



## Three new species of *Rhipidocladum* (Poaceae: Bambusoideae: Arthrostylidiinae) from South America

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### Abstract

Three new woody bamboo species from South America, *Rhipidocladum arenicolum* from Peru, *R. cordatum* from Ecuador and *R. rubrofimbriatum* from Venezuela, are here described and illustrated. Based on morphological analysis, *R. arenicolum* and *R. cordatum* are placed in sect. *Rhipidocladum* and *R. rubrofimbriatum* in sect. *Racemiflorum*. *Rhipidocladum arenicolum* and *R. cordatum* are most similar to *R. harmonicum*, but *R. arenicolum* differs in its wider foliage leaf blades and longer spikelets and florets. *Rhipidocladum cordatum* differs by having cordate culm leaf blades, more branchlets per node and smaller, narrower foliage leaf blades as well as more closely spaced spikelets. *Rhipidocladum rubrofimbriatum* is most similar to *R. sibilans* but is awnless, has fewer branchlets per node, and larger, wider foliage leaf blades.

### Resumen

Se describe e ilustra tres nuevas especies de bambúes leñosos de Sudamérica, *Rhipidocladum arenicolum* de Perú, *R. cordatum* de Ecuador y *R. rubrofimbriatum* de Venezuela. Con base en un análisis morfológico, *R. arenicolum* y *R. cordatum* se establece en sección *Rhipidocladum* y *R. rubrofimbriatum* en sección *Racemiflorum*. *Rhipidocladum arenicolum* y *R. cordatum* son más similares a *R. harmonicum*. *Rhipidocladum arenicolum* se distingue de *R. harmonicum* por sus hojas de follaje anchas y sus espiguillas y flósculos más largos mientras que *R. cordatum* se distingue por tener las láminas de las hojas caulinares cordadas, más ramitas por nudo y láminas foliares más pequeñas y angostas y espiguillas menos distantes. *Rhipidocladum rubrofimbriatum* es más parecida a *R. sibilans* pero carece de aristas, tiene menos ramitas por nudo, y hojas de follaje más grandes y anchas.

**Key words:** Bambuseae, neotropical woody bamboo

### Introduction

*Rhipidocladum* McClure (1973: 105) is a neotropical woody bamboo genus of 15 species occurring from central Mexico to Brazil and Argentina. The genus has a distinctive fan-like branching architecture that is mirrored in allied genera *Actinocladum* (McClure in Soderstrom 1981: 1201), *Didymogonyx* (L. G. Clark & Londoño 1991: 1271) C. D. Tyrrell, L. G. Clark & Londoño (2012: 146) and *Merostachys* Sprengel (1825: 132). *Rhipidocladum* species are differentiated from these by having a basic caryopsis (*Actinocladum* and *Merostachys* possess a nucoid caryopsis) and uniform culm internode lengths (*Didymogonyx* is characterized by alternating short and long internodes along the culm; Tyrrell *et al.* 2012). The genus is divided into two sections: the monotypic *Rhipidocladum* sect. *Rhipidocladum* L. G. Clark & Londoño (1991: 1271) containing the type species, *R. harmonicum* (Parodi 1944: 479) McClure (1973: 105), and *Rhipidocladum* sect. *Racemiflorum* L. G. Clark & Londoño (1991: 1275) comprising the remaining 14 species.

Section *Rhipidocladum* is distinguished from section *Racemiflorum* by its geniculate synflorescence axes (alternately bending 90° in zig-zag fashion), basally fused foliage leaf fimbriae, obtuse lemma apices, and copious adaxial intercostal sclerenchyma in foliage leaf blade cross-sections (Clark & Londoño 1991). Species in section *Racemiflorum* generally have a viny, scandent or clambering growth form, whereas those in section *Rhipidocladum* have more erect culms and are often self-supporting. *Rhipidocladum* sect. *Racemiflorum* is widespread, ranging from Mexico to Argentina and inhabits moist forests, canyon walls, river banks and, occasionally, dry savannas from low to high elevations (0–2000 m; Judziewicz *et al.* 1999). *Rhipidocladum* sect. *Rhipidocladum* appears to be more restricted, known only from montane forests in South America, mainly along the Andes, from northern Colombia to Bolivia at elevations of 1200–2800 m (Fig 1).



**FIGURE 1.** Distribution map of three new species: *Rhipidocladum arenicolum*, *R. cordatum* and *R. rubrofimbriatum*, and the known ranges of the most similar species: *R. harmonicum* and *R. sibilans* in South America.

