



## *Frullania curvilobula* (Frullaniaceae, Marchantiophyta), a new species from Brazil

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### Abstract

A new species of *Frullania* (subg. *Diastaloba*) from Southeastern Brazil is described and illustrated. It is characterized by relatively large size, large rounded underleaves with deeply arched insertion line and especially by the narrow, long-cylindrical and falcate lobules with a length-width ratio of 5.5–7:1. The occurrence of *Frullania lindenbergii* in the Neotropics is rejected. An updated key to the Brazilian species traditionally assigned to *F.* subgenus *Diastaloba* is provided.

**Key words:** Atlantic Forest, *Frullania* subg. *Diastaloba*, Jungermanniopsida, liverwort, Porellales

### Resumo

(*Frullania curvilobula* (Frullaniaceae, Marchantiophyta), uma nova espécie para o Brasil). Uma nova espécie de *Frullania* (subg. *Diastaloba*) do Sudeste do Brasil é descrita e ilustrada. Esta espécie é caracterizada pelo tamanho relativamente grande, os anfigastros grandes e rômnicos com uma profunda linha de inserção arqueada e especialmente pelos lóbulos finos, longo-cilíndricos e comprimento relativo à largura de 5,5–7:1. A ocorrência de *Frullania lindenbergii* no Neotrópico é rejeitada. Uma chave atualizada para as espécies brasileiras tradicionalmente reconhecidas para o *F.* subgênero *Diastaloba* é apresentada.

**Palavras-chave:** hepática, Jungermanniopsida, Porellales, *Diastaloba*, Mata Atlântica

### Introduction

The cosmopolitan genus *Frullania* Raddi (1818: 9), with an estimated number of 300–375 species (Yuzawa 1991, Schuster 1992, Gradstein *et al.* 2001) and more than 2000 described taxa (von Konrat *et al.* 2010), is the largest genus of Porellales. Yano (2008) listed 60 species for Brazil; however, only few taxonomic studies have been carried out on the Brazilian species. Lemos-Michel (1983) treated three species of *F.* subg. *Diastaloba* Spruce (1884: 55) from Rio Grande do Sul; Gradstein & Costa (2003) dealt with 31 species. During our study of Brazilian *Frullania* specimens we came across a new species, which is described below.

### Description

*Frullania* (subg. *Diastaloba*) *curvilobula* Schäfer-Verwimp, D.F. Peralta & S.M. Siqueira, *sp. nov.* (Figure 1)

The new species clearly differs from all known members of subg. *Diastaloba* by the very long, narrow-cylindrical and usually conspicuously falcate lobules with a length-width ratio of 5.5–7:1.

