Universidade Estadual de Campinas

Instituto de Biologia

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" Estudos Taxonômicos e Morfoanatômicos em Colanthelia (Poaceae: Bambusoideae: Bambuseae"

Este exemplar corresponde à redação final da tese defendida pelo(a) candidato (a) ANA PAULA SANTOS GONÇALVES
Tarciso Filgueiras
e aprovada pela Comissão Julgadora.

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Qualquer caminho é apenas um caminho e não constitui insulto algum -para si mesmo ou para os outros- abandoná-lo quando assim ordena o seu coração. (...) Olhe cada caminho com cuidado e atenção. Tente-o quantas vezes julgar necessárias... Então, faça a si mesmo e apenas a si mesmo uma pergunta: possui este caminho um coração? Em caso afirmativo, o caminho é bom. Caso contrário, este caminho não possui importância alguma.

Carlos Castañeda

Dedico esta tese a

Esther de Oliveira Gonçalves

Adálcio Gonçalves de Paula

Nair Santos Gonçalves

Deniz Gonçalves de Paula

Delcy Gonçalves de Paula

Por me ajudarem a encontrar o meu caminho

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RESUMO GERAL

Colanthelia McClure é um gênero de bambus lignificados cujas espécies ocorrem principalmente no Brasil, em área de Mata Atlântica s.l. Os objetivos deste estudo foram: identificar as espécies de *Colanthelia*, determinar sua distribuição geográfica e investigar alguns caracteres micromorfológicos e anatômicos das lâminas foliares das folhas dos ramos de todas as espécies do gênero.

Para este levantamento foram realizados trabalhos de campo durante o período de 2002-2004 nos Estados: Espírito Santo, Minas Gerais, Paraná, Santa Catarina, Rio de Janeiro e Rio grande do Sul, além do estudo de materiais obtidos por empréstimo de herbários nacionais e estrangeiros. Como resultado deste trabalho foram identificadas 12 espécies de *Colanthelia*, das quais cinco são novas para a ciência.

Os estudos em microscopia eletrônica de varredura demonstraram que as lâminas das folhas dos ramos das espécies de Colanthelia apresentam quatro regiões micromorfologicamente distintas. Do ponto de vista taxonômico, os caracteres mais consistentes encontrados foram: 1) Ocorrência, na face adaxial, de estômatos restritos a determinadas regiões, 2) Ocorrência de papilas associadas com as células longas da epiderme, 3) Ocorrência de corpos silicosos equidimensionais e 4) Diferentes formas de papilas associadas com os estômatos e 5) Ocorrência ou não de papilas associadas com os estômatos dentro da região da estria, na face abaxial da lâmina foliar.

A diferença em coloração da estria abaxial parece ser o resultado conjunto de dois fatores: redução ou ausência de cera epicuticular e redução da densidade de papilas associadas tanto com as células longas da epiderme como com os estômatos.

Os estudos em anatomia de lâmina foliar revelaram que, dentre os caracteres anatômicos investigados, a presença ou ausência de células fusóides, o local de ocorrência das fibras intercostais de esclerênquima, a ocorrência de adaxial "furrows", e a forma do feixe vascular de primeira ordem são úteis para separar espécies ou grupos de espécies de *Colanthelia*.

Palavras-chave:

Taxonomia, anatomia de lâmina foliar, microscopia eletrônica de varredura, gramíneas, bambus, distribuição geográfica, Mata Atlântica, conservação.

GENERAL ABSTRACT

Colanthelia McClure is a genus of woody bamboos occurring mainly in the Brazilian atlantic forest. The goals of this study were: to identify the *Colanthelia* species, to determine the geographic distribution of the species of the genus and to investigate some micromorphological and anatomical characters from the blades of the foliage leaves from all *Colanthelia* species.

For this study, fieldwork was done during 2002-2004 in the Brazilian states of Espírito Santo, Minas Gerais, Paraná, Santa Catarina, Rio de Janeiro and Rio grande do Sul, and specimens were borrowed and consulted from national and foreign herbaria. As a result of this study, 12 *Colanthelia* species were identified; amongst these, five are new species.

SEM studies revealed that the blades of the foliage leaves of *Colanthelia* consist of four micromorphological regions. From a taxonomic point of view, the more consistent micromorphological features found were: 1) Occurrence of adaxial stomata in certain regions of the blades, 2) Occurrence of papillae associated with the epidermal long cells, 3) Ocurrence of equidimensional, round silica bodies 4) Different shapes of papillae associated with the stomata, and 5) Occurrence or not of papillae associated with the stomata inside the abaxial stripe region. The different shades of color of the abaxial green stripe appear to be the result of two connected characters: reduction or absence of epicuticular wax and reduction of the density of papillae associated with both epidermal long cells and stomata.

Leaf anatomy studies revealed that the presence or absence of fusoid cells, the location of intercostal sclerenchyma fibers, the occurrence of adaxial furrows and the shape of the first order vascular bundle are useful to separate species or groups of species within the genus.

Key words:

Taxonomy, leaf anatomy, scanning electron microscopy, grasses, bamboos, geographic distribution, atlantic rainforest, conservation.

INTRODUÇÃO GERAL

Os bambus são membros da família Poaceae que apresentam características morfológicas, anatômicas, fisiológicas e ecológicas peculiares. Ocorrem como plantas nativas entre 46° N e 47° S (Zhang & Clark, 2000), associados à vegetação lenhosa, sendo componentes típicos de florestas tropicais e subtropicais (Calderón & Soderstrom, 1980). No entanto, existem espécies adaptadas a ambientes especializados, tais como o Cerrado (*Actinocladum verticillatum* (Nees) Soderstr. e espécies de *Filgueirasia* Guala), Campos de Altitude (*Glaziophyton mirabile* Franchet e algumas espécies de *Chusquea* Kunth) e até Campo Rupestre (*Aulonemia effusa* (Hack.) McClure).

No Novo Mundo, são reconhecidas cerca de 356 espécies em 38 gêneros de bambus (Judziewicz et al., 1999). O Brasil é o país do Novo Mundo com maior diversidade, apresentando cerca de 34 gêneros e 234 espécies, das quais 204 (ca. 83%) são consideradas endêmicas (Filgueiras & Santos-Gonçalves, 2004). Os bambus são plantas de grande importância econômica, ecológica e cultural, sendo registrados mais de 1300 diferentes usos, dentre eles, construção civil, múltiplos usos em áreas rurais, alimentação humana, alimentação animal, controle de erosão, usos medicinais, fabricação de instrumentos musicais, artesanatos diversos e também como plantas ornamentais.

Os bambus verdadeiros pertencem à subfamília Bambusoideae s. s. e compreendem os bambus herbáceos (tribo Olyreae) e os bambus lignificados (tribo Bambuseae). Os bambus herbáceos incluem cerca de 21 gêneros e 108 espécies

distribuídos principalmente nos trópicos e subtrópicos americanos, ao passo que os bambus lignificados compreendem cerca de 60-70 gêneros e cerca de 1.300 espécies de ampla distribuição (GPWG, 2001). Filgueiras & Santos-Gonçalves (2004) apresentam oito características morfológicas usadas para separar os bambus herbáceos de bambus lignificados.

As espécies da tribo Bambuseae apresentam as seguintes características dentre outras: sistema subterrâneo rizomatoso, do tipo paquimorfo ou leptomorfo, folhas dos ramos com lígula externa e lâmina foliar decídua, colmo lignificado, e florescimento cíclico com intervalos mais ou menos longos (Soderstrom & Ellis, 1986). Como definida por Soderstrom & Ellis (1986), a tribo Bambuseae inclui nove subtribos, dentre as quais Arthrostylidiinae e Guaduinae, ambas endêmicas do Novo Mundo (Judziewicz et al., 1999). *Colanthelia* McClure & E. W. Smith, o gênero aqui estudado, é um membro da subtribo Arthrostylidiinae. Esta subtribo caracteriza-se morfoanatomicamente por um conjunto de caracteres, tais como: ocorrência de uma região discolor ("striae") na face abaxial da lâmina foliar facilmente observada em material fresco, fibras intercostais de esclerênquima, papilas refrativas, nervura mediana da lâmina da folha dos ramos reduzida, margens da lâmina foliar com diferenças estruturais acentuadas e presença de células fusóides (Soderstrom & Ellis, 1986).

Colanthelia é um gênero de bambus lignificados cujas espécies ocorrem principalmente no Brasil, em área de Mata Atlântica s.l. (McClure, 1973; Smith et al., 1981, 1982; Soderstrom et al., 1988; Burman & Filgueiras, 1993; Judziewicz et al., 1999). Apenas uma espécie (*C. rhizantha* (Hack.) McClure) ocorre disjunta na Província de Misiones, na Argentina (Agrasar & Clark, 2000). As espécies deste gênero

caracterizam-se por apresentarem rizoma curto-paquimorfo, colmos lignificados fistulosos, com parede espessada, entrenós com comprimento regular, ocorrência de promontório no colmo, folhas do colmo com cinto ("girdle"), complemento de ramo composto por 1-13 ramos, um dos quais dominantes e sinflorescência paniculada ou racemosa, com antécio terminal reduzido (capítulo IV desta tese).

Este trabalho consta de estudos taxonômicos, anatômicos e micromorfológicos do gênero *Colanthelia*. O primeiro capítulo, intitulado "Five new species of *Colanthelia* (Poaceae: Bambusoideae:Bambuseae) from Brazil", é composto pela descrições formais, padronizadas de cinco espécies novas, descobertas durante os estudos taxonômicos. Destas cinco espécies, quatro foram descobertas durante os trabalhos de campo da autora nos estados do Espírito Santo, Paraná, São Paulo, e Rio de Janeiro. São apresentadas ilustrações de cada uma das novas espécies e são discutidas as relações morfológicas mais evidentes entre as espécies do gênero.

No segundo capítulo, intitulado "Survey of blades of foliage leaves of *Colanthelia* (Poaceae:Bambusoideae) under Scanning Electron Microscopy" são apresentados os resultados dos estudos em Microscopia Eletrônica de Varredura (MEV) da região mediana da lâmina foliar para as 12 espécies do gênero.

No terceiro capítulo, "Survey of blades of foliage leaves of *Colanthelia* (Poaceae: Bambusoideae) in transverse section" são apresentados os resultados dos estudos de anatomia da lâmina foliar das folhas dos ramos em corte transversal para as doze espécies de *Colanthelia*. Diversas características da região mediana da lâmina foliar revelaram-se de grande valor taxonômico, tanto para caracterizar o gênero quanto para se reconhecer espécies ou grupos de espécies.

O quarto capítulo, "A revision of *Colanthelia* (Poaceae:Bambusoideae: Bambuseae)", consta da revisão taxonômica do gênero. Neste capítulo, estão incluídas as descrições das 12 espécies que compõem o gênero, comentários nomenclaturais, comentários sobre a caracterização morfológica de cada uma das espécies, mapas de distribuição dos espécimes coletados e ilustrações das espécies.

NOTA BENE:

Vários nomes novos são apresentados nesta tese (*Colanthelia gracillima* Dusén ex Santos-Gon. & Filg.*, C. itatiaiae* Santos-Gon. & L. G. Clark*, C. longifolia* Santos-Gon. & Filg.*, C. secundiflora* Santos-Gon. & L. G. Clark e *C. sparsiflora* Santos-Gon. & Filg.). Não é intenção da autora que esta tese seja considerada local de publicação de tais nomes, pois os artigos nos quais eles aparecem serão submetidos, separadamente, a distintos periódicos, após a eventual aprovação desta tese pela banca examinadora. Com esta nota, a autora quer evitar a possível aplicação do conceito de *nomen nudum* (Greuter et al., 2000) para os novos nomes aqui apresentados.