Morphological investigation of *Rhipidocladum* as a part of recent phylogenetic work (Tyrrell *et al.* 2012) uncovered several distinctive specimens that we were able to separate into three new species. Here we describe and illustrate two new species of *Rhipidocladum* sect. *Rhipidocladum*: *R. arenicolum* and *R. cordatum*, and a new species from *Rhipidocladum* sect. *Racemiflorum*: *R. rubrofimbriatum*.

*Rhipidocladum arenicolum* and *R. cordatum* are clearly placed in section *Rhipidocladum* by their geniculate synflorescence axes and basally fused foliage leaf fimbriae. *Rhipidocladum arenicolum* differs from *R. harmonicum* in its wider foliage leaf blades and longer spikelets with much longer florets (Table 1).

**TABLE 1.** Morphological characters that differentiate *Rhipidocladum arenicolum* and *R. cordatum* from *R. harmonicum*.

Character		<i>R. arenicolum</i>	<i>R. cordatum</i>	<i>R. harmonicum</i>
Culm	height (m)	unknown	ca. 8	5–20(–40)
	diameter (mm)	5–8	20–25	9–30
Culm leaf	sheath length (cm)	unknown	7–10	12–19
	blade base	unknown	cordate	attenuate
Branchlets	number per node	18–25	70–100	ca. 35
	length (cm)	57–65	23–30	35–45
Foliage leaf sheath	length (mm)	32–54	20–30	25–30
	fimbriae length (mm)	1–3	4.5–5	ca. 3.5
	fimbriae color	stramineous to brown	golden-red	ivory
Pseudopetiole	length (mm)	4–5	2–3	1.5–2
	abaxial vestiture	glabrous	sparsely puberulent	puberulent
	adaxial vestiture	puberulent	hispidulous	strigulose
	color	dark brown	purple to brown	stramineous
Foliage leaf blade	Length (cm)	7–10	6–7.5	5.9–12
	Width (mm)	13–17	7–11	8–17
	L:W ratio	5–6	7–9	7–10
	abaxial vestiture	glabrous	glabrous	sparsely pubescent
	adaxial vestiture	glabrous	pubescent	sparsely pubescent
Synflorescence	length (cm)	16–23	4–6	5–6
	spikelet spacing (mm)	20–40	4–9	10–40(–50)
Spikelet	length (cm)	4.4–5	4.8–5	2.5–4
	number of glumes	2–3	3–4	2–4
	number of florets	6–7	9–10	5–7
Lowest glume	apex	obtuse	acuminate	acute
	length (mm)	ca. 4	3–4	5–5.5
	number of nerves	7	1	3
Second glume	length (mm)	ca. 9	3.5–4	ca. 7
	number of nerves	7	3–5	5–7
Third glume	length (mm)	ca. 11	ca. 6	ca. 7
	number of nerves	9	5	5–7
Lemma	apex	obtuse	acuminate	obtuse
	length (mm)	18.5–19	7.5–8	7–7.5
	number of nerves	13	5–7	11
Palea	length (mm)	ca. 13	6.5–7	6.5–7

*Rhipidocladum cordatum* differs from *R. harmonicum* and *R. arenicolum* by having cordate culm leaf blades, more branchlets per node, and smaller, narrower foliage leaf blades and more closely spaced spikelets (Table 1). *Rhipidocladum cordatum* also bears a distinct row of hairs along the margin of the leaf sheath and blade, a character known from other congeners, particularly *R. maxonii* (Hitchcock 1927: 80) McClure (1973: 105).

*Rhipidocladum rubrofimbriatum* was first recognized as “*Rhipidocladum* sp. A” and “*Rhipidocladum* sp. B” by Judziewicz in Davidse *et al.* (2004). At that time, there was insufficient material for a full description (Judziewicz and Clark 1993). Additional specimens from this region have offered enough material to demonstrate that Judziewicz’s “sp. A” and “sp. B” specimens are likely to represent a size continuum of the same entity which we recognize here as *R. rubrofimbriatum*. The lack of geniculate synflorescences and the presence of unfused fimbriae place this species in section *Racemiflorum* where it is most similar to *R. sibilans* Davidse, Judz. & L.G. Clark in Judziewicz *et al.* (1991: 84), but it is awnless, has fewer branchlets per node, and larger, wider foliage leaf blades (Table 1).