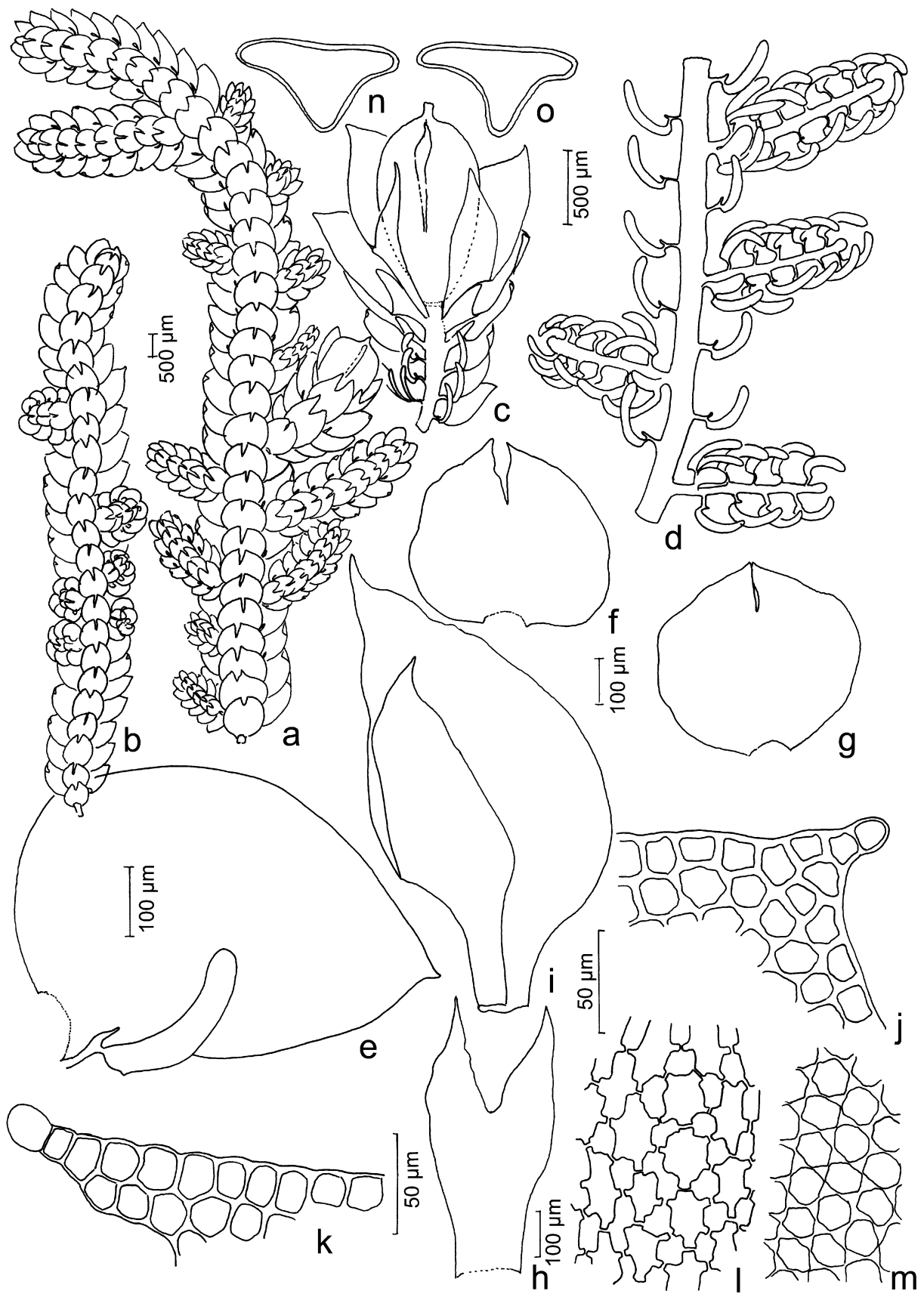
**Type:**—BRAZIL. São Paulo: Cananéia, Ilha do Cardoso, Pico do Cardoso, em vegetação arbustiva, substrato caule e ramos, 9 April 1991, S.R. Visnadi & D.M. Vital 4282 (holotype SP!).

Plants epiphytic, creeping, loosely appressed to substrate, usually pale to reddish brown, main shoots with leaves 1.5–1.8 mm wide and up to 6–8(–10) cm long. Stem of main shoot in cross section 170–200 µm wide (in branches 130–140 µm or less), with about 30 very firm-walled epidermal cells and 40–50 firm-walled medullary cells, branching irregularly to regularly pinnate, branches of the *Frullania*-type. First branch underleaf consisting of three distinct segments: a ventral lamina divided for ½ its length into two subequally sized lobes, and two dorsal long saccate lobes (and an associated stylus). First branch leaf with two distinct segments, one oblong-shaped dorsal segment and one long saccate ventral lobe (and an associated stylus). Stem leaves of main shoot flat when dry and wet, slightly imbricate, oblong-ovate, (700–)750–850(–950) × (550–)600–700(–850) µm, apex usually strongly apiculate and distinctly incurved, the apiculus 2–3(–4) cells wide at base, ending in an uniseriate tip of 2(–3) cells; the lobe base rounded, covering the stem; dorsal surface smooth; median cells hexagonal, cuticle smooth, trigones large, hyaline, small intermediate thickenings often present, and distinctive heavily pigmented secondary walls, cell cavities to 20–25 × 20–25 µm, becoming larger and thick walled basally, smaller and subquadrate at margin. Lobules remote from stem (the basal part of the lobule ca. 70–90 µm, the central part up to 200 µm), attached to the lobe by 8–10 cells, obliquely spreading at an angle of 30–45° to the stem, long and narrowly cylindrical, falcate, 350–450 µm long and 50–80 µm wide (length-width ratio 5.5–7:1), opening of the mouth small, free margin of the mouth entire. Stylus triangular, up to 70(–80) µm long, consisting of 6–8(–10) cells, 2–3 cells wide at base, terminated by a slime papilla. Underleaves on main stem somewhat distant to imbricate, rounded obovate to broadly ovate, usually as long as wide, sometimes slightly wider than long, up to 600 µm long and 800 µm wide, about 4–5 x stem width, divided to (1/4–)1/5–1/6 of its total length, the lobes acute, sinus narrowly, less often more broadly acute, margins entire or rarely with an obtuse projection, insertion line arched; underleaves of branches often considerably smaller, usually slightly longer than wide with less curved to nearly straight insertion line; cells similar to lobe cells. Oil-bodies in many cells still present 24 years after collection (in specimen SV & V 9087), (2–)3–6(–7) per cell, very finely segmented, the smaller ones rounded-oval to ellipsoidal, the larger ones often fusiform, 2.5–4 × 6–11(–12) µm, mostly considerably larger than the chloroplasts; ocelli absent.

