

## Novelties in *Lindsaea* Dryand. ex Sm. (Lindsaeaceae) from South America

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### Resumen

*Novedades en Lindsaea Dryand. ex Sm. (Lindsaeaceae) para Suramérica*

En este artículo se describen e ilustran tres especies nuevas de *Lindsaea* Dryand. ex Sm. para Suramérica: *L. falcatosora* A. Rojas, *L. nana* A. Rojas y *L. trapezoidalis* A. Rojas. La primera especie difiere de *L. pleioptera* Kramer por sus pinnas falcadas (en frondas 1-pinnadas) o pínulas (en frondas 2-pinnadas), con soro falcado restringido a 2/3 basales, o ausente en 1/3 apical donde la lámina es dentada. La segunda especie difiere de *L. falcata* Dryand. por frondas más pequeñas (4.5–8 × 1.7–2.6 cm vs. 10–25 × 4–7.5 cm), pinnas perpendiculares a ligeramente ascendentes (vs. falcadas) y segmento apical subconforme (vs. conforme), deltado (vs. hastado). La tercera especie difiere de *L. taeniata* Kramer por sus estípites and raquises angulados (vs. teretes) y pínulas proporcionalmente más cortas (2-3.5 veces más largas que anchas vs. al menos 5 veces más largas que anchas). También tres variedades son combinadas como especies.

**Palabras clave:** Helechos, nuevas especies, nuevos estatus, *Lindsaea*, Neotrópico.

### Abstract

In this paper three new species of *Lindsaea* Dryand. ex Sm. are described and illustrated from South America: *falcatosora* A. Rojas, *L. nana* A. Rojas and *L. trapezoidalis* A. Rojas. The first species differ from *L. pleioptera* Kramer by its falcate pinnae (in 1-pinnate fronds) or pinnules (in 2-pinnate fronds) with falcate sori restricted to 2/3 basal, or absent in 1/3 apical where the blade is dentate. The second species differ from *L. falcata* Dryand. by its smaller blades (4.5–8 × 1.7–2.6 cm vs. 10–25 × 4–7.5 cm), pinnae perpendicular to slightly ascending (vs. falcate) and apical segment subconform (vs. conform), deltate (vs. hastate). The third species differ from *L. taeniata* Kramer by its angulate (vs. terete) stipe and rachises and proportionally shorter (2-3.5 times longer than wide vs. at least 5 times longer than wide) pinnules. Also three varieties are combined as species.

**Key words:** Ferns, Neotropics, new species, new status, Polypodiopsida.

### Introduction

*Lindsaea* Dryand. ex Sm. is characterized because has surcate axes or evidently angulate in the fronds, ending segments dimidiate, sori along the margin of segments and indusia opening to the margin (Moran, 2011).

Moran (1995) mentioned that the neotropical

species of *Lindsaea* were monographed by Kramer (1957), who resolved several taxonomic and nomenclatural problems; however, *Lindsaea* need more studies, because several similar species sometimes are bad defined, looking hybridize or integrate. In Mesoamerica a group as them are formed by *L. arcuata* Kunze, *L. lancea* (L.) Bedd. and *L. quadrangularis* Raddi.

Schuettpelz & Pryer (2007), in their phylogeny studies from 400 leptosporangiate species of ferns, encountered that Dennstaedtiaceae family was polyphyletic with three different groups, justifying the segregations of Lindsaeaceae and Saccolomataceae family.

Tuomisto (1998) treated to *Lindsaea lancea* var. *falcata* (Dryand.) Rosenst. as a valid species (*L. falcata* Dryand.), considering that the morphological and ecological differences between it and *L. lancea* are sufficient to consider they as separated taxa.

Recently a phylogenetic analysis in the genus *Lindsaea* made by Lehtonen, Tuomisto, Rouhan & Christenhusz (2010), demonstrated that several neotropical species as *L. lancea*, *L. portoricensis* Desv., *L. rigidiuscula* Lindm. and *L. stricta* (Sw.) Dryand. were not supported as monophyletic entities. In the case of *L. lancea*, the non-monophyletic origin was expected on the basis of the great morphological differences between the varieties.