***Rhipidocladum arenicolum*** C.D. Tyrrell & L.G. Clark, *sp. nov.*, Fig 2.

Type:—PERU. San Martín. Rioja: Low forest over white sands, ca. 1 km above Aquas Verdes along trail to San Pablo, 5°41'14"S 77°37'58"W, 1200 m, 7 July 2002 (fl), J.L. Luteyn, I. Sánchez-Vega, & M. Zapata Cruz 15520 (holotype: USM!; isotypes: ISC!, MO!, NY!, US!).

**Diagnosis:**—*Rhipidocladum arenicolum* differs from *R. harmonicum* in its smaller culm diameter (5–8 mm), longer branches (57–65 cm), longer (16–23 cm) synflorescences and larger florets (lemmas 18.5–19 mm).

**Description:**—Culm height unknown; internodes ca. 26 cm long, 5–8 mm diameter, hollow. Culm leaves unknown. Branch complements with 18–25 branchlets, branchlets 57–65 cm long, occasionally rebranching from the base. Foliage leaves 4–6 per flowering branchlet; sheaths 32–54 mm long, abaxially glabrous, margins glabrous; fimbriae 1–3 mm long, stramineous to brown, mostly deciduous; pseudopetioles 4–5 mm long, abaxially glabrous, adaxially puberulent, dark brown; inner ligules ca. 0.5 mm, truncate; blades 7–10 cm long, 13–17 mm wide, L:W ratio 5–6, broadly lanceolate, abaxially and adaxially glabrous, base rounded, apex acuminate, margins smooth. Synflorescences 16–23 cm long, spicate, bearing 6–7(–8) spikelets spaced 20–40 mm apart; rachis at least apically geniculate. Spikelets 4.4–5.0 cm long, comprising 2–3 glumes and 6–7 fertile florets; rachilla internodes (2–)4 mm long. Lowest glume ca. 4 mm long, 7-nerved, ovate-lanceolate, apex obtuse, abaxially glabrous, mucronate; upper glumes ovate-lanceolate, apex obtuse, abaxially glabrous, adaxially puberulent: second glume ca. 9 mm long, 7-nerved, mucronate; third glume ca. 11 mm long, 9-nerved, mucronate. Lemma 18.5–19.0 mm long, 13-nerved, ovate-lanceolate, apex obtuse, abaxially glabrous, mucronate. Palea ca. 13 mm long, abaxially glabrous, adaxially scabrous, stramineous. Lodicules 3, the anterior pair ca. 6 mm long, posterior one ca. 4 mm long, lanceolate. Anthers 7–8 mm long. Ovary ca. 1.7 mm long, white. Caryopsis ca. 6.5 mm long, 2 mm wide, fusiform, subterete, glabrous, style base persistent, dark brown.