Autoecious. Androecia on specialized abbreviated branches without vegetative leaves, up to 525 µm wide and 325 µm long, nearly subglobose, formed only of 2–3 pairs of bracts. Bracts subequally bilobed, bracteole small, bilobed, present only at the base of the androecia. Gynoecia terminal on short branches. Inner bracts unequally bilobed for about 0.65–0.75 the dorsal lobe length, lobe elliptical, up to 2.2 × 1.1 mm, with an acute apex, margins entire or with a few irregular projections, lobule narrowly ovate-lanceolate, 1.5 × 0.5 mm, apex acute to acuminate, inner margin near the base with a stylar tooth, margins otherwise entire. Bracteole up to 550–600 × 300 µm, bilobed to 0.3–0.35, the sinus acute to narrowly rounded, the lobes acute to acuminate, slightly divergent, margin entire to slightly crenulate. Perianth half or less exerted, dorsiventrally flattened, oblong-ovate, 1500 × 700 µm, with three smooth keels and a well developed, 80–120(–140) µm long beak. Sporophyte and spores not observed. Vegetative reproduction absent.

**Ecology and Distribution:**—*Frullania curvilobula* is known from few collections from southeastern Brazil (states of São Paulo and Paraná), occurring on trunks of living trees and shrubs in very humid but at least partly exposed sites in (sub)montane rain and cloud forests of the Atlantic coast, at ca. 800–900 m elevation.

**Additional specimens examined (paratypes):**—BRAZIL. São Paulo: Cananéia, Ilha do Cardoso, Pico do Cardoso, em vegetação arbustiva densa, substrato caule, 9 April 1991, S.R. Visnadi & D.M. Vital 4292 (SP), S.R. Visnadi & D.M. Vital 4333 (SP); idem, na base do tronco, c. perianth, 840 m (25°07'S–47°57'W), 9 April 1991, D.M. Vital s.n. (SP, hb. Schäfer-Verwimp); idem, Ubatuba, Parque Estadual da Serra do Mar, Núcleo Picinguaba, em caule de arbusto, 22 March 1995, S.R. Visnadi & D.M. Vital 1516 (SP); Paraná: Serra da Graciosa near Curitiba (25°20'S, 48°54'W), Caminho dos Jesuitas, epiphytic in cloud forest, c. perianth, 850 m, 10 October 1987, A. Schäfer-Verwimp & I. Verwimp 9087 (JE, PC, SP).



**FIGURE 1.** *Frullania* (subg. *Diastaloba*) *curvilobula* Schäfer-Verwimp, D.F. Peralta & S.M. Siqueira. A. Part of plant with one perianth, ventral view. B. Part of plant with androecia, ventral view. C. Detail of the perianth with bracts. D. Detail of the stem with lobules. E. Detail of the lobe with lobule and stylus. F–G. Underleaves. H. Last underleaf on perianth. I. Female bracteole. J. Lobe apex. K. Stylus. L. Basal median cells of the lobe. M. Median cells of the lobe. N–O. Cross sections of perianth (All from the holotype, drawing by Denilson F. Peralta).

