous;

laminar tissue between the veins abaxially and adaxially glabrous; laminar margins flat.

Distribution: Widespread in the Neotropics. In Viçosa it is found on road-sides, disturbed areas, forest edges and ravines, under full sunlight exposure.

Material examined: BRAZIL. MINAS GERAIS: Viçosa, Belvedere, 11-IX-1977, “*Rosane & Rosângela*” s.n. (VIC-7931); Viçosa, Belvedere, 11-IX-1977, “*Rosane & Rosângela*” s.n. (VIC-7938); Viçosa, Belvedere, 11-IX-1977, “*Rosane & Rosângela*” s.n. (VIC-7939); Viçosa, Campus da UFV, final da mata da Biologia, 750 m, 16-VIII-2013, P.B. Schwartsburd et al. 2827 (VIC); Viçosa, Universidade Federal de Viçosa, ao final da PH Rolfs, próximo ao condomínio novo, 2-VI-2016, P.B. Schwartsburd et al. 3781 (UCS, VIC); Viçosa, Universidade Federal de Viçosa, ao final da PH Rolfs, próximo ao condomínio novo, 2-V-2016, P.B. Schwartsburd & N.S. Smith-Braga 3797 (VIC); Viçosa, campus da UFV, 31-III-2019, V.S. Miranda et al. 74 (UCS, VIC); Viçosa, campus da UFV, 31-III-2019, V.S. Miranda et al. 75 (VIC); Viçosa, campus da UFV, 31-III-2019, V.S. Miranda et al. 76 (VIC); Viçosa, campus da UFV, 31-III-2019, V.S. Miranda et al. 77 (VIC); Viçosa, campus da UFV, em frente ao Herbário, 31-III-2019, V.S. Miranda et al. 79 (VIC); Viçosa, Mata do Paraíso, 24-IX-2019, V.S. Miranda et al. 90 (VIC).

Dicranopteris flexuosa is easily recognized by the isotomically divided laminae with accessory leaflets at the base of pinnae and next branches, and thus differing from *Gleichenella pectinata*, which has anisotomically divided laminae without accessory leaflets. Both *D. flexuosa* and *G. pectinata* are thicket forming, differing from *Sticherus* spp., which do not form thickets, but grow within *D. flexuosa* and *G. pectinata* thickets (*gleiquenais*).

Gleichenella Ching

Plants terrestrial; rhizomes with hairs; leaves scandent; laminae anisotomically branched; aplebioid pinnules absent; buds at the base of furcations covered with hairs; segments abaxially glabrous or with hairs; spores monolete (Tryon & Tryon 1982; Kramer & Green 1990; Lima & Salino 2018).

Gleichenella pectinata (Willd.) Ching, Sunyatsenia 5(4): 276. 1940. *Mertensia pectinata* Willd., Kongl. Vetensk. Acad. Handl. 25: 168, t. 4. 1804. *Gleichenia pectinata* (Willd.) C. Presl, Reliq. Haenk. 1(1): 71. 1825. *Dicranopteris pectinata* (Willd.) Underw., Bull. Torrey Bot. Club 34(5): 260. 1907.

Figures 1 g-j

Plants terrestrial, thicket-forming. Rhizomes stramineous to brown, 3.7-4.8 mm diam; hairs stiff, brown. Leaves

scrambling, to 3 m long; petioles to 1.5 m long, 3.7-4 mm diam, greenish to stramineous; laminae 1-4-furcate, anisotomically divided; rachises glabrous; accessory leaflets absent; buds with stiff, brown hairs; ultimate segments linear; midveins abaxially with stellate hairs, adaxially glabrous; veins 1-2-furcate, abaxially with stellate hairs, adaxially glabrous; laminar tissue between the veins abaxially and adaxially glabrous; laminar margins revolute.

Distribution: Widespread in the Neotropics. In Viçosa it is found on road-sides, disturbed areas, forest edges and ravines, under full sunlight exposure.