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CAPÍTULO I

FIVE NEW SPECIES OF *COLANTHELIA* (POACEAE: BAMBUSOIDEAE: BAMBUSEAE) FROM BRAZIL

ABSTRACT

Five new species of C*olanthelia* from Brazil, *C. gracillima* Dusén ex Santos-Gon. & Filg., *C. itatiaiae* Santos-Gon. & L. G. Clark, *C. longifolia* Santos-Gon. & Filg., *C. sparsiflora* Santos-Gon. & Filg. and *C. secundiflora* Santos-Gon. & L. G. Clark are here described and illustrated. The names *Arundinaria gracillima* Dusén and *Colanthelia gracillima* Dusén are recognized as *nomina nuda*. *Colanthelia gracillima* Dusén is revalidated as *C. gracillima* Dusén ex Santos-Gon. & Filg. Comments on habitat, locality of occurrence as well as comparisons with the morphologically nearest species in the genus are made for each species.

RESUMO

Cinco espécies novas de *Colanthelia* para o Brasil, *C. gracillima* Dusén ex Santos-Gon. & Filg., *C. itatiaiae* Santos-Gon. & L. G. Clark, *C. longifolia* Santos-Gon. & Filg., *C. secundiflora* Santos-Gon. & L. G. Clark and *C. sparsiflora* Santos-Gon. & Filg. são descritas e ilustradas. Os nomes *Arundinaria gracillima* Dusén e *Colanthelia gracillima* Dusén são reconhecidos como *nomina nuda*. *Colanthelia gracillima* Dusén é revalidada como *C. gracillima* Dusén ex Santos-Gon. & Filg. Para cada espécie são feitos comentários sobre hábito, localidade de ocorrência bem como comparações com a espécie do gênero mais proximamente relacionada sob o ponto de vista morfológico.

Colanthelia (McClure & E. W. Smith) McClure is a genus of South American woody bamboos with seven described species occurring in Southern and Southeast Brazil (McClure, 1973; Calderón & Soderstrom, 1980; Smith et al., 1981/1982; Soderstrom et al., 1988; Burman & Filgueiras, 1993; Judziewicz et al., 1999), and one species (*C. rhizantha* (Hackel) McClure) also occurring in Argentina (Judziewicz et al., 1999; Agrasar & Clark, 2000). The species in this genus occur in the Atlantic Forest s.l. from sea level to 2200 m altitude.

Colanthelia is characterized by having short pachymorph rhizomes, woody culms, internodes with regular length, presence of a promontory, culm leaf with a girdle, branch complement composed of a few to many branches, one of them dominant, and synflorescence paniculate, racemose, sometimes reduced to a single spikelet; spikelet with a terminal reduced anthoecium.

In the course of a taxonomic revision of the genus (see chapter IV of this study), five new species were found, which are here described as new. Herbaria acronyms follow Holmgren et al. (1990).

1. *Colanthelia gracillima* Dusén ex Santos-Gon. & Filg. sp. nov. INED. TYPE: BRAZIL. Paraná: Município de Cerro Azul, Cabeceira do Ribeirão do Tigre, 18 July 1984 (fl.), *G. Hatschbach 48104* (holotype, MBM; isotypes, NY, F). Figure 1A-J.

Habit unknown. Rhizomes pachymorph. Culms ca. 3m long, apex erect or nearly so, not terminating in zig-zag. Internodes cylindrical, green, glabrous, striate, 4--13.9 cm long, 1--2.1 mm in diam., wall thickened, lumen inconspicuous. Nodes of the lower portion not

seen; intranodal area 0.8--2 mm long; promontory conspicuous; upper and lower portions of the internode glabrous. Culm leaves ca. 6.8 cm long; sheaths 3--3.7 cm x 0.45--0.5 mm, sometimes persistent, glabrous, margins ciliolate, lateral appendages inconspicuous; girdle conspicuous, light straw-colored, glabrous; blade apparently reflexed, pseudopetiolate, deciduous, ca. 2.5 cm x 2.3 mm, glabrous on both surfaces, margins with prickle hairs; internal ligule membranous, apex ciliolate, 0.2--0.3 mm long; external ligule inconspicuous (less than 0.1 mm long); fimbriae only known by small fragments, erect, straw-yellow colored. Branch complement with 2--10 branches, the branches 4--22 cm long, sometimes rebranching at the lower nodes; lower nodes sometimes geniculate. Foliage leaves 2-6 per branch; sheaths 1.3-1.8 cm x 1.5--2 mm, glabrous, margins ciliolate; lateral appendages inconspicuous; internal ligule membranous, apex ciliolate, 1--1.5 mm long; external ligule present, inconspicous; fimbriae 2--2.5 mm long, erect, light-brown; pseudopetioles 1-1.5 mm long, puberulent on both surfaces, dark brown on the adaxial surface, green-yellow on the abaxial; blades lanceolate, 1.5--5.9 cm x 3--6 mm, the base round, apex acuminate, puberulent toward the apex on the adaxial surface, pubescent on the abaxial surface, the margins with angular prickle hairs. Synflorescences paniculate, terminal, 3--7.5 x 1.5--5.8 cm, with 2-5 branches; branches not secund, 1--4.3 cm long; pedicels 2.5--13 mm, pubescent. Spikelets not secund, 0.8--2.8 cm long, 1-6-flowered; glumes 2, unequal, awnless; lower glume 3--3.3 mm x 1--1.5 mm, 5-nerved, puberulent towards the apex; upper glume 3.9--4.2 mm x 1.5--2 mm, 5-nerved, puberulent towards the apex; anthoecium slightly navicular; lemma 6--6.2 mm x 2.2--2.4 mm, 5-nerved, 3 conspicuous, 2 inconspicuous, puberulous towards the apex, awnless, surface purplish;

palea 5.1--5.5 mm x 2.2--2.4 mm, 2-nerved, puberulous towards the apex, awnless, surface green-yellow; lodicules 3, two similar, one narrower, thin, glabrous, transparent, pilose at the tip. Stamens 3; anther 2.5--2.8 mm, yellowish. Ovary 0.3--0.4 mm x 0.1--0.15 mm, glabrous, light-yellow; style 1, glabrous, 0.1--0.2 mm; stigmas 2, plumose, light yellow. Caryopsis not seen.

Comments. Plants known only from fragments. It was first collected by Dusén who named it *Arundinaria gracillima* on a herbarium sheet (F). Later, Renvoize annotated the name "*Colanthelia gracillima* Dusén" on a sheet in the Hatschbach herbarium (MBM). However, neither of these names was ever published. Therefore, both names (*Arundinaria gracillima* Dusén and *Colanthelia gracillima* Dusén) are here considered as *nomina nuda. Colanthelia gracillima* Dusén is validated as *C. gracillima* Dusén ex Santos-Gon. & Filg. The specific epithet was retained to avoid the proliferation of names.

Colanthelia gracillima is morphologically close to *C. secundiflora* Santos-Gon. & L. G. Clark because of the number of branches of the branch complement, the size of blades of foliage leaves, the fimbriate culm leaves without lateral appendages and the small number of anthoecia per spikelet; however, it differs from it because of the not secund branches of the sinflorescence, the length of the pedicels of the spikelets and the anthoecium without dark spots.

Phenology. This species was collected in flower in 1916 by Dusén and in 1984 by Hatschbach.

Distribution and habitat. South of Brazil, Paraná State, in Atlantic rainforest habitat.

Paratype. BRAZIL. Paraná: Jaguariahyva [Jaguariaíva], ad marginem silvae primaevae, 710 m, 25 March 1916, Dusén s.n. (F, K, NY).

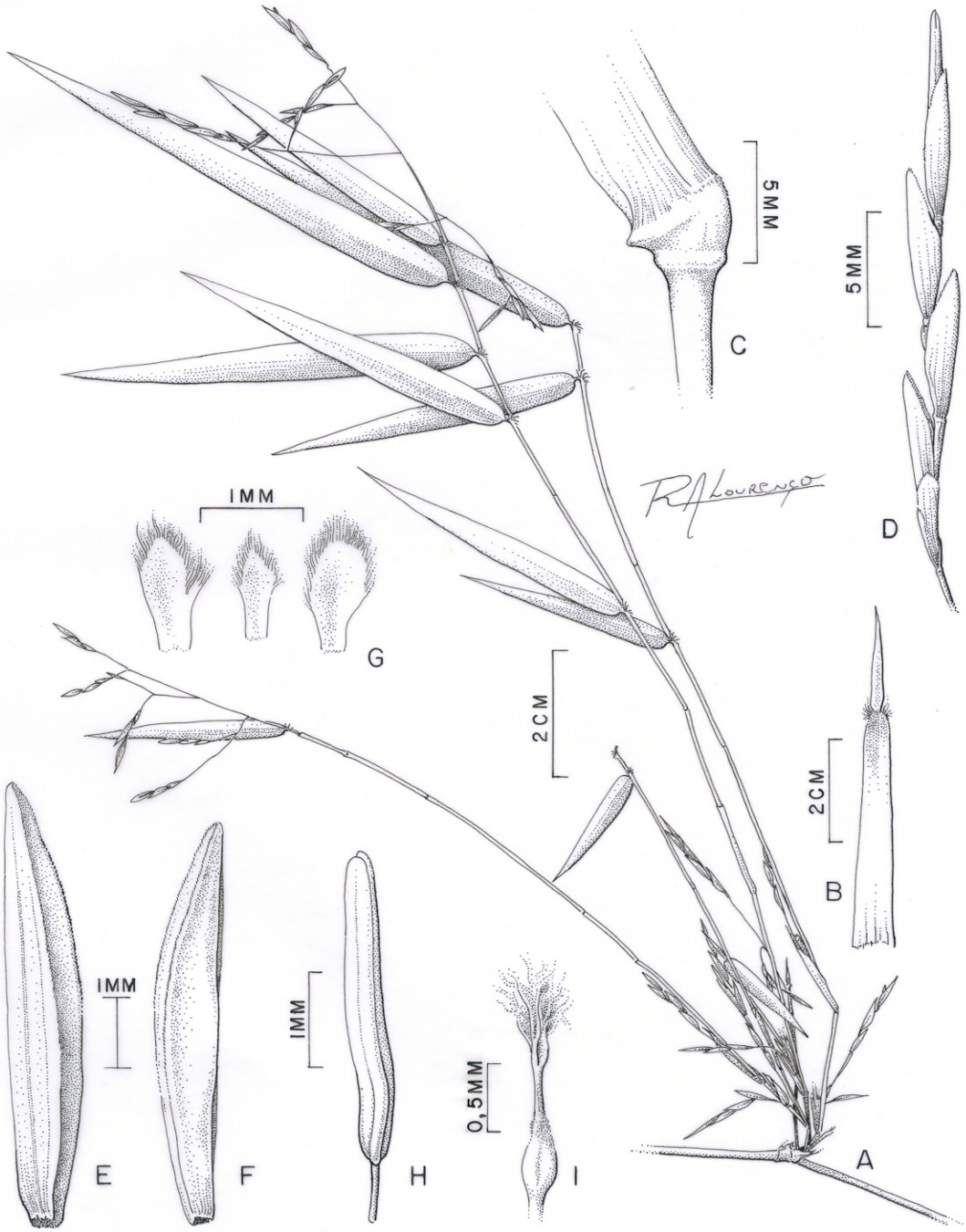

Figure 1. A-J. *Colanthelia gracillima* (based on *Hatschbach 48104*). A. Branch complement in a floriferous state. B. Culm leaf. C. Nodal region and promontory. D. Spikelets. E. Lemma. F. Palea. G. Lodicules. H. Stamen. I. Gynoecium.

2. *Colanthelia itatiaiae* Santos-Gon. & L. G. Clark, sp. nov. INED. TYPE: BRAZIL. Rio de Janeiro: Município de Itatiaia, Parque Nacional de Itatiaia, 1.100m, 22º 25'S, 44º 37'S, trilha para a cachoeira Véu da Noiva e Itaporani, 5 Nov. 2003 (veg.), *Santos-Gonçalves & Matsumoto 565* (holotype UEC; isotypes IBGE, ISC, K, MBM, MO, RB, SP, UFMG, US). Figure 2A-E.