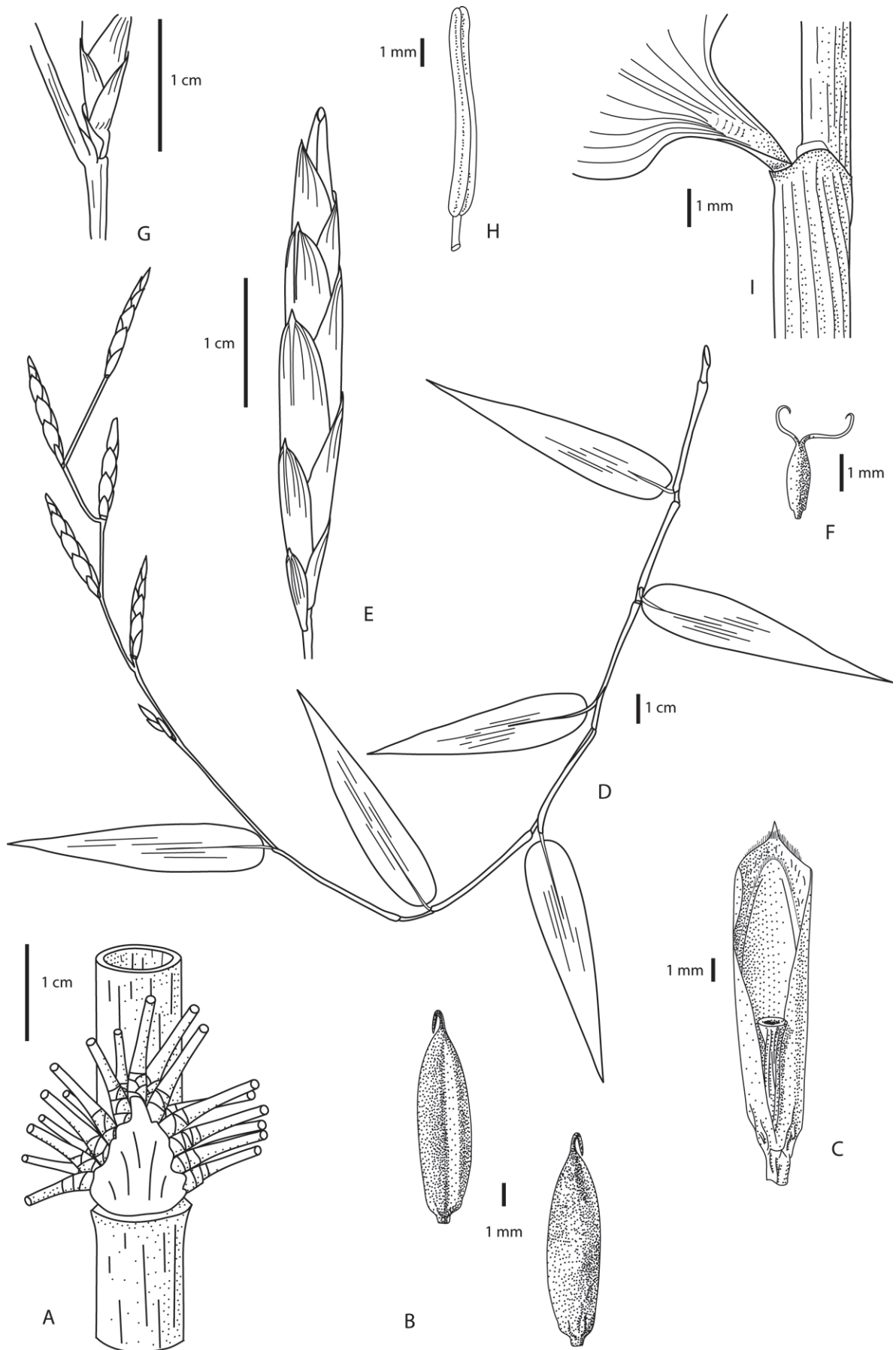
**Distribution and Habitat:**—Known only from the type locality, growing in (and possibly endemic to) a white sand forest at 1200 m elevation in northern Peru.

**Etymology:**—Named for the habitats with white sandy soils where it occurs: *aren-* = sand, *cola* = dwelling.

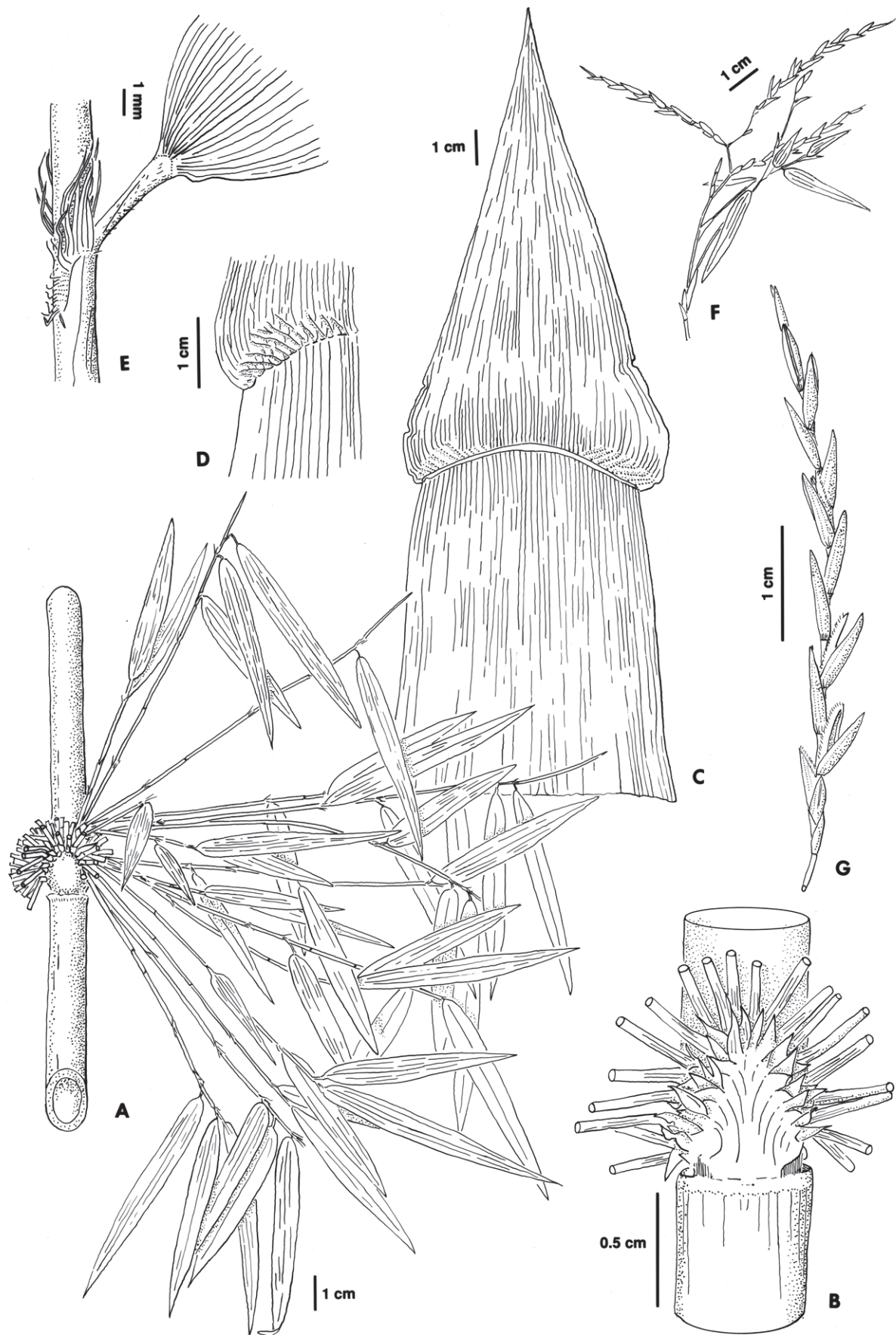
***Rhipidocladum cordatum*** C.D. Tyrrell & L.G. Clark, *sp. nov.*, Fig 3