The objective of this work is to resolve several taxonomic problems that the phylogenetic analysis proposed by Lehtonen et al. (2010), showed through the cladogram additionally to new taxa discovered.

## Materials and methods

The new taxa and new combinations here presented are the result of comparison of specimens with the species registered from South America, and after the revision of related species in treatments and papers from the Neotropics as: Boudrie & Cremers (2005), Gómez & Arbeláez (2009), Kramer (1957, 1989), Moran (1995), Mickel & Smith (2004), Murillo et al. (2008), Smith (1995) and Tryon & Stolze (1989); helped by phylogenetic analysis made by Lehtonen et al. (2010). The specimens mentioned are deposited in Herbario Amazónico Colombiano (COAH), herbario Instituto de Biología, UNAM (MEXU) and Missouri Botanical Garden (MO). The new species and status are based in the analysis of type specimens deposited in following herbaria: A, B, BR, CAY, GOET, IAN, K, MO, NY, P, S, U, UC and US (acronyms following Thiers 2016), seen through JSTOR page (<http://plants.jstor.org/>).

## Results

### New taxa

***Lindsaea falcatosora*** A. Rojas, **sp. nov.** (fig. 1)

TYPE: COLOMBIA. **Amazonas:** Puerto Santander, trocha a la Chorrera, 15 ago 1998,

*R. Alfonso* et al. 112 (Holotype: COAH, herb. n° 38068; isotype: COAH, herb. n° 38067).

**Diagnoses.** *Lindsaea falcatosora* is similar to *L. pleioptera* but differs in having falcate pinnae (in fronds 1-pinnate) or pinnules (in 2-pinnate fronds) with falcate sori restricted to 2/3 basal, or absent in 1/3 apical where the blade is dentate.

**Description.** Perennial epipetric herbs, rhizomes short creeping, 1–2 mm in diameter, with fronds 3–6 mm distant between them; rhizome scales 1–3 × 0.1–0.3 mm, linear, brown-yellowish to brown, entire; fronds (5–) 8–30 cm long, erect; stipes (2–)10–16 cm long, yellowish-brown to dark brown, lustrous, not angulate and not winged abaxially; blade 1-pinnate to 2-pinnate, deltate to linear-lanceolate; pinnae (in 2-pinnate fronds) 6–15 × 1.0–2.3 cm, 1–3 pairs, linear, oblique, short-pedicellate, with a short acroscopic segment at base, apically pinnatifid or with a small attenuate segment, the apex acuminate to cuspidate with longer apical pinnae; pinnules (or pinnae in 1-pinnate fronds) 0.7–1.5 × 0.3–0.6 cm, 2–2.5 times longer than wide, (7–)12–16 pairs, uniformly spaced and alternates along the rachis, falcate, ascending, dimidiate except the basal ones, with dentate apex; sori continuous along acroscopic margin of segments, absent in 1/3 apical where the segment is dentate; indusia ca. 0.5 mm broad, stramineous, entire to slightly crenate.

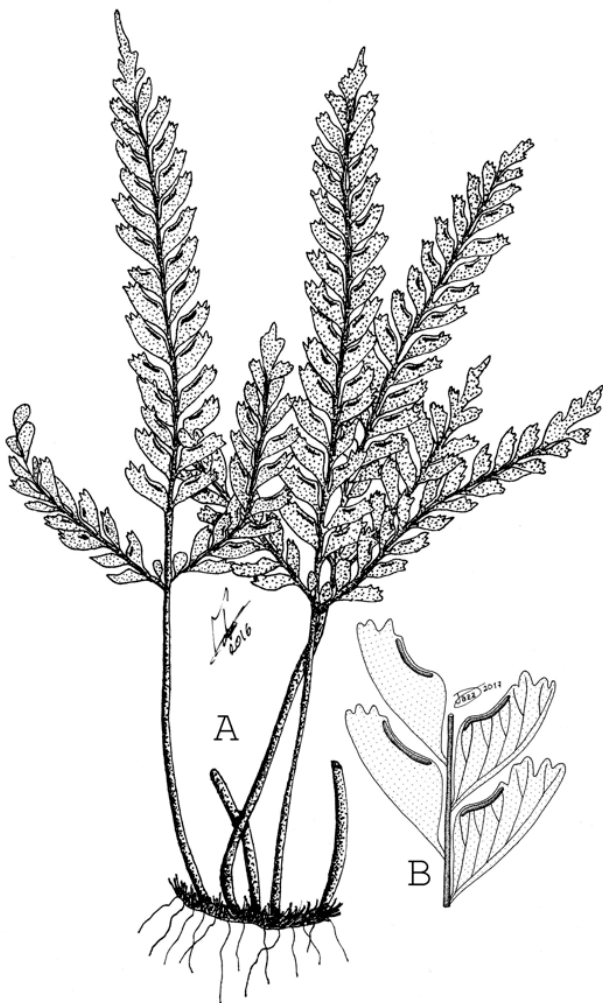
**Distribution.** Known only from amazonian region of Colombia at 100-500 m.