Plants creeping, clambering to climbing. Rhizomes pachymorph. Culms 2-3 m long, apex terminating in zig-zag. Internodes cylindrical, green, sometimes purplish when young, puberulent when young, striated, 9--22 cm long, 1.51--1.80 mm in diam., wall thickened, lumen inconspicuous. Nodes of the lower portion sometimes rooting; intranodal area 1.5--2.4 mm long; promontory inconspicuous; upper and lower portions of the internode glabrescent. Culm leaves 4.9--6.1 cm long; sheaths 3.1--4 cm x 4--9 mm, sometimes persistent, puberulent on the adaxial surface, margins ciliolate, lateral appendages conspicuous; girdle inconspicuous, glabrous; blade erect to more or less reflexed, continuous with the sheath, falling as a unit, 1--2.1 cm x 1.5--3 mm, puberulent on both surfaces; margins with prickle hairs; internal ligule membranous, 0.2--0.3 mm long; external ligule null; fimbriae 2--4 mm long, spreading, first reddish then becoming brown. Branch complement with 1-5 branches, the branches 13--21.5 cm long, sometimes rebranching at the lower nodes; lower nodes sometimes geniculate. Foliage leaves 5--13 per branch; sheaths 1.7--2.1 cm x 3.5--4.1 mm, puberulent on the abaxial surface, margins ciliolate; lateral appendages conspicuous; internal ligule membranous, 1.5--2 mm long; external ligule present, inconspicuous; fimbriae 5--8 mm long, spreading, first reddish then becoming straw-yellow. Pseudopetioles 1--1.5 mm long,

puberulent on both surfaces, dark green on both surfaces; blades lanceolate, 5.1--8.9 cm x 0.9--2.2 cm, the base asymmetrical, sometimes round, apex acuminate, glabrescent on the adaxial surface, puberulent towards the apex on the abaxial surface; margins with pickle hairs. Synflorescences not seen.

Comments. In its vegetative state this species can be recognized by the creeping, clambering to climbing habit, the commonly asymmetrical base of the foliage leaves, and the conspicuous lateral appendages on the sheaths of both the foliage leaves and the culm leaves. The apex of the culm terminating in a strong zig-zag (this character is shared by some *Colanthelia* and *Aulonemia* species) is also characteristic of the species. In its vegetative state, *C. itatiaiae* resembles *C. burchellii* (Munro) McClure because of the number of branches per branch complement (1--5 in *C. itatiaiae* x 1--4 in *C. burchellii*) and the size of blades of foliage leaves (5.1--8.9 cm long in *C. itatiaiae* x 4.1--5.6 cm long in *C. burchellii*).

Phenology. This species was collected only in its vegetative state.

Distribution and habitat. Southeast Brazil, in “Parque Nacional do Itatiaia”, which is located in an area shared by three Brazilian states: Rio de Janeiro, Minas Gerais and São Paulo. The vegetation is a mesophytic forest and the habitat is along river banks, in places of high humidity.

Paratypes. BRAZIL. Rio de Janeiro: Município de Itatiaia, Parque Nacional do Itatiaia, 22^{o} 25'S, 44^{o} 37' W, trilha para a cachoeira Véu da Noiva e Itaporani, 1.100m, 22^{o} 25'S, 44^{o} 37' W, 5 Nov. 2003 (veg.), Santos-Gonçalves et al. 566 (ICN, R, SP, UEC, UFMG); idem, 12 Feb. 1990 (veg.), L. Clark et al. 672). (ISC, MO, NY, SJRP). Município de

Macaé de Cima, Reserva Ecológica de Macaé de Cima, Sítio do David Miller, trilha do bambu, 1572m, 22º 22' 25"S, 42º 30' 17"W, 9 Mar. 2002 (veg.), Santos-Gonçalves et al. 477 (ISC, UEC, UFMG, US); idem, 1636m, 22º 22' 26"S, 42º 30' 20"W, 9 Mar. 2002 (veg.), Santos-Gonçalves et al. 478 (ICN, R, SP, UEC).

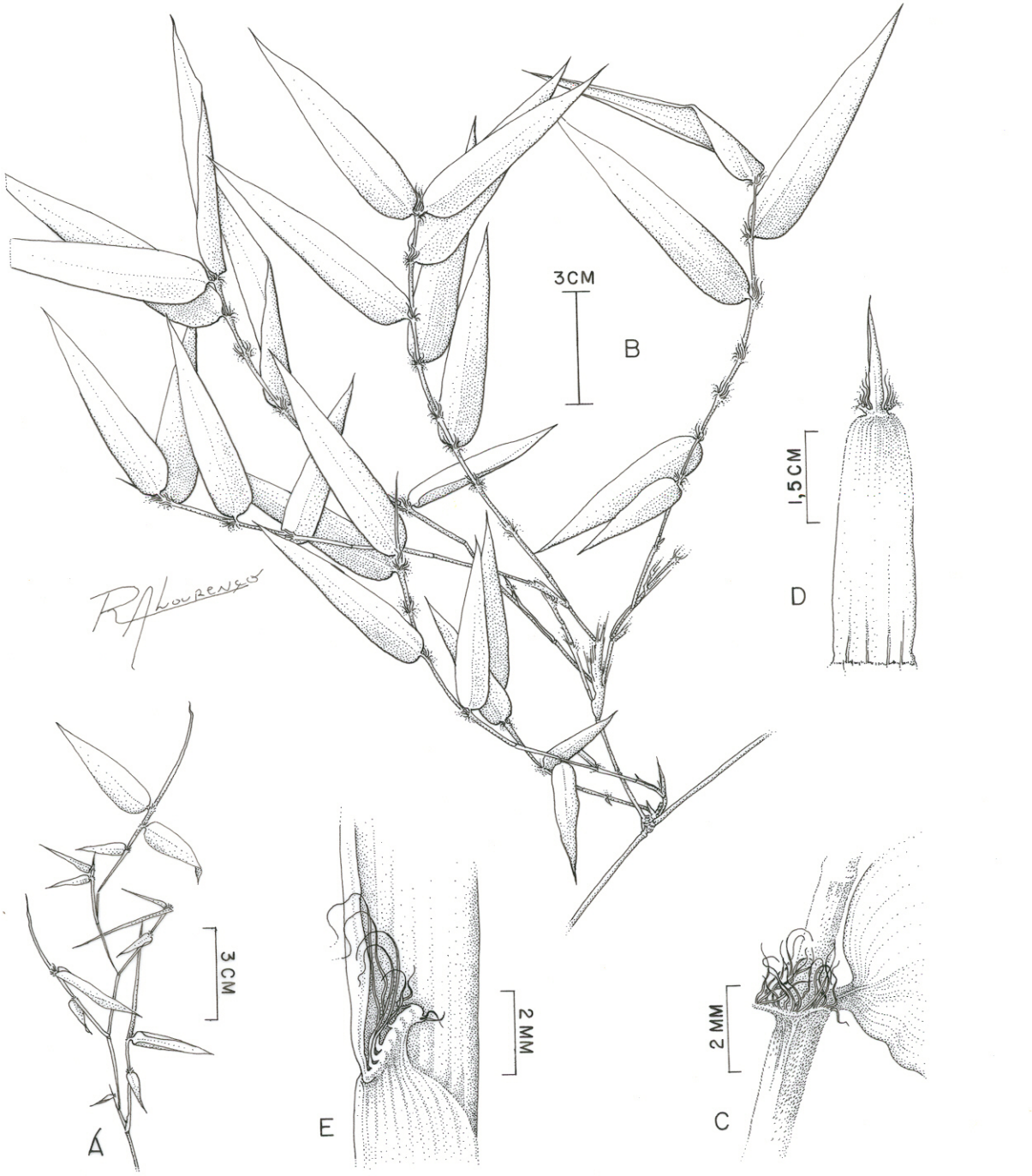

Figure 2. A-E. *Colanthelia itatiaiae* (based on *Santos-Gonçalves et al. 565, L. Clark et al. 672*). A. Apex of a vegetative culm terminanting in zig-zag. B. Branch complement in the vegetative state. C. Lateral appendages of the sheath of the foliage leaves. D. Culm leaves. E. Culm leaf in detail evidencing the lateral appendages of the sheath.

3. *Colanthelia longifolia* Santos-Gon. & Filg., sp. nov. INED. TYPE: BRAZIL. Espírito Santo: Município de Linhares, Reserva Natural da Vale do Rio Doce, 19º 23' 27.96"S, 40º 4' 19.92"W, ca. 60 m, Estrada Jacarandá, próximo ao Aceiro da Aracruz, 14 Oct. 2002 (veg.), *Santos-Gonçalves & Matsumoto 510* (holotype UEC; isotypes IBGE, ISC, K, MBM, MO, RB, SP, UFMG, US). Figure 3A-G.

Plants initially erect then becoming scandent to clambering. Rhizomes pachymorph. Culms 6-7 m long, apex terminating in zig-zag. Internodes cylindrical, green, glabrous, smooth, 14--81 cm long, 3.5--6.2 mm in diam., wall thickened, lumen inconspicuous. Nodes of the lower portion not rooting; intranodal area 0.5--0.7 mm long; promontory conspicuous; upper and lower portions of the internode when young with tomentose-velvety ochre trichomes. Culm leaves 12.1--38.6 cm long; sheaths 8--21 cm x 5--8 mm, sometimes persistent, glabrous, margins densely ciliate, lateral appendages null; girdle conspicuous, 3.15--6.54 mm long, with hirtellous-hispid dark-brown trichomes; blades erect at first and then reflexed, pseudopetiolate, readily deciduous, 4.1--9.6 cm x 3--7 mm, glabrous on both surfaces; margins with prickle hairs; internal ligule membranous, 0.3--0.4 mm long; external ligule null; fimbriae 1.1--2.2 cm long, erect, dark brown. Branch complement with 1-3 branches, the branches 16--44 cm long, sometimes rebranching at the lower nodes. Lower nodes sometimes geniculate. Foliage leaves 6--15 per branch; sheaths 3.5--6.5 cm x 8--11 mm, glabrous on the adaxial surface, margins densely ciliolate; lateral appendages null; internal ligule membranous, 0.4--0.5 mm long; external ligule present, inconspicuous; fimbriae 0.8--1.3 cm long, erect, dark brown; pseudopetioles 3--5 mm long, with hispid, brown trichomes on the adaxial

surface, glabrous on the abaxial surface, dark brown; blades lanceolate, 13.7--26.3 x 2.1--4.3 cm, the base asymmetrical, apex acuminate, glabrous on the adaxial surface, except for a narrow submarginal stripe of brown small hard trichomes at one side of the base, glabrescent on the abaxial surface; margins with angular prickle hairs. Synflorescences not seen.

Comments. *Colanthelia longifolia* is the tallest and most robust of all known species in the genus. It has internodes with very thick walls and a very small lumen, large foliage leaves, and conspicuous, erect fimbriae. Sometimes, there is no lumen at the apex of the culm, which terminates in a slight zig-zag. As previously commented, this character is shared by some *Colanthelia* and *Aulonemia* species. In its vegetative state, *C. longifolia* is closest to *C. lanciflora* (McClure & L. B. Sm.) McClure because of the diameter of the culm (3.5--6.2 mm in *C. longifolia* x 3--7 mm in *C. lanciflora*), but differs from it because of the longer size of the blades of the foliage leaves (13.7--26.3 long in *C. longifolia* x 3--15.1 cm long in *C. lanciflora*), the occurrence of tomentose-velvety ochre trichomes in the young internodes, and the conspicuous girdle, with hirtellous-hispid dark-brown trichomes.

Phenology. This species was collected only in its vegetative state.

Distribution and habitat. Southeast Brazil, Espírito Santo state, in a single formation of the Atlantic rainforest locally called "Restinga arbórea" (arboreal Restinga).

Paratypes. BRAZIL. Município de Linhares, Reserva Natural da Vale do Rio Doce, 19° 23’ 27.96”S, 40° 4’ 19.92”W, ca. 60 m, Estrada Jacarandá próximo ao Aceiro da Aracruz, 14 Oct. 2002 (veg.), Santos-Gonçalves et al. 511 (IBGE, K, R, SP, UEC, US);

idem, Estrada Jureiana Vermelha, próximo ao km 1,5, 14 oct 2002 (veg.), Santos-Gonçalves et al. 513 (ICN, K, MO, SP, UEC, UFMG).