Type:—ECUADOR. Morona-Santiago: 16 km W of Limon on the road to Gualaceo, 2110 m, 4 June 1980 (fl), S.M. Young 164 (holotype: QCA!; isotypes: AAU!, ISC!, US!).

**Diagnosis:**—*Rhipidocladum cordatum* differs from *R. harmonicum* by its cordate culm leaf blades, greater number (70–100) of branchlets per node, greater number of florets (9–10) per spikelet, and more closely (4–9 mm) spaced spikelets per synflorescence.



**FIGURE 2.** *Rhipidocladum arenicolum*. A. Culm node with branch complement showing apsidate branching, B. Caryopsis, C. Floret showing persistent rachis internode, D. Branchlet bearing terminal synflorescence, E. Spikelet, F. Gynoecium, G. Node of geniculate synflorescence with pulvinus, H. Anther, I. Foliage leaf ligular area. Illustration by Eric Small based on *Luteyn et al. 15520*.



**FIGURE 3.** *Rhipidocladum cordatum*. A. Branch complement, B. Apsidate branching pattern, C. Culm leaf, D. Close up of culm leaf blade base showing “pleats” (a folding or puckering of the blade tissue across the venation) illustrated with stippling, E. Foliage leaf ligular area, F. Synflorescence, G. Spikelet. Illustration by Anna B. Gardner; A, C, D, and E based on *Clark et al. 1092*, B based on *Clark & Asimbaya 1415*, F and G based on *Young 164*.

**Description:**—Culms 8 m tall; internode length unknown, 20–25 mm diameter, hollow. Culm leaves 13.5–22.5 cm long; sheaths 7–10 cm long, abaxially glabrous, margins glabrous; blades cordate, pleated near the base, 8–13 cm long, abaxially glabrous, margins glabrous. Branch complements with 70–100 branchlets, branchlets 23–30 cm long, often rebranching from the base. Foliage leaves 3–4 per flowering branchlet; sheaths 20–30 mm long, abaxially glabrous with a row of hispid hairs along one side, margins glabrous; fimbriae 4.5–5.0 mm continuing down sheath shoulder becoming 2 mm long, basally fused, reddish-brown to golden; pseudopetioles 2–3 mm long, abaxially sparsely puberulent, adaxially hispidulous, purple to brown; inner ligules 0.2–0.4 mm long, truncate; blades 6.0–7.5 cm long, 7–11 mm wide, L:W ratio 7–9, lanceolate, abaxially glabrous, adaxially pubescent with a row of hispid hairs along one side, base slightly asymmetrical and attenuate, apex acute, margins smooth. Synflorescences 4–6 cm long, spicate, bearing 4–6 spikelets spaced 4–9 mm apart; rachis geniculate. Spikelets 4.8–5.0 cm long, comprising 3–4 glumes and 9–10 fertile florets; rachilla internodes 4.0–4.5 mm long. Lowest glume 3–4 mm long, 1-nerved, ovate-lanceolate, apex acuminate, abaxially glabrous, mucronate; upper glumes ovate-lanceolate, apex acuminate, abaxially glabrous, adaxially puberulent: second glume 3.5–4.0 mm long, 3–5-nerved, mucronate; third glume ca. 6 mm long, 5-nerved, mucronate. Lemmas 7.5–8.0 mm long, 5–7-nerved, lanceolate, apex acuminate, abaxially glabrous, mucronate. Paleas 6.5–7.0 mm long, abaxially glabrous, stramineous. Flowers and fruit unknown.