## Discussion

*Frullania curvilobula* is a member of *F.* subg. *Diastaloba* as traditionally defined, having remote lobules (distant from the stem at least by their own width) and smooth 3(–4–5)-keeled perianths. As shown by recent molecular-phylogenetic work (Hentschel *et al.* 2009), however, subg. *Diastaloba* is polyphyletic and needs revision. The new species clearly differs from all known members of subg. *Diastaloba* by the very long, narrow-cylindrical and usually conspicuously falcate lobules (length-width-ratio 5.5–7:1), hence the species name. *Frullania curvilobula* seems to be most closely related to the Brazilian *F. grossifolia* Stephani (1911: 633) and the African *F. lindenberghii* Lehmann (1844: 17) by its large plant size (up to 8–9 cm), usually only slightly imbricate leaves and loose adherence of the plants to the substrate, *F. curvilobula* is indeed superficially very similar to *F. grossifolia*. However, the lobules in *F. grossifolia* as well as in *F. lindenberghii* are less elongate than in *F. curvilobula*, and not falcate. In *F. grossifolia* the length-width-ratio of the lobules is reaching 2.7–3.0(–3.2):1, with lobules about 210–280(–300) × 75–100(–110) μm, in *F. lindenberghii* only 2.0–2.4:1 with lobules reaching 240–450(–480) × 100–200(–230) μm (Vanden Berghen 1976). The latter species, moreover, has leaf lobes often broadly rounded to (more rarely) inconspicuously subacute to apiculate, and underleaves sharply dissected to ca 1/3 (–1/2) with V-shaped sinus, the lateral margins often with 1–2 teeth or projections (see Vanden Berghen 1976) and a nearly straight to slightly arched insertion line. Our study of *F. grossifolia* and *F. lindenberghii* (specimens examined cited below) indicates that the two species have probably been confused in Brazil. *Frullania grossifolia* is different from *F. lindenberghii* in its more constantly broadly acute to apiculate leaf lobes and less deeply incised underleaves, which moreover are more rounded to slightly wider than long without (or very rarely with) lateral teeth or projections, and have a strongly arched insertion line (at least on main axis). Beside this, *Frullania grossifolia* seems to be a considerably longer plant with stems up to 6–8(–10) cm long, against 2–3(–6) cm in *F. lindenberghii*. Moreover leaves in *F. grossifolia* are often subimbricate and the plants are only loosely adhered to the substrate or even hanging, whereas *F. lindenberghii* usually grows in flat mats closely appressed to the substrate and always has distinctly imbricate leaves. The illustrations (and description) of *F. lindenberghii* in Lemos-Michel (1983) fit *F. grossifolia* much better and agree very well with the illustration of the type of the latter (Stephani 1985: fig. 3249). Indeed, the single lobule figured by Lemos-Michel (1983: fig. 32) is about 290 × 107 μm (length-width-ratio 2.7:1), being more similar to *F. grossifolia* than to *F. lindenberghii*. Although we have not been able to study the material of *F. lindenberghii* recorded from Brazil (Rio Grande do Sul) by Lemos-Michel, we consider that this record refers to *F. grossifolia*.

In addition to the record from Rio Grande do Sul, Yano (2008) recorded *F. lindenberghii* from Minas Gerais based on Ångstroem (1876) but the latter author listed the name "*F. lindberghii* Gottsche", not *F. lindenberghii* Lehm. *Frullania lindenberghii* therefore should be excluded from the hepatic flora of Brazil, and from tropical America as a whole as no genuine records of this species are known from the Neotropics. Lemos-Michel (1983: 123) recorded the species from "U.S.A., Antilhas, Jamaica, Guadalupe, Venezuela, Ilhas Galápagos, Ilhas Cocos, Panamá, Nicarágua, Honduras" but this must have been an error. In fact, exactly the same general distribution was given by Lemos-Michel (1983: 121) for *F. gymnotis* Nees & Mont. in Montagne (1843: 257). Material from the Dominican Republic cited by Schäfer-Verwimp & Pócs (2009) belonged to *F. caulisequa* (Nees 1833: 373) Nees in Gottsche *et al.* (1844: 448), having constantly broadly rounded leaf lobes. Indeed, *F. lindenberghii* seems to be closely related to the common neotropical *F. caulisequa*. Recent molecular studies (Hentschel *et al.* 2009) revealed a close relationship of *F. lindenberghii*, *F. hypoleuca* Nees in Gottsche (1843: 470) from Java and *F. caulisequa* (as "*F. obcordata*") and even suggested conspecificity of the three species. Further studies are needed to clarify whether one polymorphic and pantropical species is at hand.