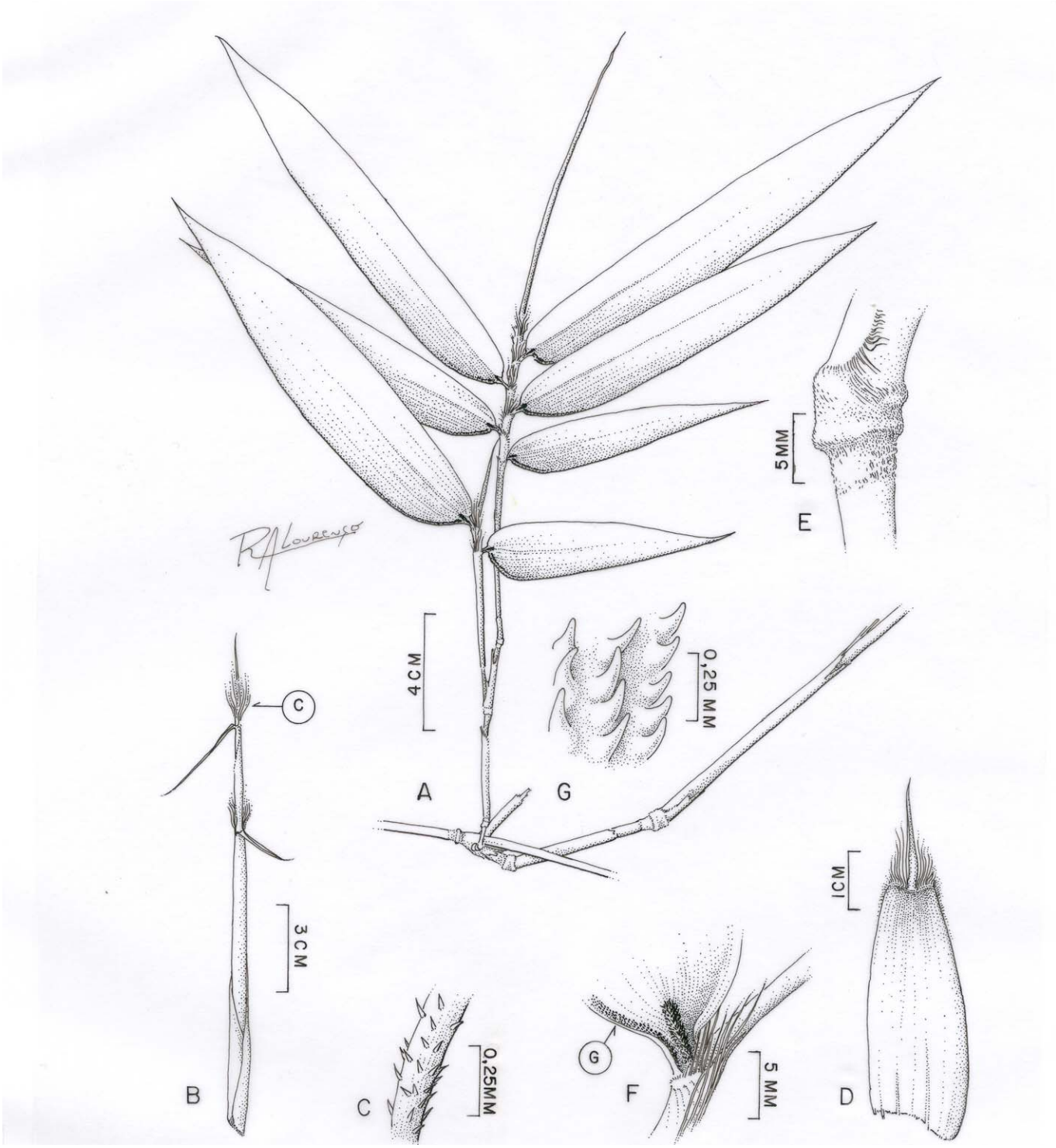

Figure 3. A-G. *Colanthelia longifolia* (based on *Santos-Gonçalves et al. 510*). A. Branch complement in the vegetative state. B. Apex of a young culm. C. Fimbriae in detail. D. Culm leaf. E. Nodal region. F. Blade of the foliage leaves evidencing the trichomes of the submarginal stripe and the hispid ones on the adaxial surface of the pseudopetiole. G. Small hard trichomes in detail.

4. *Colanthelia secundiflora* Santos-Gon. & L. G. Clark, sp. nov. INED. TYPE: BRAZIL. São Paulo: Município de Itanhaém, Parque Estadual da Serra do Mar (Núcleo Curucutu), 23° 59' 44"S, 46° 44' 13" W, Trilha do Mambu, 14 Apr. 2001 (fl., fr.), *Santos-Gonçalves & L. D. Meirelles 353* (holotype UEC; isotypes IBGE, ISC, K, MBM, MO, RB, SP, UFMG, US). Figure 4A-K.

Plants initially erect, then becoming decumbent to clambering. Rhizome pachymorph. Culms 1-6 m long, apex terminating in slight zig-zag. Internodes cylindrical, green, glabrous, smooth, 9--21.5 cm long, 1--2.45 mm in diam., wall thickened, lumen inconspicuous. Nodes of the lower portion sometimes rooting; intranodal area 2--3 mm long; promontory inconspicuous; upper portion of the internode glabrous; lower portion of the internode glabrous. Culm leaves 5.1--7.2 cm long; sheaths 3.2--4 cm x 5--8 mm, deciduous, glabrous, margins ciliolate, lateral appendages null; girdle inconspicuous, glabrous; blade erect, continuous with the sheath, falling as a unit, 2.6--3.1 cm x 10--15 mm, glabrous in both surfaces; internal ligule membranous, 0.5--0.6 mm long; external ligule null; fimbriae 3.5--4 mm long, erect, straw-yellow. Branch complement with 1--4 branches, the branches 10--25 cm long, sometimes rebranching at the lower nodes. Foliage leaves 3--21 per branch; sheaths 8--10 mm x-1.5--2 mm, adaxially puberulent when young, margins ciliolate; lateral appendages null; internal ligule membranous, inconspicuous (less than 0.1 mm long); external ligule present, inconspicuous; fimbriae 3--5 mm long, erect, light-brown; pseudopetioles 1--1.5 mm long, hispidulous on both surfaces; blades lanceolate, 2.5--6.6 cm x 4--8 mm, the base round, apex acuminate, glabrous on both surfaces except for a narrow line of hispid trichomes along one margin

of the stripe; margins with prickle hairs. Synflorescence racemose, 1.5--4 cm x 1.0--2.5 cm, with 3-7 branches; branches secund, 1.8--2.8 cm long; pedicels 1--3 mm long, puberulent. Spikelets secund, 1.7--2.7 cm long, 2-6-flowered; glumes 2, subequal, mucronate; lower glume 2--3.5 mm x 1.2--1.5 mm, 1-nerved, puberulent towards the apex; upper glume 3.2--4 mm x 1.2--2 mm, 1-nerved, puberulent towards the apex; anthoecium navicular; lemma 6--7 mm x 2.2--2.4 mm, 5-nerved, nerves inconspicuous, puberulent, awnless, surface brown with dark spots; palea 5.5--6.3 mm x 2--2.2 mm, 2-nerved, puberulent, awnless, surface brown with dark spots; lodicules 3, two similar and one narrower, thin, glabrous, transparent, with a few scattered hairs at the tip. Stamens 3; anther 3.1--4 mm long, yellowish. Ovary 0.3--0.4 mm x 0.1--0.15 mm, glabrous, light-yellow; style 1, glabrous, 0.5--0.7 mm; stigmas 2, plumous, light-yellow. Caryopsis narrowly elliptic, ca. 3--4 mm, light brown; hilum linear, as long as the caryopsis; embryo brown, ca.0.3 mm long.

Comments. *Colanthelia secundiflora* is one of the most delicate species in the genus. It is morphologically close to *C. gracillima* Dusén ex Santos-Gon. & Filg. because of the number of branches in the branch complement, the size of blades of foliage leaves, the fimbriate culm leaves without lateral appendages and the small number of florets per spikelet; however, it differs from it because of the secund branches of the synflorescence, the length of the pedicels of the spikelets and the anthoecium with dark spots.

Phenology. Collected in flower in April 2001 and February 2002.

Distribution and habitat. Southeast Brazil, São Paulo state, in “Parque Estadual da Serra do Mar”, in Atlantic rainforest, in two contrasting vegetation types, i.e., “Florestas Montanas” (mountain forest) and “Campos de Altitude” (high plateau with open field formation).

Paratypes. BRAZIL. Itanhaém, Parque Estadual da Serra do Mar, Núcleo Curucutu, 23° 59' 44"S, 46° 44' 13"W, Trilha do Mambu, Santos-Gonçalves et al. 352 (IBGE, UFMG); idem, trilha do Mirante, 13 Feb. 2002 (veg.), Santos-Gonçalves et al. 372 (ISC, SP, UEC); idem, trilha do Mirante, 13 Feb. 2002 (st), Santos-Gonçalves et al. 377 (RB, SJRP, UEC); idem, trilha do Mirante, 13 Feb. 2002 (fl.) Santos-Gonçalves et al. 378 (UFMG, UEC). Idem, trilha á Direita do Marco, 15 Feb 2002 (fl.), Santos-Gonçalves et al. 384 (IBGE, UEC); idem, Mata á Esquerda da Estrada de Entrada, 15 Feb. 2002 (fl.), Santos-Gonçalves et al. 385 (RB, UEC); idem, Mata á Esquerda da Estrada de Entrada, 15 Feb. 2002 (fl.), Santos-Gonçalves et al. 386 (ISC, UEC); idem, Mata á Esquerda da Estrada de Entrada, 15 Feb. 2002 (fl.), Santos-Gonçalves et al. 387 (ISC, US, UEC).

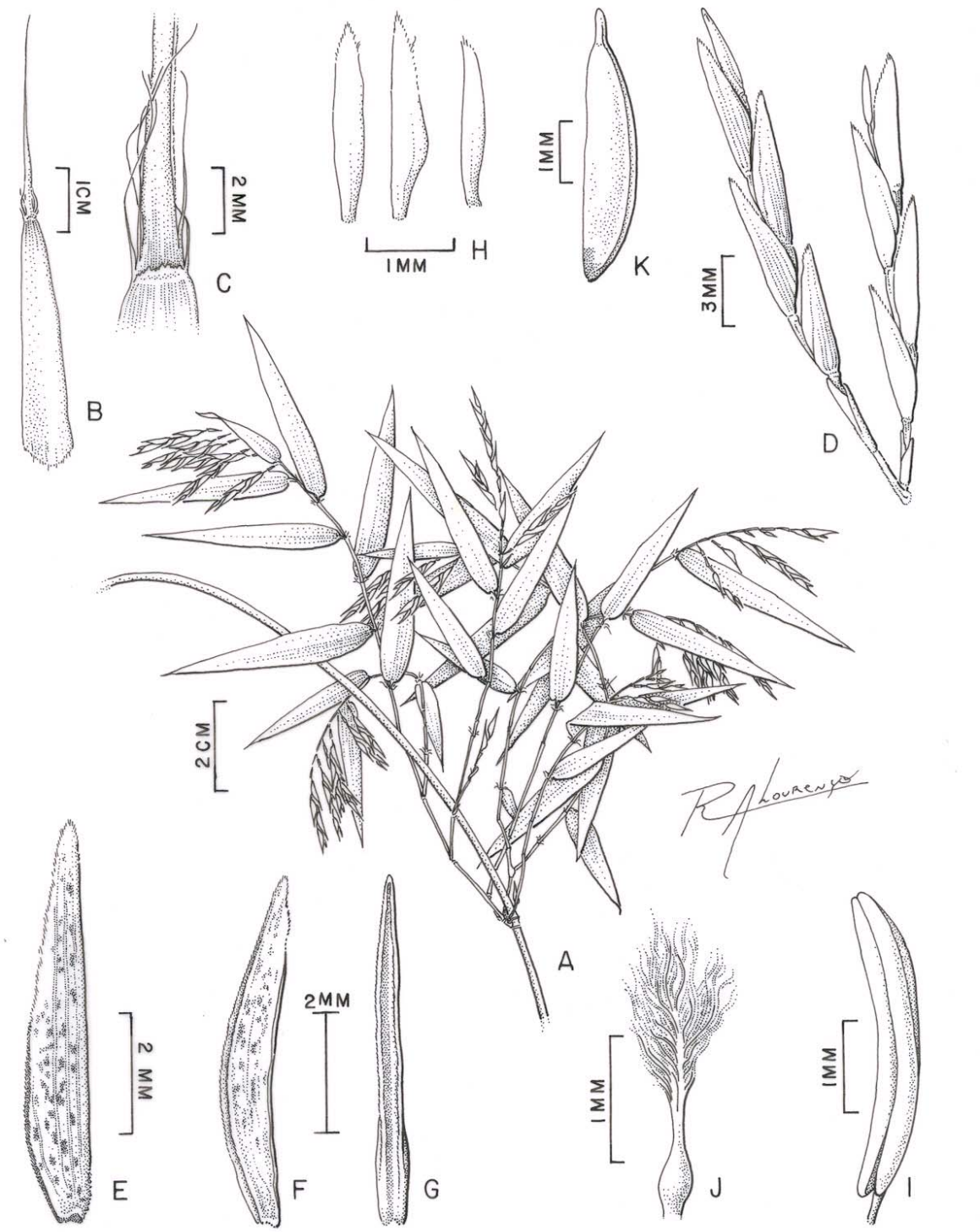

Figure 4. A-K. *Colanthelia secundiflora* (based on *Santos-Gonçalves et al. 353*). A. Branch complement in a floriferous state. B. Culm leaf, abaxial side. C. Culm leaf in detail showing the fimbriae and internal ligule. D. Spikelets. E. Lemma. F-G. Palea. H. Lodicules. I. Stamen. J. Gynoecium. K. Caryopsis.