**Distribution and Habitat:**—Cloud forests in the Cordillera Oriental of Ecuador, at 2100–2900 m elevation.

**Etymology:**—The name is descriptive of the heart-shaped (cordate) culm leaf blades.

**Additional Specimens Examined:**—ECUADOR. Morona-Santiago: road Gualaceo-Limón (Gral. L. Plaza Gutierrez), 33.1 km E of Gualaceo, 7.8 km E of the pass, ca. 41.2 km W of Limón, 2885 m, 18 February 1996 (fl), *Clark & Asimbaya 1464* (AAU!, ISC!, QCA!, US!); 32 km E of pass on the road from Gualaceo to Limón (Gral. L. Plaza Gutierrez), 2080 m, 30 May 1992 (fl), *Clark et al. 1092* (ISC!, MO!, QCA!, US!). Zamora-Chinchi: 22.9 km E of Loja on the new road to Zamora 2250 m, 10 February 1996 (fl), *Clark & Asimbaya 1415* (AAU!, ISC!, MO!, QCA!, US!); Valle de San Francisco near casa de INEFAN at road Loja-Zamora, 2150 m, 9 March 1998 (fl), *Laegaard et al. 18521* (AAU!, LOJA).

***Rhipidocladum rubrofimbriatum*** C.D. Tyrrell, L.G. Clark & Judz., *sp. nov.*, Fig 4

Type:—VENEZUELA. Bolívar: Distrito Cendeño, planicie aluvial, piedemonte y altiplanicie entre el margen derecho del Río Orinoco medio y el borde NW de la Serranía de Los Pijiguas (Bajo Río Suapure), laja y sus alrededores en piedemonte al borde de caño Trapichote, 6° 18'–6° 48' N, 66° 30'–67° 11' W, 260 m, 21 March 1987 (fl), *F. Guanchez and O. Huber 4583* (holotype: VEN!; isotypes: MYF, TFAV, US!).

**Diagnosis:**—*Rhipidocladum rubrofimbriatum* differs from *R. sibilans* in its reddish to coppery-colored fimbriae 1.8–6 mm long borne on the foliage leaf sheaths, fewer (20–60) branchlets per node, lanceolate and relatively wider (L:W ratio 5–6) foliage leaf blades and awnless lemmas.

**Description:**—Culms 2–5 m tall; internodes 12–24 cm long, 3–15 mm diameter, hollow. Culm leaves 8–9 cm long; sheaths 5.0–5.5 cm long, abaxially glabrous, margins glabrous; blades 3.0–3.5 cm long, abaxially glabrous, margins glabrous, apex involute into an awn-like tip. Branch complements with 20–60 branchlets, branchlets 15–35 cm long, occasionally rebranching. Foliage leaves lacking on flowering branchlets (4–7 per vegetative branchlets); sheaths 10–25 mm long, abaxially pubescent-pilose to glabrous, margins ciliate; fimbriae 1.8–6.0 mm long, rubescent, apically wavy to curly; pseudopetioles 0.5–1.0 mm long, abaxially and adaxially glabrous to pubescent, yellow; inner ligules ca. 0.1 mm long, truncate; blades 3.2–8.5 cm long, 6–14 mm wide, L:W ratio 5–6, lanceolate, abaxially puberulent, adaxially glabrous, base often slightly asymmetrical and rounded-attenuate, apex acute, margins finely serrulate. Synflorescences 4.5–8.0(–10.0) cm long, spicate, bearing 3–5 non-secund spikelets spaced 10–20(–40) mm apart; rachis straight. Spikelets 2.0–2.5 cm long, comprising 2 glumes and 1–2 fertile florets; rachilla internodes 6–7 mm long. Lowest glume 6–7 mm long, 3-nerved, narrowly lanceolate, apex attenuate, abaxially glabrous, awnless to mucronate; upper