Material examined: BRAZIL. MINAS GERAIS: Viçosa, ESAV, 24-XII-1958, H.S. Irwin 2308 (VIC); Viçosa, Campus da UFV, pastagem da Zootecnia, 20-V-1997 S.J.S. Neto s.n. (UCS, VIC-22923); Viçosa, Campus da UFV, Mata da Biologia, Barranco entre Belvedere I e Belvedere das Bandeiras, 10-IX-1998, G.E. Valente & L.A. Basílio 352 (VIC); Viçosa, Mata da Biologia, Recanto das Cigarras, primeira praça, 10-IX-1998, G.E. Valente & L.A. Basílio 354 (VIC); Viçosa, Mata da Prefeitura, 26-VII-1999, A.F. Carvalho 704 (VIC); Viçosa, Campus da UFV, final da Mata da Biologia, estrada 20°45'31"S, 42°51'56"W, 750 m, 16-VIII-2013, P.B. Schwartsburd et al. 2827b (VIC); Viçosa, Campus da UFV, Avenida P.H. Rolfs, Próximo ao R.U. 2, 2-VI-2014, P.B. Schwartsburd & T. Campos 3265 (UCS, VIC); Viçosa, Universidade Federal de Viçosa, ao final da PH Rolfs, próximo ao condomínio novo, 2-V-2016, P.B. Schwartsburd et al. 3778 (UCS, VIC); Viçosa, Universidade Federal de Viçosa, Estrada para a criação de Equídeos, 13-X-2016, P.B. Schwartsburd & N.S. Smith-Braga 3798 (UCS, VIC); Viçosa, Mata da Biologia, Recanto das Cigarras entre as churrasqueiras e Bandeiras, esquina da rotatória, 20°45'18"S, 42°10'40"W, 28-III-2019, V.S. Miranda et al. 56 (UCS, VIC); Viçosa, Mata da Biologia, Recanto das Cigarras entre as churrasqueiras e Bandeiras, esquina da rotatória, 20°45'18"S, 42°10'40"W, 28-III-2019, V.S. Miranda et al. 59 (UCS, VIC); Viçosa, Mata da Biologia, Recanto das Cigarras, 29-III-2019, V.S. Miranda et al. 66 (UCS, VIC).

See the comments of *Dicranopteris flexuosa* for comparison with *Gleichenella pectinata*.

Sticherus C. Presl

Plants terrestrial or epipetric; rhizomes with scales; leaves erect or scandent; laminae isotomically branched; aplebioid pinnules absent; buds at the base of furcations covered with scales; segments abaxially glabrous or with scales; spores monolete (Tryon & Tryon 1982; Kramer & Green 1990; Gonzales & Kessler 2011; Lima & Salino 2018).

Key to species of *Sticherus* from Viçosa

1. Leaves erect; ultimate segments about two times longer than wider; bud scales without blackish stains *S. lanuginosus*
1. Leaves prostrate or scandent; ultimate segments about four times longer than wider; bud scales entirely black or with black stains
 2. Leaves scandent; bud scales entirely black; laminar tissue between the veins abaxially glabrous *S. nigropaleaceus*
 2. Leaves prostrate; bud scales stramineous with blackish stains; laminar tissue between the veins abaxially lanose, with arachnoid scales *S. bifidus*

Sticherus bifidus (Willd.) Ching, Sunyatsenia 5(4): 282. 1940. *Mertensia bifida* Willd., Kongl. Vetensk. Acad. Nya Handl. 25: 168, t. 5, fig. B. 1804. *Gleichenia bifida* (Willd.) Spreng., Syst. Veg. ed. 16 [Sprengel] 4(1): 27. 1827. *Dicranopteris bifida* (Willd.) Maxon, N. Amer. Fl. 16(1): 60. 1909.

Figures 2 a-f

Plants terrestrial. Rhizomes brown, 2.2-3.3 mm diam; scales brown, laceate, rigid, with dentate margins. Leaves prostrate; stipes 20-40 cm long, 2.0-2.7 mm diam., greenish to brownish, with stramineous scales with fimbriate margins; rachises terete, with stramineous scales with blackish stains, with fimbriate margins; buds with stramineous scales with blackish stains; ultimate segments linear, about four times longer than wider; midveins abaxially with fimbriate scales and arachnoid scales, adaxially glabrous; veins 1-furcate, abaxially with fimbriate scales and arachnoid scales, adaxially glabrous; laminar tissue between the veins abaxially lanose, adaxially glabrous; laminar margins flat to revolute.

Distribution: Widespread in the Neotropics. In Viçosa it is found on road-sides, disturbed areas, forest edges and ravines, under full or part-time sunlight exposure.

Material examined: BRAZIL. MINAS GERAIS: Porto Firme, 10 km da estrada de Viçosa, Sítio São Domingos, 25-I-2014, *A. Gonçalves da Silva* 4 (VIC). Viçosa, ESAV, 24-V-1935, *J.G. Kuhlmann s.n.* (VIC-1903); Viçosa, Campus da UFV, Recanto das Cigarras, 1-VI-1986, *C.C. de Paula s.n.* (VIC-9652); Viçosa, Campus da UFV, Silvicultura, 16-XII-1986, *G.E. Valente & A.A. Azevedo 1* (UCS, VIC); Viçosa, Universidade Federal de Viçosa, Estação Mata do Paraíso, 20°48'04"S, 42°51'19"W, 800 m, 23-V-2013, *P.B. Schwartzburd & L. Rabelo-Sales* 2799 (UCS, VIC); Viçosa, continuação da P.H. Rolfs, próximo ao condomínio novo, 25-IV-2016, *P.B. Schwartzburd et al.* 3776 (UCS, VIC); Viçosa, continuação da P.H. Rolfs, próximo ao condomínio novo, 2-V-2016, *P.B. Schwartzburd et al.* 3779 (UCS, VIC); Viçosa, continuação da P.H. Rolfs, próximo ao condomínio novo, 2-V-2016, *P.B. Schwartzburd & N.S. Smith-Braga* 3795 (UCS, VIC); Viçosa, Universidade Federal de Viçosa,