5. *Colanthelia sparsiflora* Santos-Gon. & Filgueiras, sp. nov. INED. TYPE: BRAZIL. Espírito Santo: Município de Santa Tereza, Cabeceira do Rio Bonito, 40° 36' 1.08"W, 19° 50' 8.16"S, 9 Oct. 2002 (veg.), *Santos-Gonçalves & Matsumoto 496* (holotype, UEC; isotypes, IBGE, ISC, K, MBM, MO, RB, SP, UFMG, US). Figure 5A-N.

Plants creeping, clambering to climbing. Rhizomes pachymorph. Culms 5-6 m long, apex terminating in zig-zag. Internodes cylindrical, green, glabrous, striate, 14.3--21 cm long, 1.8--3.8 mm in diam., wall thickened, lumen inconspicuous. Nodes of the lower portion sometimes rooting; intranodal area 3--7 mm long; promontory inconspicuous; upper and lower portions of the internode glabrous. Culm leaves 5.3--7.8 cm long; sheaths 2.8--3.8 cm x 4.5--5 mm, sometimes persistent, glabrescent on the abaxial surface, margins ciliolate, lateral appendages conspicuous; girdle inconspicuous, glabrous; blade first erect then reflexed, readily deciduous, pseudopetioles 2.5--3.9 cm x 6--7 mm, glabrous on both surfaces; margins with prickle hairs; internal ligule membranous, 0.2--0.3 mm long; external ligule inconspicuous (less than 0.1 mm long); fimbriae 5--12 mm long, erect, spreading, purplish becoming brown. Branch complement with 1--5 branches, the branches 23--45 cm long, sometimes rebranching at the lower nodes; lower nodes sometimes geniculate. Foliage leaves 6--12 per branch; sheaths 2.2--3.5 cm x 3--5 mm, glabrous on the adaxial surface, margins glabrous; lateral appendages inconspicuous; internal ligule membranous, 1.5--2 mm long; external ligule present, inconspicuous; fimbriae 4--9 mm long, spreading, purplish becoming brown; pseudopetioles 2--3 mm long, hispidulous on the adaxial surface, glabrous on the abaxial, dark-purple on both surfaces; blades lanceolate, 7.5--17.8 cm x 1.7--3 cm, the

base asymmetrical, apex acuminate, glabrous on both surfaces, except for a narrow stripe of brown prickles along one submarginal side of the base; margins with angular prickle hairs. Synflorescences racemose, terminal and lateral, 7.1--12.9 cm long, with 4--7 branches; branches not secund, glabrous, 1.5--2.5 cm long; pedicels 0.8--1.5 mm long. Spikelets not secund, 1.4--2.3 cm long, 2--4 flowered; glumes 2, unequal, reduced to scales, 1-2 mm each, nervous inconspicuous, sometimes with a few hairs scattered at the tip, mucronate; anthoecium slightly navicular; lemma 0.5--1.6 cm x 2.5--3.2 mm, 5--7 nerved, nerves inconspicuous, puberulent toward the apex, awnless, surface brown with dark spots; palea 0.5--1.4 cm x 2.3--2.6 mm, 2-nerved, puberulent on the sulcus, glabrescent on the margins, awnless, surface brown; lodicules 3, two similar, one narrower, thick, tomentose, brown. Stamens 3; anther ca. 5.5 mm. Ovary ca. 4 mm x 0.2 mm, pubescent, light-yellow; style 1, puberulous, c 0.1 mm; stigmas 2, light yellow, slightly plumose. Caryopsis narrowly elliptic, 6--7 x 1--1.5 mm, light brown; hilum linear, as long as the caryopsis; embryo brown, ca.1 mm.

Comments. This species can be recognized by the racemose synflorescences with scattered spikelets along the rachis, the dark-purple pseudopetioles and the conspicuous lateral appendages of the sheaths of the culm leaves. The apex of the culm sometimes terminates in a conspicuous zig-zag. As previously commented, this character is shared by some *Colanthelia* and *Aulonemia* species.
Colanthelia sparsiflora is morphologically close to *C. distans (Trin.)* McClure because of the synflorescences with short branches, which are widely separated from each other, the prominent internode below the first anthoecium and the very reduced basal glumes.

Phenology. This species was collected in a late flowering state in October 2002.

Distribution and habitat. Southeast Brazil, Espírito Santo state, in Atlantic rainforest.

Paratype. BRAZIL. Espírito Santo: Município de Santa Tereza, Cabeceira do Rio Bonito, 40° 36' 1.08"W, 19° 50' 8.16"S W, Cabeceira do Rio Bonito, 9 Oct. 2002 (veg.), Santos-Gonçalves et al. 497 (IBGE, ICN, K, MO, R, UFMG, UEC).

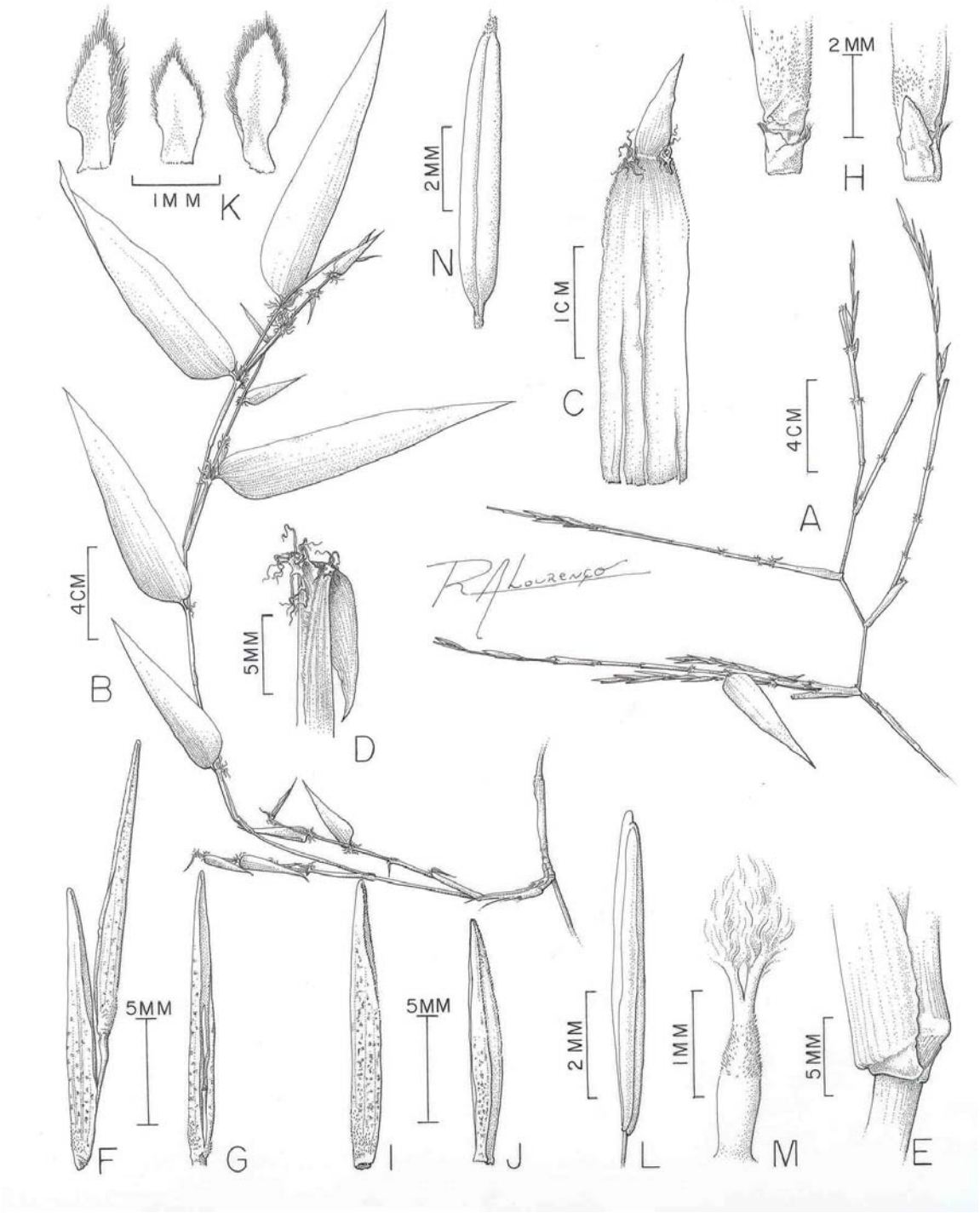

Figure 5. A-K. *Colanthelia sparsiflora* (based on *Santos-Gonçalves et al. 496*). A. Apex of a floriferous culm. B. Branch complement. C-D. Culm leaves. E. Nodal region evidencing the girdle. F. Spikelet. G. Anthoecium with a terminal reduced spikelet. H. Base of spikelet showing the glumes. I. Lemma. J. Palea. K. Lodicules. L. Stamen. M. Gynoecium. N. Caryopsis.

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CAPÍTULO II

SURVEY OF THE SURFACES OF FOLIAGE LEAVES OF *COLANTHELIA* (POACEAE:BAMBUSOIDEAE) UNDER SCANNING ELECTRON MICROSCOPY

ABSTRACT

A scanning electron microscopy survey was conducted to investigate the micromorphological characters of the middle portion of the blades of foliage leaves of *Colanthelia spp.* (both surfaces) to analise the micromorphological nature of the adaxial and abaxial submarginal green stripe and to verify whether the features surveyed are of any taxonomic value. The results revealed that under SEM, the blades of the foliage leaves of *Colanthelia* present four micromorphological regions. From a taxonomic point of view, the most consistent micromorphological features found were: 1) occurrence of adaxial stomata in certain regions of the blades, 2) occurrence of papillae associated with the epidermal long cells, 3) occurrence of equidimensional, round silica bodies 4) Different shapes of the papillae associated with the stomata, and 5) occurrence or not of papillae associated with the stomata inside the abaxial stripe region. Adaxial stomata in special regions of the blades of the foliage leaves and equidimensional, round silica bodies are here reported for both *Colanthelia* and the Arthrostylidiinae subtribe for the first time. The different shades of color of the abaxial green stripe appear to be the result of two connected characters: reduction or absence of epicuticular wax and reduction of the density of papillae associated with both epidermal long cells and stomata.

Key words: foliar micromorphology, papillae, equidimensional silica bodies, *Colanthelia*, Arthrostylidiinae, Bambusoideae, Bambuseae, grasses, bamboos.