### Additional revised specimens. COLOMBIA.

**Amazonas:** Puerto Santander, trocha a Monochoa por El Calvario, 24 ago 1998, *R. Alfonso* & *M. Fiagama* 323 (COAH). **Caquetá:** Municipio Solano, Araracuara, quebrada del Amor, 16 ago 1998, *R. Alfonso* & *J. Murillo* 168 (COAH); ibídem, 20 ago 1998, *R. Alfonso* & *J. Tejada* 259 (COAH); Municipio Solano, margen izquierda del río Caquetá, Paujil, (área del caño Paujil), 10 km NW de Araracuara, 0°45–48'N, 72°20–25'W, 100–350 m, 18 jul 1992, *M. Arbeláez* & *F. Sueroque* 159 (COAH); Sierra de Chiribiquete, campamento Norte, recorrido por el cauce de un arroyo al NE del campamento, 1°07'N, 72°50'W, 350–500 m, 13 dic 1991, *S. Castroviejo* 12041 (COAH); Araracuara, along trail road Araracuara-Puerto Arturo to Cueva de Guacharos, slope towards river Caquetá, 350 m, 29 Oct 1988, *H. Sipman* & *J. Duivenvoorden* 27718 (COAH).

**Etymology.** The specific epithet makes reference to their falcate sori.

*Lindsaea falcatosora* differs from *L. pleioptera* in having falcate pinnae (in fronds 1-pinnate) or pinnules (in 2-pinnate fronds) (vs. perpendicular)



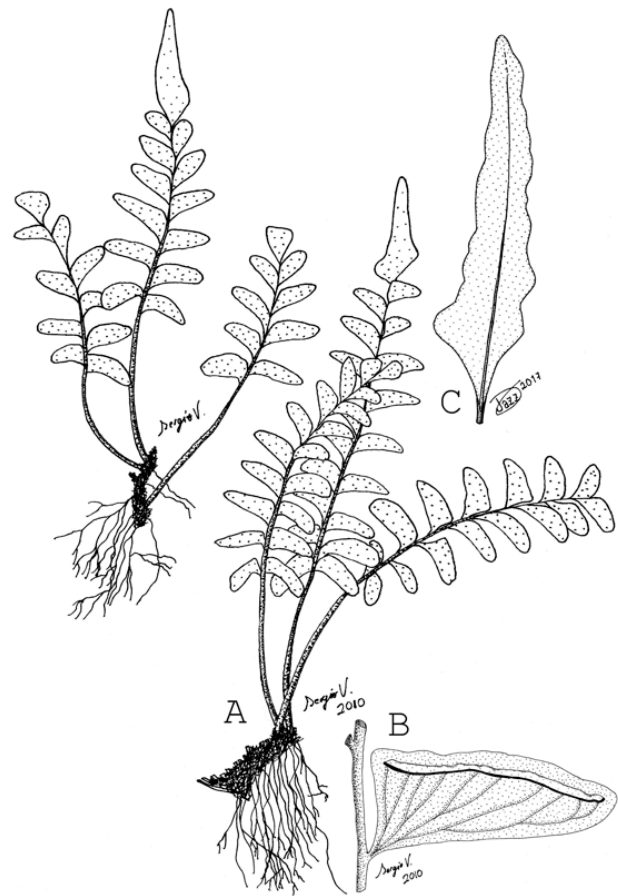
**Figure 1. A-B.** *Lindsaea falcatosora* (R. Alfonso et al. 112, COAH). **A.** General aspect of type specimen. **B.** Blade detail. **Figura 1. A-B.** *Lindsaea falcatosora* (R. Alfonso et al. 112, COAH). **A.** Aspecto general del espécimen tipo. **B.** Detalle de la lámina.