**Specimens examined of *Frullania grossifolia*:**—BRAZIL. "Brasília orient.", *E. Ule* 126 (holotype G00067452); São Paulo: Ilha de São Sebastião, rain forest in the central part, hanging from twigs of shrubs along road, c. perianth, 650 m, 29 March 1986, A. Schäfer-Verwimp & I. Verwimp 6768 (SP, herb. Schäfer-

Verwimp); Rio Grande do Sul: Serra Gaucha near Canela, epiphytic in rain forest, c. perianth, 780 m, 20 January 1987, A. Schäfer-Verwimp & I. Verwimp 8221 (SP, herb. Schäfer-Verwimp).

**Specimens examined of *Frullania lindenbergii*:**—RÉUNION Island. Cirque de Mafate, mossy elfin forest on Piton Marmite, 20°03' S, 55°27' E, epiphytic on shrub, c. perianth, 1850 m, 23 May 1998, A. Schäfer-Verwimp & I. Verwimp 19853/A (JE, herb. Schäfer-Verwimp); Piton de la Fournaise, southwestern slope, Sentier Botanique de Grand Coude, culture zone, epiphytic in secondary shrub, c. perianth, 1350 m, 3 June 1998, A. Schäfer-Verwimp & I. Verwimp 20343 (JE, SP, herb. Schäfer-Verwimp); Ravine Divon on the W slope of Piton Mado, 21°03'47" S, 55°21'59" E, mesic *Acacia heterophylla* forest with clumps of the bamboo *Nastus borbonicus*, on *Acacia* bark, 1740–1750 m, 17 September 2008, T. Pócs 08070/A (EGR, herb. Schäfer-Verwimp). SOUTH AFRICA. Western Cape: Diepwalle forest, ca 30 km north of Knysna Elephants trail, on tree stem along forest trail, 500 m, 26 October 1996, T. Arts RSA 120/13 (herb. Schäfer-Verwimp).

### Key to the species of *Frullania* subg. *Diastaloba* from Brazil

This is an updated version of the key in Gradstein & Costa (2003). *Frullania lindenbergii* is excluded based on the evidence given above. In addition, *Frullania subtilissima* (Nees ex Montagne 1840: 333) Lindenbergh in Gottsche *et al.* (1845: 443) recorded from Brazil by Spruce (1884) as a member of *F.* subg. *Diastaloba*, is excluded as this species seems to be a member of *F.* subgen. *Thyopsiella* (Gradstein & Hekking 1989). It should be noted, however, that Hattori (1982) lectotypified *F.* subg. *Diastaloba* with *F. subtilissima*. However, Schuster (1992) considered *F. exilis* Taylor (1846: 405), widely regarded as a synonym of *F. apiculata* (Reinwardt *et al.* 1824: 222) Dumortier (1835: 13), as the type of subg. *Diastaloba*. This matter needs further study.

- 1a. Leaves with ocelli (Brazil) ..... *Frullania vitalii*
- 1b. Leaves without ocelli ..... 2
- 2a. Leaf apex broadly rounded, plants robust, closely appressed to substrate (neotropical, common).....  
..... *Frullania caulisequa*
- 2b. Leaf apex at least in part apiculate or (sub-)acute ..... 3
- 3a. Female bracts strongly toothed to lacinate (pantropical) ..... *Frullania serrata*
- 3b. Female bracts entire to moderately denticulate ..... 4
- 4a. Plants small, 1 mm wide, 2–4(–5) cm long, closely appressed to substrate (pantropical) ..... *Frullania apiculata*
- 4b. Plants large, up to 1.8 mm wide and 6–8(–10) cm long, loosely adhered to substrate ..... 5
- 5a. Lobules straight, 200–300 µm long, 80–100 µm wide (length-width ratio 2.7–3.0:1) ..... *Frullania grossifolia*
- 5b. Lobules curved, 350–450 µm long, 50–80 µm wide (length-width ratio 5.5–7.0:1) ..... *Frullania curvilobula*

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