INTRODUCTION

Foliar epidermal features play a key role in grass systematics (e.g., Prat, 1932, 1936; Brown, 1958; Metcalfe, 1960; Jacques-Félix, 1962; Palmer and Tucker, 1981, 1983; 1985; Ellis, 1986). Foliar anatomy and epidermal micromorphology are important in the characterization of broad groups within the grasses at higher levels, such as subfamilies and tribes (Brown, 1958; Jacques Félix, 1962; Ellis, 1986). More recently, they also have been used at lower taxonomic levels, to help understanding both inter and intra specific variations of some features (Dávila & Clark, 1990; Whang et al., 1998; Acedo & Llamas, 2001 and others) as well as to help to better circumscribe some taxonomic groups. However, according to Dávila & Clark (1990), it cannot be assumed that there is little or no variation in both anatomy and micromorphology leaf at the species level. Metcalfe (1960) supplied most information on foliar anatomy and micromorphology of grasses, including the Bambusoideae. However, as Dávila & Clark (1990) pointed out, the problem is the lack of adequate sampling in all groups concerned.

Soderstrom & Ellis (1986) characterized the Arthrostylidiinae by a suite of morphoanatomical features, amongst them the occurrence of a green stripe along one margin of the abaxial epidermis of the foliage leaves and also the occurrence of refractive papillae. According to Clark & Londoño (1991), this green stripe may be up to one-fourth to one-third as wide as the blade, and is believed to be probably due to a irregular deposition of wax; however, this has not been studied in detail. According to Clark (pers. commun.), this type of asymmetrical wax deposition which occurs in the

Arthrostylidiinae and some other bamboos species is unusual. Papillae are variously shaped protusions from the outer wall which occur mostly on the epidermal long-cells particularly in the intercostal zones; they occur sporadically throughout the Poaceae, and they are especially numerous in, and characteristic of, certain groups such as the bamboos (Metcalfe, 1960).

Colanthelia McClure is a genus of South American unarmed woody bamboos. It comprises twelve species, five of them recently discovered (see chapter I of this study), which occur along the Atlantic rainforest, mainly in South and Southeast Brazil, from sea level to ca. 2,200m altitude. A single species (*Colanthelia rhizantha* (Hack.) McClure is known to occur also in Misiones, Argentina (Agrasar & Clark, 2000). In the most recent revision of the whole genus 12 species are recognized (see chapter IV of this study).

The present Scanning Electron Microscopy (SEM) survey was undertaken in view of the importance of epidermal micromorphology in grass systematics and the lack of such information for *Colanthelia*. The goals of this study were: 1) to investigate the micromorphological characters of the middle portion of the blades of the foliage leaves of *Colanthelia spp.* on both surfaces, 2) to analise the micromorphological nature of the adaxial and abaxial submarginal green stripe and 3) to verify whether the features surveyed are of any taxonomic value.

MATERIALS AND METHODS

Undamaged, mature and completely developed foliage leaves from twelve *Colanthelia spp*. were selected for analysis. Depending upon of the availability of

material, at least one and as many as three different specimens were examined under the SEM for each species. Sections from the middle portion were taken from dried herbarium material (Table 1).

Four samples from the blade (first exposing the adaxial surface within the stripe, the second exposing the adaxial surface outside the stripe, the third one exposing the abaxial surface inside the stripe and the fourth one exposing the abaxial surface outside the stripe) of each species were mounted on stubs with double-coated scotch tape. The specimens were coated with gold-palladium in a Balvers SCD050 sputter coater and observed at 10 kv in a JEOL JSM4800LV scanning electron microscope. Images obtained were saved on a CD or high capacity diskette and later printed for analysis. Herbarium acronyms follow Holmgren et al. (1990). Photomicrographs were processed using the software Photoshop 7.0.

Table 1. Herbarium vouchers from where foliage leaves were taken for the SEM survey.

Species	Locality	Voucher	Herbarium
Colanthelia burchellii (Munro) McClure	Brazil: São Paulo, Salesópolis, Estação Biológica da Boracéia	*Clark & Morel 831*	SJRP
C. cingulata (McClure & L. B. Sm.) McClure	Brazil: Santa Catarina, Sombrio, Garapuvu	*Santos-Gonçalves et. al. 538*	UEC
	Brazil: Santa Catarina, Florianópolis, Ilha de Santa Catarina, Pântano do Sul	*Santos-Gonçalves et al. 554*	UEC
	Brazil: São Paulo, Campinas, Fazenda São Vicente	*L. C. Bernacci 24.307*	UEC
C. distans (Trinius) McClure	Brasil: Minas Gerais, In umbrosis Montis Itacolumi	*Riedel s.n.*	MO
C. gracillima Dusén ex Santos-Gonçalves & Filg.	Brazil: Paraná, Cerro Azul, cabeceira do Ribeirão do Tigre	*G. Hatschbach 48104*	MO
C. intermedia (McClure & L. B. Sm.) McClure	Brazil: Santa Catarina, Florianópolis, Ilha de Santa Catarina, Pântano do Sul	*Santos-Gonçalves et al. 553*	UEC
	Brazil: Santa Catarina, Governador Celso Ramos, beira de regato	*Santos-Gonçalves et al. 557*	UEC
	Brazil: Santa Catarina, Morro do Ribeirão	*Klein 8329*	R
C. itatiaiae Santos-Gonçalves & L. G. Clark	Brazil: Rio de Janeiro, Itatiaia, Parque Nacional de Itatiaia	*L. Clark et al. 672*	SJRP
	Brazil: Rio de Janeiro, Itatiaia, Parque Nacional de Itatiaia	*Santos-Gonçalves et al. 565*	UEC
	Brazil: Rio de Janeiro, Macaé, Reserva Ecológica de Macaé de Cima	*Santos-Gonçalves et al. 471*	UEC

Table 1. cont.

Species	Locality	Voucher	Herbarium
C. lanciflora (McClure & L. B. Sm.) McClure	Brazil: Paraná, Alto Purunã	*Santos-Gonçalves et al. 563*	UEC
	Brazil: Santa Catarina, Bom Retiro, Between fazenda Santo Antônio and the falls of the Rio Canoas, Campo dos Padres	*L. Smith 7837*	RB
	Brazil: Rio de Janeiro, Teresópolis, Parque Nacional da Serra dos Órgãos	*Santos-Gonçalves et al. 494*	UEC
C. longifolia Santos-Gonçalves & Filg.	Brazil: Espírito Santo, Linhares, Reserva Natural da Vale do Rio Doce	*Santos-Gonçalves et al. 510, 513*	UEC
C. macrostachya (Nees) McClure	Brazil: Rio de Janeiro, s.l.	*Kuhlmann 1920*	RB
	Brazil: Rio de Janeiro (antiga Guanabara), Morro do Bico do Papagaio, Horto Florestal	*Sucre 5293*	RB
	Brazil: Rio de Janeiro, Cabo Frio, Alcalis	*Sucre 10022*	RB
C. rhizantha (Hack.) McClure: Argentina	Argentina: Misiones, Depto. Gral. Manuel Belgrano, Salto Andresito	*Morrone et al. 856*	NY
C. secundiflora Santos-Gonçalves & Clark	Brazil: São Paulo, Itanhaém, Parque Estadual da Serra do Mar, Núcleo Curucutu	*Santos-Gonçalves et al. 353, 372*	UEC
C. sparsiflora Santos-Gonçalves & Filg.	Brazil: Espírito Santo, Santa Tereza, cabeceira do Rio Bonito	*Santos-Gonçalves et al. 496, 497*	UEC

RESULTS AND DISCUSSION

This micromorphology survey of *Colanthelia* revealed that under SEM the blades of the foliage leaves of *Colanthelia* can be characterized by having four different micromorphological regions: 1) the adaxial surface inside the stripe 2) the adaxial surface outside the stripe, i.e., the remainder of the blade area 3) the abaxial surface inside the stripe , and 4) the abaxial surface outside the stripe, i. e., the remainder of the blade area. There is also an interface between the two adjacent regions on each surface, which sometimes presents intermediate characteristics. It is noteworthy that the stripe is more conspicuous on the abaxial surface and less so on the adaxial surface.

It was possible to recognize the occurrence of various micromorphological characters on the foliage leaves of *Colanthelia*. However, as the present paper does not have a descriptional purpose, only the occurrence of certain characters and their states which were considered consistent from a morphological point of view (such as: stomata in special regions of the blade on the adaxial surface, papillae associated with the stomata on the abaxial surface inside the stripe, shape of the papillae associated with the stomata and occurrence of equidimensional, round silica bodies associated with the papillae of the epidermal long cells) are here presented and discussed. Table 2 summarize these data.

The occurrence of epicuticular wax, prickle hairs, unicellular macro-hairs and bicellular micro-hairs on the blade surfaces is universal in all samples examined. All *Colanthelia* species present amphistomatic foliage leaves; however, it is noteworthy that the adaxial stomata (Figs. 1-6) do not present such a wide distribution throughout that

surface, where they are confined to just a narrow region on the adaxial surface inside the stripe as they do on the abaxial surface. From a taxonomic point of view, the occurrence of adaxial stomata in this group is very interesting. According to Clark (pers. comm.), considering all the Bambuseae, the occurrence of stomata on the adaxial surface of the foliage leaves is rare, except for the Guaduinae subtribe. If we consider that the most recent phylogenetic studies using both macromolecular and morphoanatomical data (Zhang & Clark, 2000 amongst others) have showed the Arthrostylidiinae Soderstr. & Ellis and the Guaduinae Soderstr. & Ellis (sensu Soderstrom & Ellis, 1986) subtribes as a single clade, the occurrence of stomata on the adaxial foliage leaves surface of all *Colanthelia* species is a consistent morphological character which once more connects these two subtribes. On the other hand, this finding shows that perhaps this character may have a more complex distribution in this clade than previously thought. Gomes (2002) has observed the "occasional occurrence of stomata on the marginal region of the adaxial surface" in the foliage leaves of eight *Merostachys* Spreng. species. However, in her work it is not clear whether the stomata display a restricted distribution or if they occur on the adaxial surface inside the stripe, such as in *Colanthelia*. The occurence of adaxial stomata on the blades of the foliage leaves is here recognized for the first time as a morphological novelty for both *Colanthelia* and *Merostachys*.

In general, it was possible to verify the occurrence of papillae associated with the epidermal long cells (costal, intercostal and interstomatal) and the stomata. However, these structures are shaped differently. The papillae not associated with the stomata are simple conical (Ellis, 1979). The papillae associated with the stomata are sometimes

longer; the following three shapes are recognized here: a) round: *C. burchelli*, *C. distans* and *C. secundiflora* (Figs. 7-8); b) apiculate: *C. cingulata*, *C. gracillima*, *C. intermedia*, *C. lanciflora*, *C. longifolia*, *C. macrostachya* and *C. rhizantha* (Figs. 9-11) and c) digitiform, which only includes *C. itatiaiae* (Fig. 12). According to Clark & Londoño (1991) (except in a few cases), the genera and species so far examined in the Arthrostylidiinae exhibit a distinctive pattern of four, often branching, angular papillae that overarch the stomata. This pattern was found to be variable in *Colanthelia*. Here, the papillae associated with the stomata were found to be commonly overarching, with the occasional exception of *C. itatiaiae*. In the latter, the papillae are located sometimes in an almost right angle with the stomata. This is problably related to the local conditions were the plants grow, as explained below. According to Ellis (1979), inflated papillae often serve to protect the stomata by overarching them. In this case, the position of the papillae associated with the stomata may be correlated with prevailing ecological conditions. One way to address this question could be by freezing samples of the blades of the foliage leaves of the same species growing under different ecological conditions and examining them under SEM.

The number of papillae per stomata is also variable, ranging from four to 11. *Colanthelia sparsiflora* presents no papillae associated with the stomata so this character is not applicable. It is noteworthy that *C. itatiaiae* is the only species with digitiform papillae. Thus, *C. itatiaiae* and *C. sparsiflora* can be micromorphologically recognized by the occurrence of this feature. These two species show an isolated positions amongst all species in the genus in this regard.