with falcate sori restricted to 2/3 basal (vs. not falcate sori over throughout acroscopic side, or absent in 1/3 apical where the blade is dentate). The new species also is similar to *L. hemiptera*, but the second species, additionally to *L. pleioptera* because has blackish axes, more segments pairs (to 35 pairs per pinna) and they overlapping (vs. distant) and perpendicular to costa (vs. ascending).

The habitat of this species is particularly interesting because it grow over rock in the margin of water courses.

***Lindsaea nana* A. Rojas, sp. nov.** (Fig. 2)

**TYPE:** COLOMBIA. **Amazonas:** 8 km SW of the confluence of Oso river with Caquetá, 1°11'S, 71°38'W, 150-250 m, 29 May 1998, H. Tuomisto et al. 12538 (Holotype: COAH).



**Figure 2. A-B.** *Lindsaea nana* (H. Tuomisto et al. 12538, COAH). **A.** General aspect of type specimen. **B.** Blade detail. **C.** Blade Apex detail of the same species (H. Tuomistuo et al. 12549, COAH). **Figura 2. A-B.** *Lindsaea nana* (H. Tuomisto et al. 12538, COAH). **A.** Aspecto general del espécimen tipo. **B.** Detalle de la lámina. **C.** Detalle del ápice de la lámina de la misma especie (H. Tuomistuo et al. 12549, COAH).

*Lindsaea pumila* Klotzsch var. *remota* Kunze, Linnaea 21: 226. 1848. Type: Suriname, Sornau creek near Joden-Savanne, Nov 1845, H. Kegeel 1066 (GOET!).

*Lindsaea lancea* (L.) Bedd. var. *remota* (Kunze) Kramer, Acta Botanica Neerlandica 6: 247, f. 29. 1957.

**Diagnoses.** *Lindsaea nana* is similar to *L. falcata* Dryand. and but it differs in having smaller blades (4.5–8 × 1.7–2.6 cm vs. 10–25 × 4–7.5 cm), pinnae perpendicular to slightly ascending (vs. falcate) and apical segment subconform, deltate (vs. hastate). Also is similar to *L. leprieurii* Hook., but the new species has terete (vs. angulate), yellowish-brown to grayish-brown (vs. atropurpureous to blackish) and opaque (vs. lustrous) stipe, green (vs. dark



green) laminar tissue and commonly ascending pinnae (vs. perpendicular to decurved).

**Description.** Perennial terrestrial herbs, rhizomes short creeping, 1-1.5 mm in diameter, with fronds 1–3 mm distant between them; rhizome scales 1–1.5 × 0.1–0.2 mm, lineate-deltate with short hair-like apices on the rhizome tips, orange-reddish to reddish-brown or dark reddish, lustrous, clathrate or occluded; fronds 6-14 cm long, ascending to arching; stipes 1.5-6.0 cm long, 1/3–1/2 the length of fronds, yellowish-brown to grayish-brown, opaque, not angular, not winged or scarcely in distal part; blades 4.5–8 × 1.7–2.6 cm, 1-pinnate, lanceolate, with 4–12 pinnae pairs, that are contiguous but not overlapping, gradually reduced towards apex, apically reduced to subconform or lanceolate segment; pinnae dimidiate, dark green, glabrous; pinnae 0.9-1.9 × 0.3–0.5 cm, rectangular-trapezoidal, short-petiolulate (0.5–1.5 mm), decurrently on the rachis and form an adaxial wing, perpendicular to more commonly slightly ascending with respect to rachis; highlighted veins, the primary forked sympodially 3–4 times; sori continuous, parallel and close to acroscopic margin; indusium 0.5 mm wide, entire, yellowish to pale green.