glume 8–10 mm long, 5-nerved, narrowly lanceolate, apex attenuate, abaxially glabrous, adaxially glabrous, awnless to mucronate. Lemma 9–13 mm long, 7-nerved, narrowly lanceolate, apex attenuate, abaxially glabrous, awnless or mucronate. Palea 9–13 mm long, abaxially glabrous, stramineous, sulcus shallower than congeners. Lodicules 3, the anterior pair 2.0–2.2 mm long, the posterior one 1.0–1.3 mm long, ovate. Anthers 4.5–5.5 mm long. Ovary 1.5 mm long, brown to cream. Fruit unknown.

**Distribution and Habitat:**—Apparently endemic to southwestern Venezuela, growing in savannas in the foothills of a granitic outcrop region along the middle stretch of the Río Orinoco. Found at 85–260 m elevation

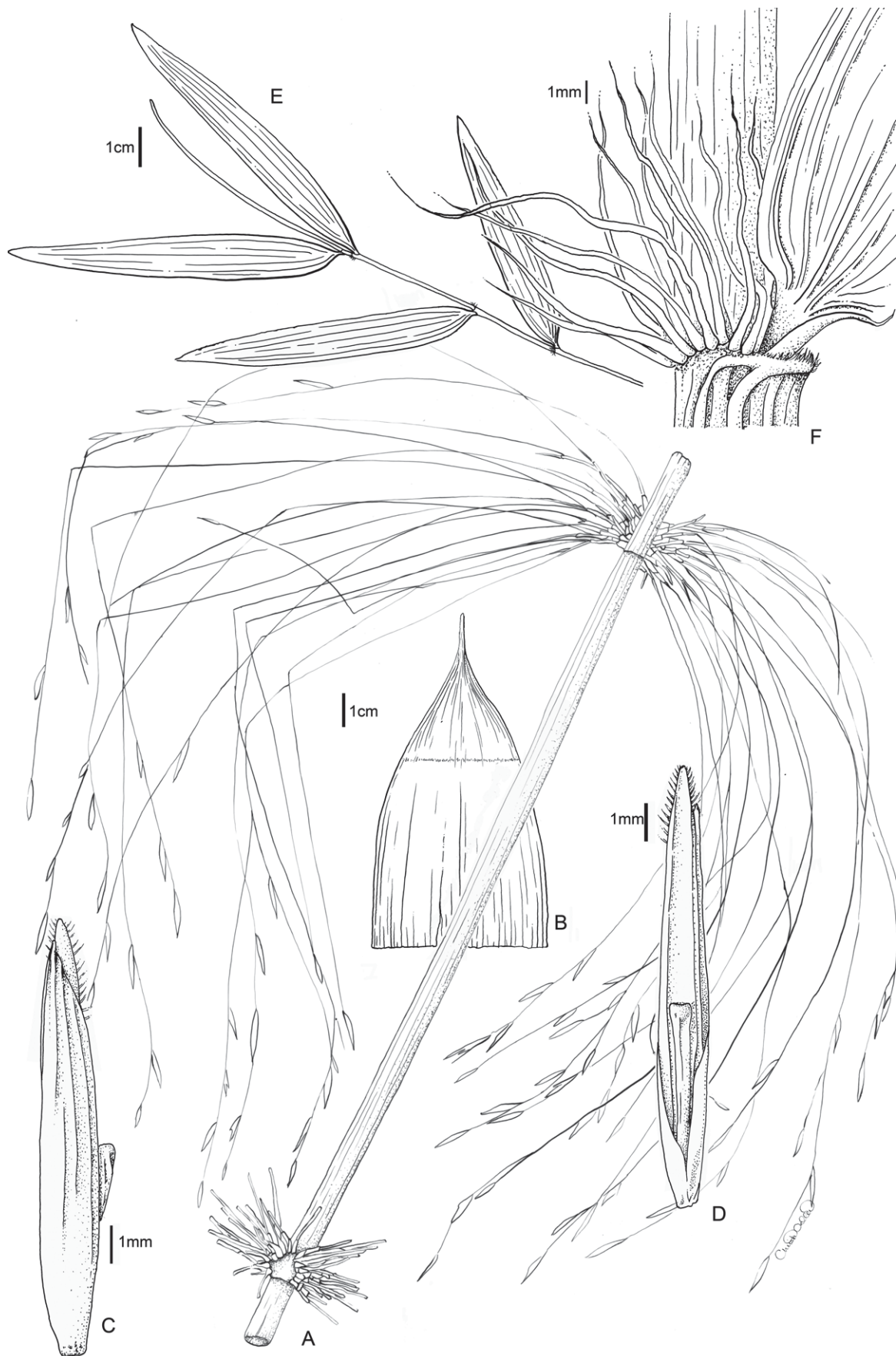
**Etymology:**—The name denotes the coppery red fimbriae which are characteristic of this species: (*rubro* = red, *fimbriatum* = fimbriae).