On the abaxial surface inside the stripe of *Colanthelia* there are some variation related to the occurrence or not of papillae associated with the stomata. Using this character, the *Colanthelia* species can be divided in two informal groups. The first one includes four species: *C. itatiaiae*, *C. lanciflora*, *C. longifolia* and *C. secundiflora*, which present papillae associated with the stomata on the abaxial surface inside the stripe (Figs. 13-16). The second group includes the remaining eight species in the genus, i.e.: *C. cingulata*, *C. burchellii*, *C. distans*, *C. gracillima, C. intermedia*, *C. macrostachya, C. rhizantha and C. sparsiflora* (Figs. 17-22). *Colanthelia rhizantha* does not present any papillae associated with the stomata on the abaxial surface inside the stripe. It is noteworthy that *C. sparsiflora* shows an isolated position in the genus because of characters six and eight (Table 2 and Appendix 1). This species presents no papillae associated with the stomata in any region of the blade. If we consider that, as showned in this paper, the occurrence of papillae associated with the stomata on the abaxial surface outside the stripe is a common feature to all the remainder *Colanthelia* species, it is reasonable to suggest that probably the lack of papillae associated with the stomata can be considered as an autapomorphy (probably a character under reversal) for *C. sparsiflora*, which can be of some taxonomic significance.

Silica bodies are discrete deposits of hydrated silica present in the epidermal cells, which are deposited in the lumens of specific and specialized cells or idioblasts (Ellis,1979). The shape of silica bodies is very important for taxonomic purposes (Metcalfe, 1960; Ellis, 1979). According to Ellis (1986), the Bambusoideae present vertically elongated silica bodies which are dumbbell, saddle, cross or olyroid shaped. However, in this work it was possible to verify that in all *Colanthelia spp.* the silica

bodies were found to be equidimensional, i.e., vertical and horizontal dimensions approximately equal (Ellis, 1979) and round, i. e., circular in outline (Ellis, 1979) (Figs. 23-26) instead of vertically elongated. These silica bodies are found associated with the costal, intercostal and interstomatal epidermal long cells. So far as is known, no *Colanthelia spp.* has any papillae associated with either the costal short cells or with the bulliform cells.

Whang et al. (1998) discussed the variation of silica bodies in leaf epidermal long cells within and amongst some species of *Oryza* L. According to these authors, one of the main obstacles in phytolith systematics is the variation in silica body morphology from tissue to tissue and within specific tissues. In all studied species of *Colanthelia* the shape of the silica bodies was constant. So far as known, there is no record of variation in the shape of the silica bodies in any bamboo species. However, this aspect should be better investigated in the Bambusoideae subfamily. The occurrence of equidimensional, round silica bodies closely associated with the papillae in all types of epidermal long cells in *Colanthelia* is here recorded for the first time and it is a novelty for the entire subfamily as well.

Finally, it is important to emphasize the main trends observed when the abaxial surface inside the stripe and the abaxial surface outside the stripe regions are analized comparatively. As mentioned before, macromorphologically, the abaxial surface inside the stripe is a discolored region of the blade. Under SEM, it was possible to verify that, generally, the occurrence of epicuticular wax in this region is visually reduced (or even be completely lacking) when compared with the abaxial surface outside the stripe. Also, there is a visual decrease in the occurrence of papillae associated with both stomata

and the epidermal long cells on the abaxial surface inside the stripe when compared with the abaxial surface outside the stripe. The density of stomata on the abaxial surface inside the stripe is another point to be rigorously studied, because sometimes the stomatal density is visually reduced in this region. There may be some ecological correlation amongst these features, but this possibility needs more detailed investigation. Also, there may be some correlation between the irregular occurrence of epicuticular wax in *Colanthelia* (and also in some species of the Arthrostylidiinae) with leaf vernation, i.e., how the leaf is rolled up in the sheath before it emerges. In *Colanthelia*, the submarginal green stripe corresponds to the more protected part of the leaf. This region of the stripe is protected by the remainder of the leaf before the blade expands itself or when it is under severe ecological (dry) conditions and the leaf rolls up. In this case, the outermost part of the leaf enveloping the emerging leaf blade it would be expected to get more protection (more epicuticular wax and higher density of papillae associated with the stomata), as it does. However, there is no explanation for the reduction of the density of papillae associated with the epidermal long cells in the stripe region. The occurrence of adaxial stomata apparently does not make sense, because the adaxial surface is the most exposed surface of the leaf. However, in a more accurate analysis it can be observed that the stomata in this region get some protection from the prickles and epicuticular wax. Also, when the ecological conditions are severe, the blade is rolled up and the submarginal stripe (adaxial and abaxial surfaces inside the stripe) is enveloped and remain protected by the rest of the blade.

CONCLUSIONS

The occurrence of adaxial stomata in special regions of the blades of the foliage leaves as well as the occurrence of equidimensional, round silica bodies associated with the papillae from the costal, intercostal and interstomatal epidermal long cells are here recorded for the first time in *Colanthelia*.

Based on the occurrence of papillae associated with the stomata on the abaxial surface inside the stripe region two informal groups can be established in *Colanthelia*: 1. *C. itatiaiae*, *C. lanciflora*, *C. longifolia* and *C. secundiflora* (which present papillae associated with the stomata in this region of the blade) and 2. *C. cingulata*, *C. burchellii*, *C. distans*, *C. intermedia*, *C. gracillima*, *C. macrostachya C. rhizantha* and *C. sparsiflora* with no papillae. This feature can be used along with other characteristics to help in the identification of the species.

Papillae associated with the stomata in *Colanthelia* are here recognized as presenting the following shapes: round (*C. burchelli*, *C. distans*, *C. lanciflora* and *C. secundiflora*), apiculate (*C. cingulata*, *C. gracillima*, *C. intermedia*, *C. longifolia*, *C. macrostachya* and *C. rhizantha*) and digitiform (*C. itatiaiae*).

Colanthelia sparsiflora can be micromorphologically recognized by the lack of papillae associated with the stomata on both adaxial and abaxial surfaces. This character is probably a reversal for this species, but phylogenetic studies have to be made in order to better understand the evolutionary process involved.

Colanthelia itatiaiae can be micromorphologically recognized by the occurrence of digitiform papillae associated to the stomata.

The number of papillae per stomate in *Colanthelia spp.* varies from four to eleven.

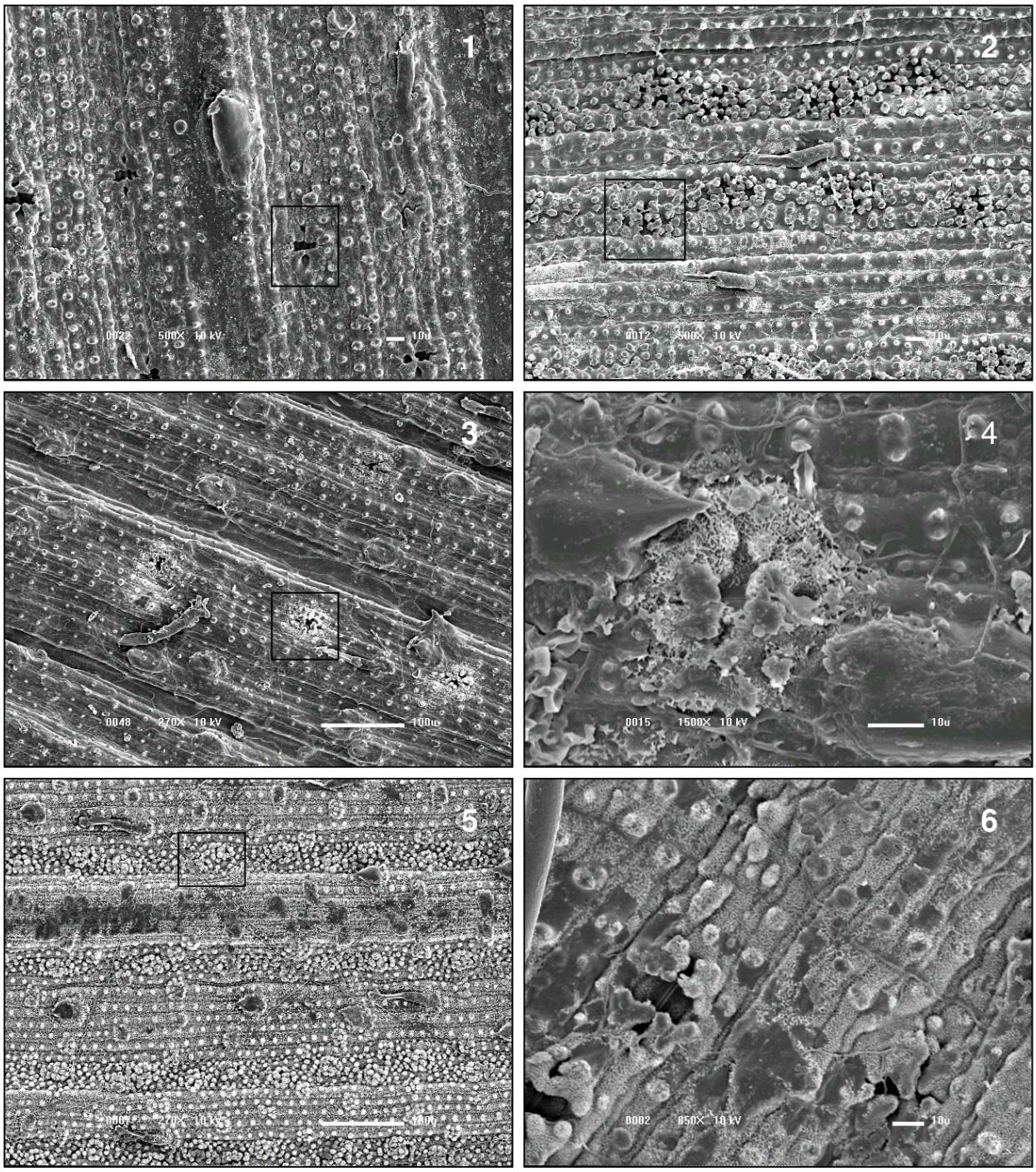
The different shade of color of the abaxial green stripe appear to be the result of two interconnected features: reduction or absence of epicuticular wax and reduction of the density of the papillae associated with both stomata and epidermal long cells (costal, intercostal and interstomatal). This discolored region (stripe) needs to be better investigated in other genera of Arthrostyliidinae and Guaduinae in order to provide more information for these two subtribes.

Table 2. Selected micromorphological characters of Colanthelia spp. and their states (the characters are indicated by the numbers 1-9, and their states by the numbers 0-3. (For the character states see Appendix 1)