Estação Mata do Paraíso, Trilha dos Alpes, 9-II-2017, *P.B. Schwartzburd. Et al.* 3875 (VIC); Viçosa, Recanto das Cigarras, entre as churrasqueiras e as Bandeiras, 28-III-2019, *V.S. Miranda et al.* 55 (VIC); Viçosa, Recanto das Cigarras, entre as churrasqueiras e as Bandeiras, 28-III-2019, *V.S. Miranda et al.* 57 (VIC); Viçosa, Recanto das Cigarras, 28-III-2019, *V.S. Miranda et al.* 60 (VIC); Viçosa, Recanto das Cigarras, 28-III-2019, *V.S. Miranda et al.* 62 (VIC); Viçosa, estrada Viçosa-Cajuri, BR 121, Córrego Canela, a caminho do Sítio da EVA, 31-III-2019, *V.S. Miranda et al.* 72 (UCS, VIC).

Sticherus lanuginosus (Moric. Ex Feé) Nakai, Bull. Natl. Sci. Mus. Tokyo 29: 20. 1950. *Mertensia lanuginosa* Moric. Ex Fée, Crypt. Vasc. Brésil 1. 202. 1869. *Gleichenia lanuginosa* (Moric. Ex Fée) Hieron., Hedwigia 48: 287. 1909.

Figures 2 g-l

Plants terrestrial. Rhizomes brown, 2.4-5.5 mm diam; scales brown, lanceate, with dentate to serrate margins. Leaves erect; petioles 50-90 cm long, 3.1-4.5 mm diam, greenish to stramineous, with stramineous, fimbriate scales and arachnoid hairs; rachises sulcate, with stramineous or brown scales; buds with stramineous scales; ultimate segments two times longer than wide; midveins abaxially with fimbriate scales and arachnoid hairs, adaxially glabrous; veins 1-forked, abaxially with fimbriate scales and arachnoid hairs, adaxially glabrous; laminar tissue between the veins abaxially with fimbriate scales and arachnoid hairs, adaxially glabrous; laminar margins plane to revolute.

Distribution: Widespread in South America (and also in Costa Rica). In Viçosa it is found on road-sides, disturbed areas, forest edges and ravines, under full sunlight exposure.

Material examined: BRAZIL. MINAS GERAIS: Viçosa, 1930, *Y. Mexia* 4856 (F, MICH, NY, UC, US, VIC); Viçosa, ESAV, 24-II-1959, *H.S. Irwin* 2730 (MICH, NY, TEX, UC, US, VIC); Viçosa, Belvedere, 11-IX-1977, "*Rosane & Rosângela*" *s.n.* (VIC-7937); Viçosa, Campus da UFV, Silvicultura, 6-XII-1986, *G.E. Valente & A.A. Azevedo* 4 (VIC); Viçosa, Campus da UFV, Silvicultura, 23-II-1987,