**Distribution.** Known from Colombia, Venezuela, Guayana, Suriname and Brazil at 150-250 (-900) m.

**Additional revised specimens.** COLOMBIA. Amazonas: 0-6 km SW of the confluence of Oso river with Caquetá, 1°09'S, 71°36'W, 150-250 m, 28 May 1998, H. Tuomisto et al. 12524 (COAH); 13-19 km SW of the confluence of Oso river with Caquetá, 1°14'S, 71°41'W, 150-250 m, 31 May 1998, H. Tuomisto et al. 12549 (COAH).

**Etymology.** The specific epithet makes reference to its small size.

**Comments.** Kunze (1848) published it taxa as a varietal of *Lindsaea pumila* Klotzsch probably based in the small plants with 1-pinnate blade, but *L. pumila* has linear and narrower blade with small pinnae base, probably more related to *L. cubensis* Underw. & Maxon and *L. parkeri* (Hook.) Kuhn. Also the name *L. pumila* was used by Hooker (1867). After that, Kramer (1957) include this taxa as a varietal of *L. lancea* (L.) Bedd., but it is more related to *L. leprieurii* Hook. and *L. falcata* Dryand., two species with lanceolate and broader blades with an hastate with subconform apex. Also Kramer (1957) included as synonym of these taxa to *L. pusilla* Splitgerber, but this species is really



**Figure 3. A-C.** *Lindsaea trapezoidalis* (J. Pipoly et al. 14129, MEXU). **A.** General aspect of type specimen. **B.** Blade detail. **Figura 3. A-C.** *Lindsaea trapezoidalis* (J. Pipoly et al. 14129, MEXU). **A.** Aspecto general del espécimen tipo. **B.** Detalle de la lámina.

synonym of the typical *L. pumila* (var. *pumila*), for these reasons here is preferred to describe as a new species.

This species grow in clayey or sandy banks near water courses.

***Lindsaea trapezoidalis*** A. Rojas, **sp. nov.** (Fig. 3)

**TYPE:** PERU. **Loreto:** Maynas Province, región de Amazonas, Departamento Las Amazonas, Explornapo Camp, Inventario MacArthur, cerca de Sucusari, a lo largo del río Napo, 3°20'S, 72°55'W, 100-140 m, 3 mar 1991, J. Pipoly et al. 14129 (holotype: MEXU; isotype: MO).

**Diagnoses.** *Lindsaea trapezoidalis* differs from *L. taeniata* by its angulate (vs. terete) stipe and rachis and proportionally shorter (2-3.5 times longer than wide vs. at least 5 times longer than wide) pinnules. Also differ from *L. lancea* by its angulate stipe and rachises, and principal veins centered at middle and apex part.

**Description.** Perennial terrestrial herb, rhizomes short-creeping, 1.5–3 mm in diameter, with fronds 2–4 mm between them; rhizome scales 1–1.5 × 0.3–0.5 mm, lanceolate, yellowish-brown to brown, entire, flat and appressed to slightly patent; fronds 85–110 cm long, with vertical stipes, ascending in the blades; stipes 63–67 cm long, brown at the base and yellowish-brown up, angulate; blades 9–19 × 2.5–4.3 cm, ovate to lanceolate, 2-pinnate, with 2–3 pinnae pairs; rachises stramineous to yellowish-brown, quadrangular, not winged; pinnae 21.5–32.5 × 8–10 cm, 1–3 pairs, lanceolate to oblong, ascending with respect to rachis, the apical segments hastate to lanceolate; pinnules 3.5–6.5 × 1–1.8 cm, trapezoidal, 2–3.5 times longer than wide, ascending, excavate in basiscopic side, attenuate at apex; principal veins dimidiate at base and centered at the apex, secondary veins dichotomous; sori continuous along acroscopic and basiscopic sides of pinnules; indusia 0.2–0.3 mm broad, brown, entire to crenate.

**Distribution.** Known only from the type specimen of amazonian region of Peru at 100–140 m.

**Etymology.** The specific epithet makes reference to their trapezoidal pinnae.

**Comments.** *Lindsaea trapezoidalis* is similar to *L. taeniata* because both have principal veins dimidiate at base and centered at the apex, but differs in having angulate (vs. terete) stipe and rachis and proportionally shorter (2–3.5 times longer than wide vs. at least 5 times longer than wide) pinnules. This species was confused with *L. lancea* because has angulate stipe and rachises, and trapezoidal pinnules, but the principal veins centered at middle and apex part, and the sori make this species more related to *L. taeniata*.