**Comments:**—This is the species referenced by Judziewicz in Davidse *et al.* (2004) as “*Rhipidocladum* sp. A” and “*Rhipidocladum* sp. B.”

TABLE 2. Morphological characters that differentiate *Rhipidocladum rubrofimbriatum* from *R. sibilans*.

Character		<i>R. rubrofimbriatum</i>	<i>R. sibilans</i>
Culm	height (m)	2–5	4–8(–10)
	diameter (cm)	3–15	7–18
	internode length (cm)	12–24	19–45
Culm leaf	sheath length (cm)	5–5.5	9–12
	blade length (cm)	3–3.5	15–17
Branchlets	number per node	20–60	150–200
Foliage leaf sheath	abaxial vestiture	pubescent to glabrous	puberulent
	fimbriae length (mm)	1.8–6	1–3
	fimbriae color	rubescent	white
Pseudopetiole	color	yellow	cream
Foliage leaf blade	shape	lanceolate	linear
	width (mm)	6–14	1.8–2.7(–3.5)
	L:W ratio	5–6	20–28
	abaxial vestiture	puberulent	glabrous
	adaxial vestiture	glabrous	glabrous to short pilose
Synflorescence	number of spikelets	3–5	1–3
	spacing (mm)	10–20(–40)	18–22
Spikelets	number of glumes	2	4
	number of florets	2	2–3
	internode length (mm)	6–7	3–4(–8)
Lowest glume	abaxial vestiture	glabrous	puberulent
	number of nerves	3	1
	awn length (mm)	mucronate	2.5–3.5
Second glume	shape	narrowly lanceolate	lanceolate
	abaxial vestiture	glabrous	puberulent
	length (mm)	8–10	5–9
	number of nerves	5	3–5
	awn length (mm)	awnless to mucronate	2.5–4
Lemma	shape	narrowly lanceolate	lanceolate
	abaxial vestiture	glabrous	puberulent
	awn length (mm)	awnless to mucronate	4–5





**FIGURE 4.** *Rhipidocladum rubrofimbriatum*. A. Culm internode with flowering branch complement showing leafless branches bearing terminal synflorescences, B. Culm leaf, C. Floret, lateral view, D. Floret, ventral view, E. Foliage leaf complement, F. Foliage leaf ligular area showing fimbriae. Illustration by Christa Adler; A based on *Guanchez & Huber 4583*, B based on *Steyermark et al. 131610*, C, D and F based on *Gröger & Meier 483*, E based on *Davidse & Huber 15183*.

**Additional Specimens Examined:**—VENEZUELA. Bolivar [as Territorio Federal Amazonas]: Depto. Atures, 22 km S of Puerto Ayacucho along road to Samariapo, near Garcitas, 85 m, 5°28' N 67°36' W, 16 April 1978 (fl), *Davidse & Huber 15183* (MO!, US!); carretera de Los Pijiguaos hacia Pto. Ayacucho, km 78; Cerro Gavilan al Norte de la carretera, 6°13'N 67°12'W, en una grieta ancha de 2 m de profundidad, 3 March 1993 (fl), *Gröger 836* (MO!); Dpto. Atures, Río Sipapo, 5 km de su desembocadura al Río Orinoco, Cerro Caldero, 5°1'N 67°46' W, 17 May 1992 (fl), *Gröger & Bancroft 416* (MO!); Dpto. Atures, carretera Samariapo-Puerto Ayacucho, Km 5.5, laja al oeste de la carretera, 5°17'N 67°48' W, 4 June 1992 (fl), *Gröger & Meier 483* (MO!); forest E of Río Parguaza bordering savanna 1 km S of Quebrada La Flore, affluent of Río Ore, affluent of Río Parguaza, 6°17'N 67°5'W, 85 m, 9 September 1985 (fl), *Steyermark et al. 131610* (MO!).

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