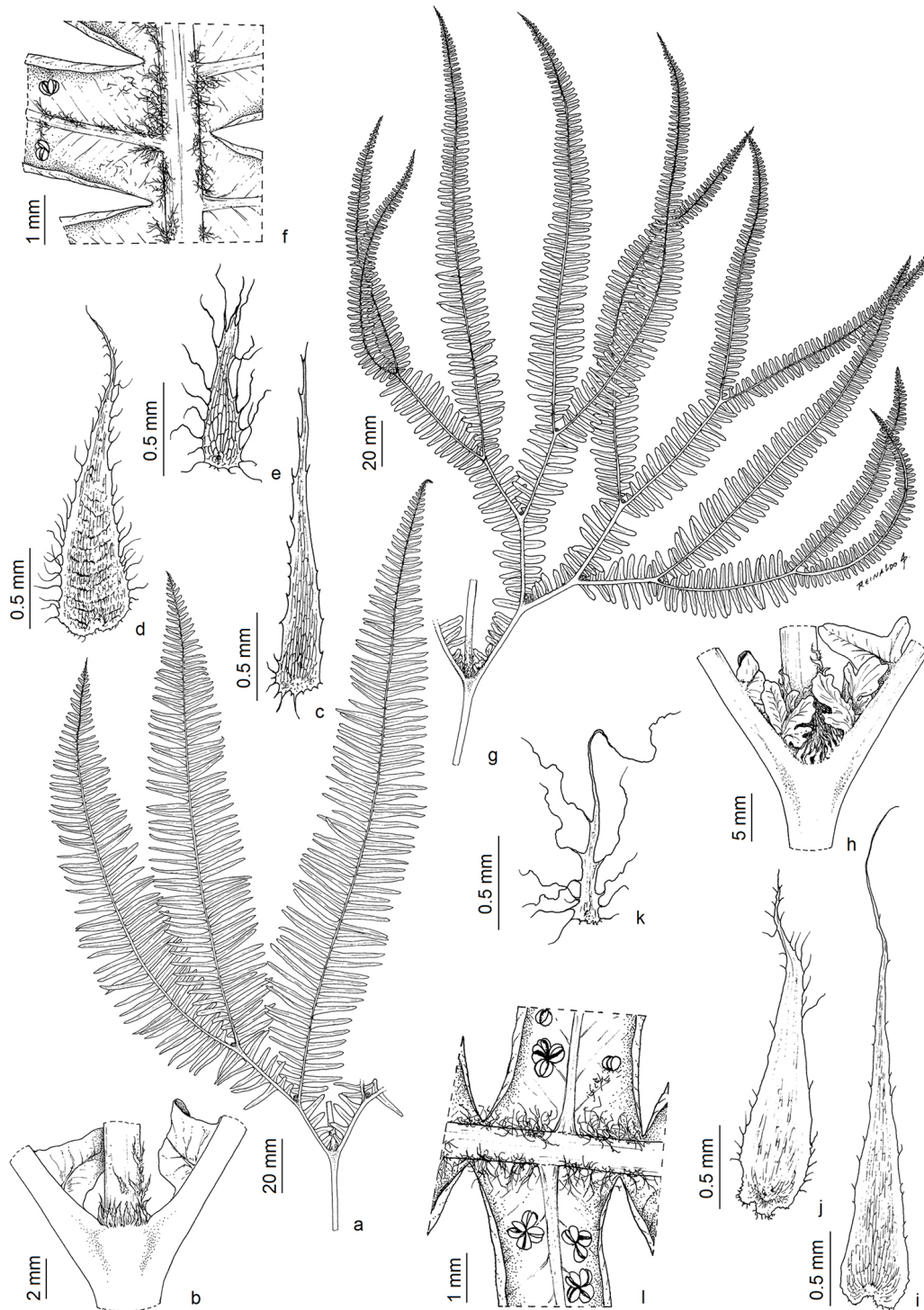


Figure 2. a-f. *Sticherus bifidus*. (Miranda 72) a. Pinna. b. Bud, showing scales. c. Rhizome scales. d. Bud scales. e. Rachis scales. f. Segment, abaxially. g-l. *Sticherus lanuginosus*. (Miranda 70) g. Pinna. h. Bud, showing scales. i. Rhizome scales. j. Bud scales. k. Rachis scales. l. Segment, abaxially.

G.E. Valente & A.A. Azevedo 12 (VIC); Viçosa, Campus da UFV, Mata da Biologia, 10IX-1998, *G.E. Valente & L.A. Basílio 353* (VIC); Viçosa, continuação da PH Rolfs, próximo ao condomínio novo, 25-IV-2016, *P.B. Schwartzburd et*

al. 3775 (UCS, VIC); Viçosa, continuação da P.H. Rolfs, próximo ao condomínio novo, 2-V-2016, *P.B. Schwartzburd et al. 3780* (UCS, VIC); Viçosa, continuação da P.H. Rolfs, próximo ao condomínio novo, 2-V-2016, *P.B. Schwartzburd*

& N.S. Smith-Braga 3793 (UCS, VIC); Viçosa, continuação da P.H. Rolfs, próximo ao condomínio novo, 2-V-2016, P.B. Schwartzburd & N.S. Smith-Braga 3794 (VIC); Viçosa, Universidade Federal de Viçosa, estrada para criação de Equídeos, 13-X-2016, P.B. Schwartzburd & N.S. Smith-Braga 3799 (UCS, VIC); Viçosa, Universidade Federal de Viçosa, Estação Mata do Paraíso, Trilha dos Alpes, 9-II-2017, P.B. Schwartzburd et al. 3876 (VIC); Viçosa, Universidade Federal de Viçosa, Recanto das Cigarras, 29-III-2019, V.S. Miranda et al. 64 (UCS, VIC); Viçosa, Universidade Federal de Viçosa, Recanto das Cigarras, 29-III-2019, V.S. Miranda et al. 65 (UCS, VIC); Viçosa, estrada Viçosa a Cajuri, BR 120, Córrego Canela, a caminho do Sitio da EVA, 31-III-2019, V.S. Miranda et al. 70 (VIC); Viçosa, estrada Viçosa a Cajuri, BR 120, em frente ao Hare Krishna, 31-III-2019, V.S. Miranda et al. 73 (VIC); Viçosa, Universidade Federal de Viçosa, 31-III-2019, V.S. Miranda et al. 78 (VIC).