#### New status

***Lindsaea elatior* (Kunze) A. Rojas, stat. nov.**

**Basionym.** *Lindsaea falcata* Dryand. var. *elatior* Kunze, *Linnaea* 21: 225. 1848. Type: Suriname, Sornau creek near Joden-Savanne, Nov 1845, *H. Kegel 1068* (Holotype: GOET!, # herb. GOET008857; isotype: GOET!, # herb. GOET008858).

*Lindsaea lancea* (L.) Bedd. var. *elatior* (Kunze) Kramer, *Acta Botanica Neerlandica* 6: 248, f. 75. 1957.

**Known distribution.** Colombia, Venezuela, Guyana, Suriname and Brazil.

**Comments.** This species probably is more related to *L. falcata* because has hastate apex, however *L. elatior* has more pinnae pairs (25–40 vs. 10–20 (25) pairs) and they are close between them or imbricate (vs. distant) and the apex of terminal pinna is obtuse (vs. acute).

***Lindsaea jamesoniiformis* (Kramer) A. Rojas, stat. nov.**

**Basionym:** *Lindsaea stricta* var. *jamesoniiformis* Kramer, *Acta Botanica Neerlandica* 6: 231, f. 76. 1957. Type: Surinam, Tafelberg (Table Mountain), savanna no. 4, 15 Aug 1944, *B. Maguire 24377* (Holotype: US!; isotypes: A!, BR!, IAN!, K!, MO!, P!, S!, U!, UC!).

**Comments.** *L. jamesoniiformis* was associated to *L. stricta* by Kramer (1957) probably because has many pinnule pairs per pinna and they small, however the phylogenetic analysis proposed by Lehtonen et al. (2010) show that this species is more related to *L. tenuis* Klotzsch and *L. cubensis* Underw. & Maxon, in support of this hypothesis they share very narrow and atropurpureous rhizome hairs, a character few used in this genus, contrary to *L. stricta* with broad and yellowish to brown rhizome hairs. Also *L. tenuis* has atropurpureous axes same to *L. jamesoniiformis* (vs. yellowish to brown in *L. stricta*).

***Lindsaea submontana* (Boudrie & Cremers) A. Rojas, stat. nov.**

**Basionym:** *Lindsaea lancea* var. *submontana* Boudrie & Cremers, *Adansonia*, série 3, 27, 10–12, f. 1–4. 2005. Type: Guyane française, Montagne de la Trinité, zone Sud, bassin de la Mana, 04°34'N, 53°21'W, 580 m, 16 Jan 1988, *Granville et al. 13665* (holotype: P!; isotypes: B!, BR!, CAY!, K!, NY!, U!, US!).

**Comments.** *Lindsaea submontana* probably is more related to *L. falcata*, because the two species have lanceolate and broad fronds with few pinnae pairs, but *L. submontana* differ by its rounded pinnae apex.

***Lindsaea terminalis* (Kramer) A. Rojas, stat. nov.**

**Basionym:** *Lindsaea quadrangularis* Raddi subsp. *terminalis* Kramer, Type: Paraguay, Colonia Presidente González, 10 ago 1893, *C. Lindman A 1757* (holotype: S!; isotype: US!).

**Comments.** *Lindsaea terminalis* apparently is more related to *L. divaricata* Klotzsch and *Lindsaea subalata* (Kramer) A. Rojas & Tejero because all of them have subconform pinnae apex and dark

axes. Rojas & Tejero (2017) mentioned that these taxa is more similar to *L. divaricata* because both have strongly ascending pinnae and pinnules, but *L. terminalis* has blackish stipes and rachises (vs. atropurpureous), fewer pinnae (commonly 2–3 vs. commonly 4–6 pairs), fewer pinnules ((5–)10–15 vs. (13–)20–25) pairs, and a deltate to hastate terminal segment (vs. narrowly lanceolate).

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