Gonzales & Kessler (2011) and Lima & Salino (2018) made some errors in the nomenclatural paragraph of *S. lanuginosus*. They cited the basionym as “*Gleichenia lanuginosa* Moric. ex Fée”, but this name was never published by Fée. Instead, Fée (1869: 202) published *Mertensia lanuginosa*. The name *Gleichenia lanuginosa* was then combined by Hieronymus (1909), which was omitted by Gonzales & Kessler (2011) and Lima & Salino (2018). Furthermore, these authors also cited “*Gleichenia pennigera* var. *lanuginosa* (Moric. Ex Fée) T. Moore” as a homotypic synonym of *S. lanuginosus*. In fact, *Gleichenia pennigera* var. *lanuginosa* T. Moore is a *nomen nudum*, which Moore (1862) was trying to publish as a new variety of *Gleichenia pennigera*, and in no way related to *M. lanuginosa*, which is a later name.

Sticherus lanuginosus is the most common *Sticherus* in southern and southeastern Brazil (*pers. obs.*), and is characterized by the erect leaves, and the ultimate segments about two times longer than wide. The other *Sticherus* from Viçosa have prostrate or scandent leaves, and the ultimate segments are about four times longer than wide.

Sticherus nigropaleaceus (J.W. Sturm) J. Prado & Lellinger, Amer. Fern J. 86(3): 98. 1996. *Mertensia nigropaleaceae* J.W. Sturm, Fl. Bras. (Martius) 1(2): 222. 1859. *Gleichenia bifida* var. *nigropaleacea* (J.W. Sturm) Rosenst., Hedwigia 46: 60. 1906. *Sticherus longipinnatus* var. *nigropaleaceus* (J.W. Sturm) Nakai, Bull. Natl. Sci. Mus. Tokyo 29: 22. 1950.

Figures 3 a-f

Plants terrestrial. Rhizomes blackish, 2.5-3 mm diam; scales blackish, triangular, with dentate margins. Leaves scandent; petioles 40-72 cm long, 3.5-4 mm diam, blackish or reddish, glabrous; rachises with blackish scales with setose margins; buds with blackish scales; ultimate segments about four times longer than wide; midveins abaxially with stramineous scales

and arachnoid hairs, adaxially glabrous; veins abaxially with stramineous scales and arachnoid hairs, adaxially glabrous; laminar tissue between the veins abaxially and adaxially glabrous; laminar margins plane to revolute.

Distribution: Endemic to Brazil, from Bahia to Rio Grande do Sul. In Viçosa it is found on road-sides, disturbed areas, forest edges and ravines, under full or part-time sunlight exposure.

Material examined: BRAZIL. MINAS GERAIS: Viçosa, Fazenda da Aguada, Buraco Frio, 725 m, 2-X-1930, Y. Mexia 5137 (F, MICH, NY, TEX, US, UC, VIC); Viçosa, Campus da UFV, Mata da Biologia, 10-IX-1998, G.E. Valente & L.A. Basílio 351 (VIC); Viçosa, Campus da UFV, final da Mata da Biologia, 20°45'31"S, 42°51'56"W, 16-VIII-2013, P.B. Schwartzburd et al. 2828 (UCS, VIC); Viçosa, continuação da PH Rolfs, próximo ao condomínio novo, 2-V-2016, P.B. Schwartzburd & N.S. Smith-Braga 3792 (VIC); Viçosa, continuação da PH Rolfs, próximo ao condomínio novo, 2-V-2016, P.B. Schwartzburd & N.S. Smith-Braga 3796 (VIC); Viçosa, nova P.H. Rolfs, no barranco do condomínio novo, 3-X-2019, P.B. Schwartzburd 4605 (UCS, VIC); Viçosa, UFV, Recanto das Cigarras, 20°48'30"S, 42°50'54"W, 29-III-2019, V.S. Miranda et al. 61 (VIC); Viçosa, UFV, Recanto das Cigarras, 20°48'30"S, 42°50'54"W, 29-III-2019, V.S. Miranda et al. 63 (UCS, VIC); Viçosa, UFV, Recanto das Cigarras, 20°48'30"S, 42°50'54"W, 29-III-2019, V.S. Miranda et al. 63b (VIC); Viçosa, UFV, Recanto das Cigarras, 20°48'30"S, 42°50'54"W, 29-III-2019, V.S. Miranda et al. 67 (VIC); Viçosa, UFV, Recanto das Cigarras, 20°48'30"S, 42°50'54"W, 29-III-2019, V.S. Miranda et al. 68 (VIC); Viçosa, estrada Viçosa a Cajuri, BR 121, Córrego Canela, a caminho do Sitio da EVA, 31-III-2019, V.S. Miranda et al. 71 (VIC).

Osmundales

Plants terrestrial or from paludose soils; corms with ectophloic siphonosteles, with a ring of discrete xylem strands; leaves dimorphic or hemidimorphic; sporangia large, with lateral annuli, opening by an apical split (Tryon & Tryon 1982; Kramer & Green 1990; Smith et al. 2006).

Osmundaceae Martinov

Leaves erect, dimorphic or hemi-dimorphic; laminae 1-2-pinnate; veins free; sporangia not forming sori, born along veins or covering the whole laminar abaxial surface; spores green, subglobose, trilete (Tryon & Tryon 1982; Kramer & Green 1990; Smith et al. 2006; Sylvestre et al. 2022).

Six genera: *Claytosmunda* (not occurring in Brazil), *Leptopteris* (not occurring in Brazil), *Osmunda*, *Osmundastrum*, *Plenasium* (not occurring in Brazil), and *Todea* (not occurring in Brazil).

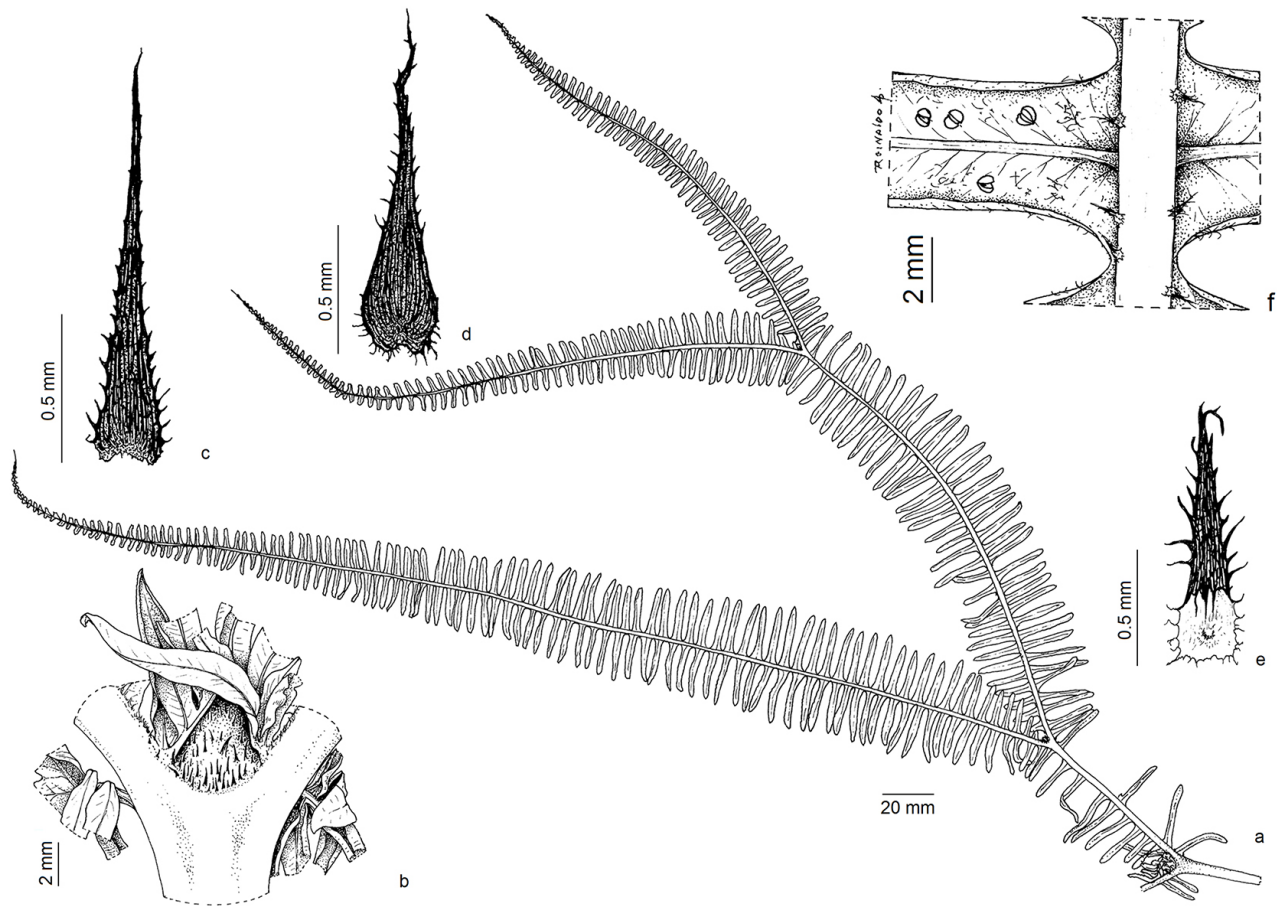


Figure 3. *Sticherus nigropaleaceus*. (Miranda 71) a. Pinna. b. Bud, showing scales. c. Rhizome scales. d. Bud scales. e. Rachis scales. f. Segment, abaxially.

Osmunda L.

Leaves hemi-dimorphic (with the fertile pinnae disposed on the distal 2/3 of the laminae) (Tryon & Tryon 1982; Kramer & Green 1990; Sylvestre *et al.* 2022).

Osmunda palustris Schrad., Gött. Gel. Anz.: 866. 1824.

Osmunda spectabilis var. *palustris* (Schrad.) C. Presl, Supp. Tent. Pterid. 63. 1845. *Osmunda regalis* var. *palustris* (Schrad.) C. Chr. ex Angely, Fl. Paraná 23: 10. 1963. *Osmunda regalis* subsp. *palustris* (Schrad.) Á. Löve & D. Löve, Taxon 26(2, 3): 324. 1977.

Figures 4 a-e

Corms erect, massive. Leaves hemi-dimorphic, fertile in the distal 1/3. Fertile leaves 70-100(-120) cm long; petioles 20-40 cm × 3.2-4.5 mm, adaxially sulcate, glabrous; laminae 2-pinnate, 50-80 × 30-60 cm, chartaceous to coriaceous; rachises glabrous; pinnae in 7-12 pairs, opposite to sub-opposite, strongly ascending, imbricate, tapering at the apex, producing apical pinnules 1/3 the length of the lateral pinnules; pinnules opposite to sub-opposite, articulate, petiolulate; petiolules with reddish hairs; costae abaxially and adaxially glabrous; veins abaxially strongly raised, abaxially

and adaxially glabrous; laminar tissue between the veins abaxially and adaxially glabrous; laminar margins serrulate, glabrous.

Distribution: Likely widespread in the Neotropics. In Viçosa it is found on flooded soils inside forest or in forest edges, under shade or part-time sunlight exposure.

Material examined: BRAZIL. MINAS GERAIS: Piranga, entre Piranga e São João de Pirapitinga, próximo ao Bar do Arlindo, 21-X-2017, *P.B. Schwartzburd et al.* 4369 (VIC); Viçosa, Fazenda da Aguada, 700 m, 14-X-1930, *Y. Mexia 5169* (IAN, MO, NY, PO, U, UC, US, VIC); Viçosa, 14-I-1935, *J.G. Kuhlmann s.n.* (RB, VIC-1905); Viçosa, Mata da Prefeitura, 8-V-1978, *M.P. Coons et al.* 78-448 (VIC); Viçosa, Mata do Paraíso, 27-VI-2014, *P.B. Schwartzburd et al.* 3281 (UCS, VIC); Viçosa, Mata do Seu Nico, 15-XII-2014, *P.B. Schwartzburd et al.* 3456 (VIC).

Additional material examined: BRAZIL. ESPÍRITO SANTO: Domingos Martins, 27-VI-2014, *P.B. Schwartzburd et al.* 3281 (VIC). Minas Gerais: Araçuaia, Parque Estadual da Serra do Brigadeiro, 1400 m, 5-V-2017, *P.B. Schwartzburd et al.* 4161 (UCS, VIC); Simonésia, RPPN Mata do Sossego, 19-IX-2014, *P.B. Schwartzburd et al.* 3350 (VIC). PARANÁ:

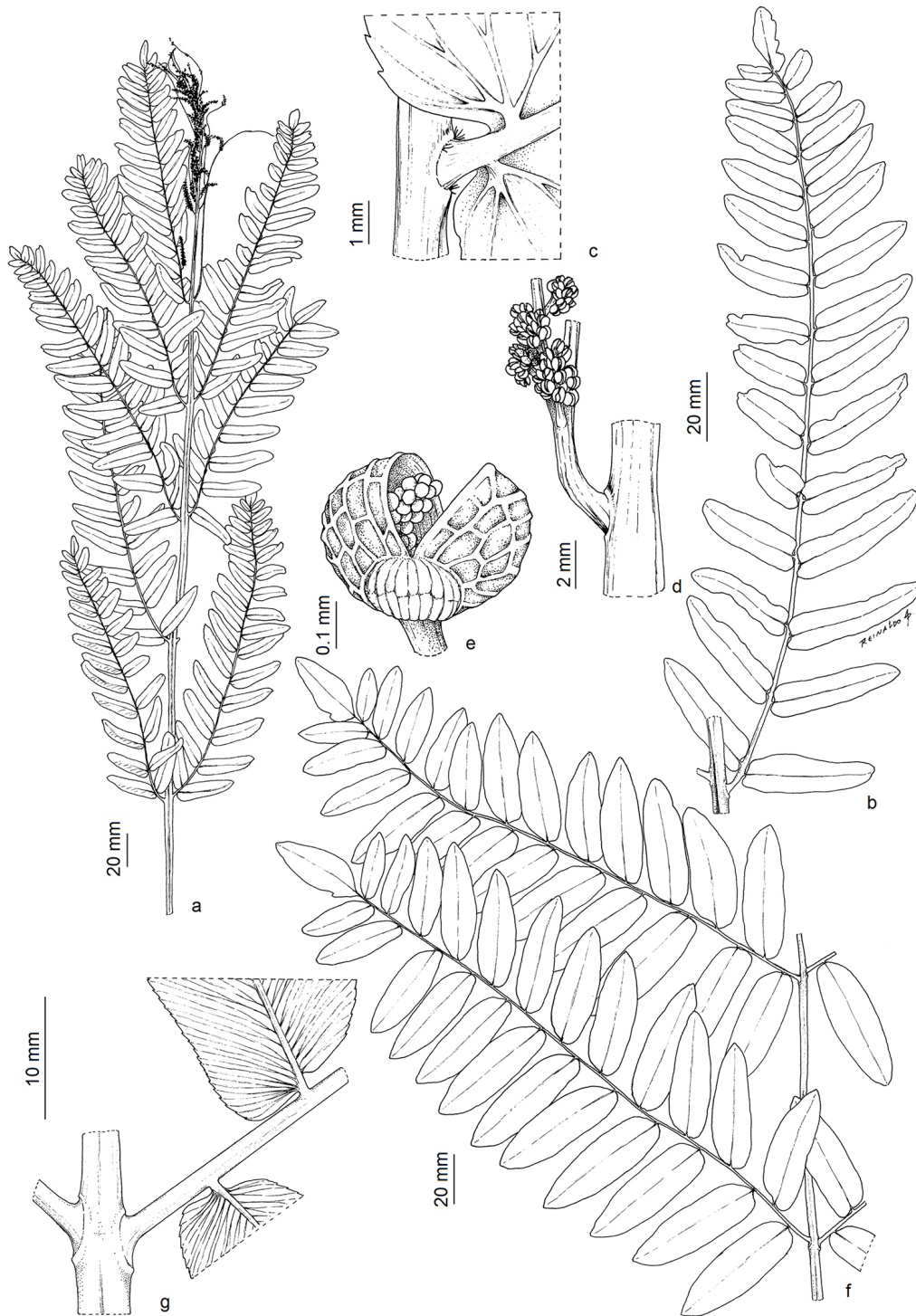


Figure 4. a-d. *Osmunda palustris*. (Miranda 115) a. Hemi-dimorphic leaf. b. Basal pinna. c. Base of pinnule, showing attachment, petiolule, and strongly raised veins. d. Fertile pinnule. e. Sporangium and spores. f-g *Osmunda spectabilis*. (Schwartzburd 4449). f. Two basal most pinnae. g. Base of pinnule, showing attachment, petiolule, and immersed veins.

Curitiba, Parque Municipal Tingui, 10-VII-2007, P.B. Schwartzburd 1354 (UPCB); Francisco Beltrão, 25-X-2006, P.B. Schwartzburd et al. 1134 (UPCB); Ponta Grossa, Parque

Estadual de Vila Velha, 22-X-2004, P.B. Schwartzburd & R. Nagata 351 (HUPG, MBM, SP, UPCB).

Material examined of extra-Brazilian *Osmunda*: *Osmunda regalis* L., Sp. Pl. 2: 1065. 1753.

Material examined: ITALY. PIEDMONT: Torino, Giardino Reale di Savoia, 2-XII-2022, *P.B. Schwartzburd 4903* (VIC); Torino, Giardino Reale di Savoia, 2-XII-2022, *P.B. Schwartzburd 4905* (VIC).

Osmunda spectabilis Willd., Sp. Pl., ed. 4 [Willdenow] 5: 98. 1810. *Osmunda regalis* var. *spectabilis* (Willd.) A. Gray, Manual (Gray), ed. 2. 600. 1856. *Osmunda regalis* subsp. *spectabilis* (Willd.) Á. Löve & D. Löve, Taxon 26(2, 3): 324. 1977.

Figures 4 f-g

Material examined: UNITED STATES OF AMERICA. VERMONT: outside Burlington, 10-IX-2018, *P.B. Schwartzburd et al. 4471* (VIC, VT); Waterbury, around the Reservoir, 10-VII-2018, *P.B. Schwartzburd & M.P. Schwartzburd 4449* (VIC, VT).

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Collecting permits disclaimer

Pedro Schwartzburd thanks IBAMA-SISBIO, for the collecting permits in Brazil (no. 15074-1); IEF, for the collecting permits in P.E. Serra do Brigadeiro (no. COL 131/12), IAP for the collecting permits in P.E. Vila Velha, SMMA for the collecting permits in P.M. Tingui, Fundação Biodiversitas for the collecting permits in RPPN Mata do Sossego, Gumerindo Lima (UFV) for the collecting permits in Mata do Paraíso; the Department of Fish and Wildlife of Vermont, for the collecting and fishing permits in Vermont (no. W132082926), and the staff of Giardino Reale di Savoia, for the local sampling permit.

Conflicts of interest

The authors declare no conflict of interest.

Author's contributions

Vanessa Miranda: collected and analyzed the data, and wrote the text.

Pedro Schwartzburd: conceived the project, analyzed the data, and wrote the text.

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