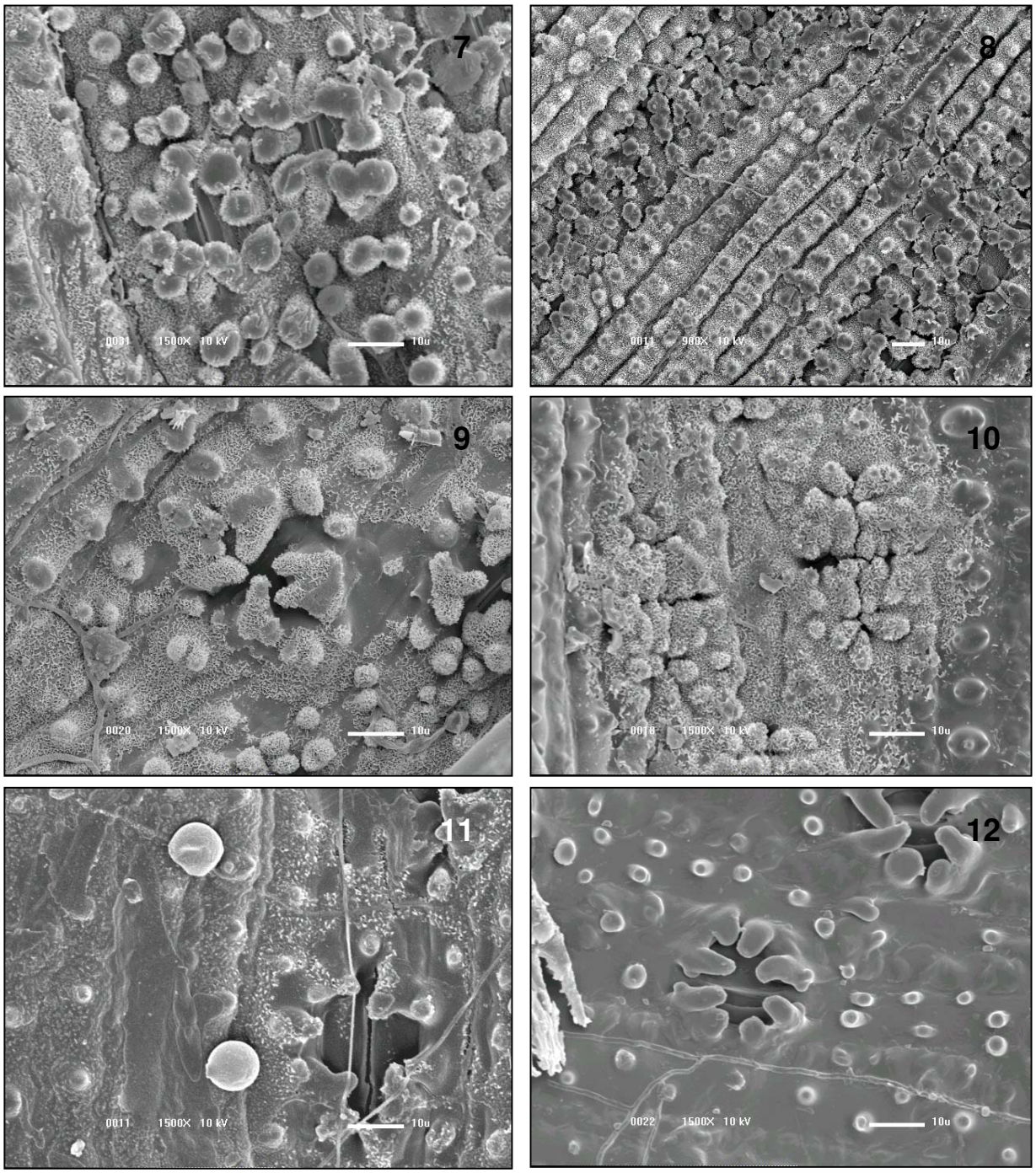
	1	2	3	4	5	6	7	8	9
C. cingulata	0	1	1	1	1	1	0	1	3
C. burchellii	0	1	1	1	1	1	0	1	1
C. distans	0	1	1	1	1	1	0	1	1
C. gracillima	0	1	1	1	1	1	0	1	3
C. intermedia	0	1	1	1	1	1	0	1	3
C. itatiaiae	0	1	1	1	1	1	1	1	2
C. lanciflora	0	1	1	1	1	1	1	1	3
C. longifolia	0	1	1	1	1	1	1	1	3
C. macrostachya	0	1	1	1	1	1	0	1	3
C.rhizantha	0	1	1	1	1	1	0	1	3
C. secundiflora	0	1	1	1	1	1	1	1	1
C. sparsiflora	0	1	1	1	1	1	0	0	-

Appendix 1. Selected micromorphological characters of *Colanthelia* spp. and their states (the characters are indicated by the numbers 1-9, and their states by the numbers 0-3.

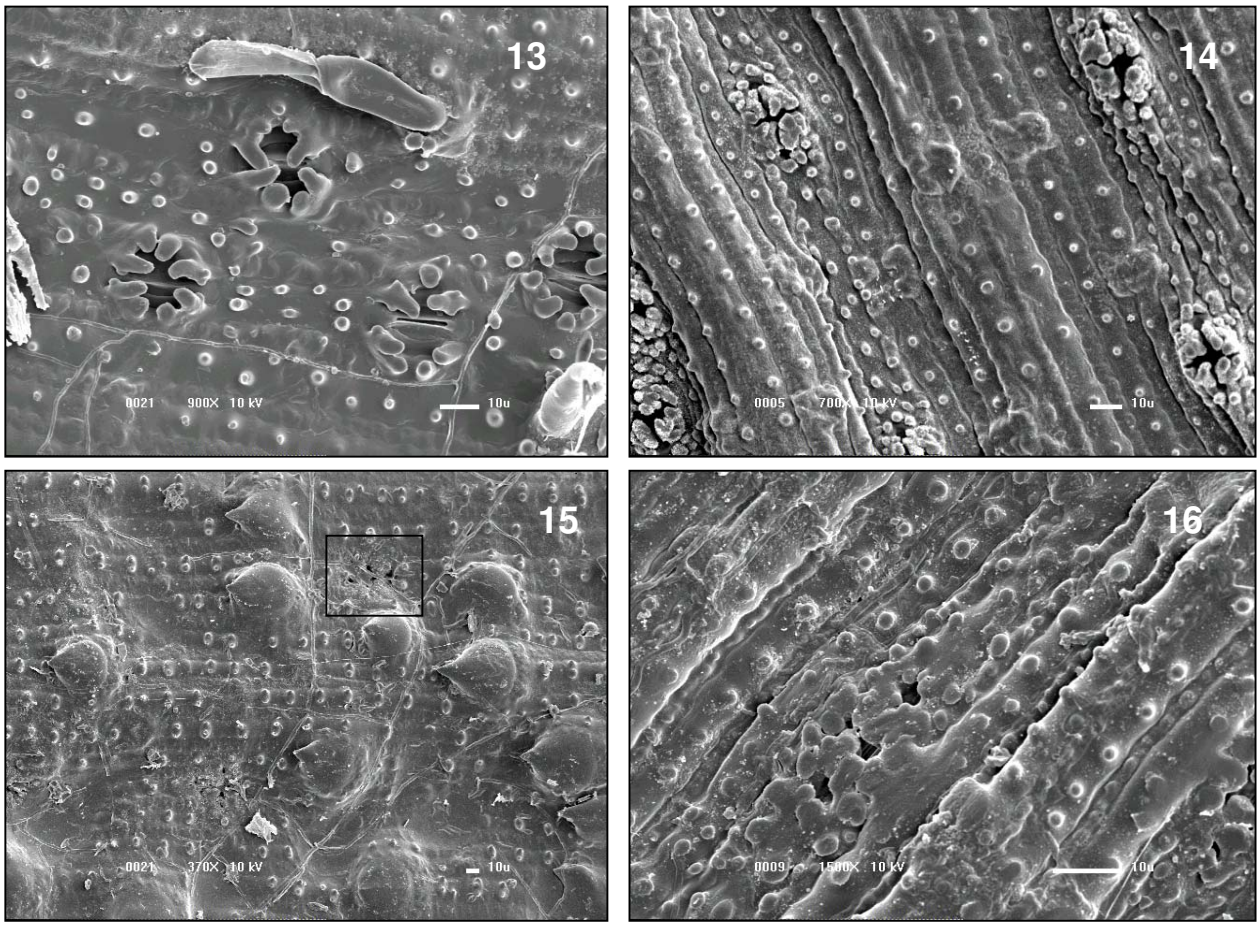
1. Stomata on the adaxial surface outside the stripe region (0: absent; 1: present)
2. Stomata on the adaxial surface inside the stripe (0: absent; 1: present)
3. Stomata on the abaxial surface outside the stripe (0: absent; 1: present)
4. Stomata on the abaxial surface inside the stripe (0: absent; 1: present)
5. Papillae associated with the stomata on the adaxial surface inside the stripe (0: absent; 1: present)
6. Occurrence of equidimensional round silica bodies associated with the papillae (one silica body per papillae) inside the epidermal long cells (costal, intercostal and interstomatal) (0: absent;1: present).
7. Papillae associated with the stomata on the abaxial surface inside the stripe (0: absent; 1: present)
8. Papillae associated with the stomata on the abaxial surface outside the stripe that is, the remainder area of the blade (0: null; 1: present)
9. Shape of the papillae associated with the stomata: apex round (1), apex digitiform (2), apex apiculate (3).



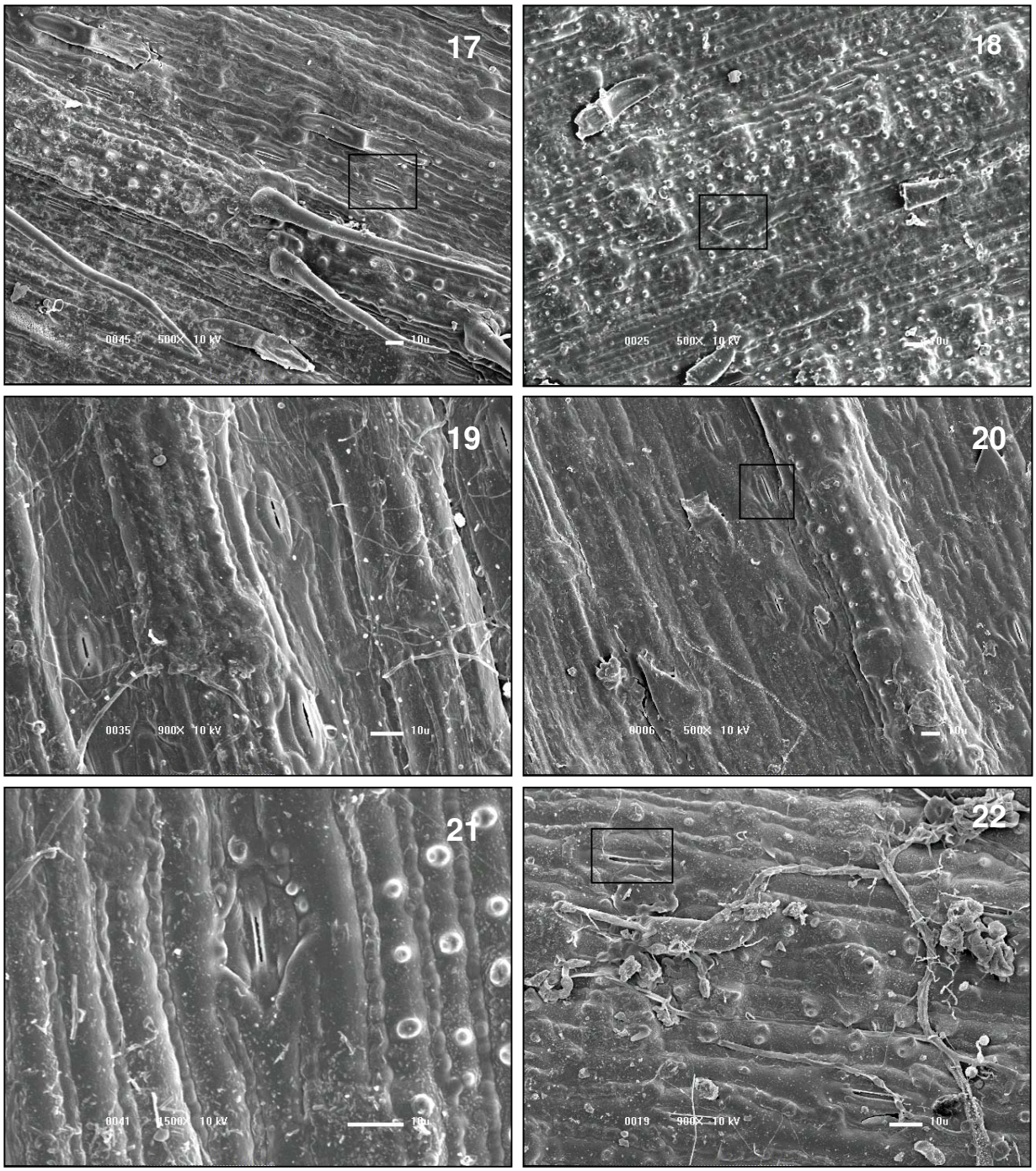
Figures 1-6. Scanning electron micrographs of adaxial foliage leaf epidermises inside the stripe in six *Colanthelia* species showing the occurrence of stomata. 1. *C. rhizantha* (*Morrone et al.856*). 2. *C. burchellii* (*Clark & Morel 831*). 3 *C. cingulata* (*Santos-Gonçalves et al. 554*). 4. *C. gracillima* (*Hatschbach 48104*). 5. *C. lanciflora* (*Santos-Gonçalves et al.563*). 6. *C. intermedia* (*Santos-Gonçalves et al. 553*). Squares indicate one stomate.



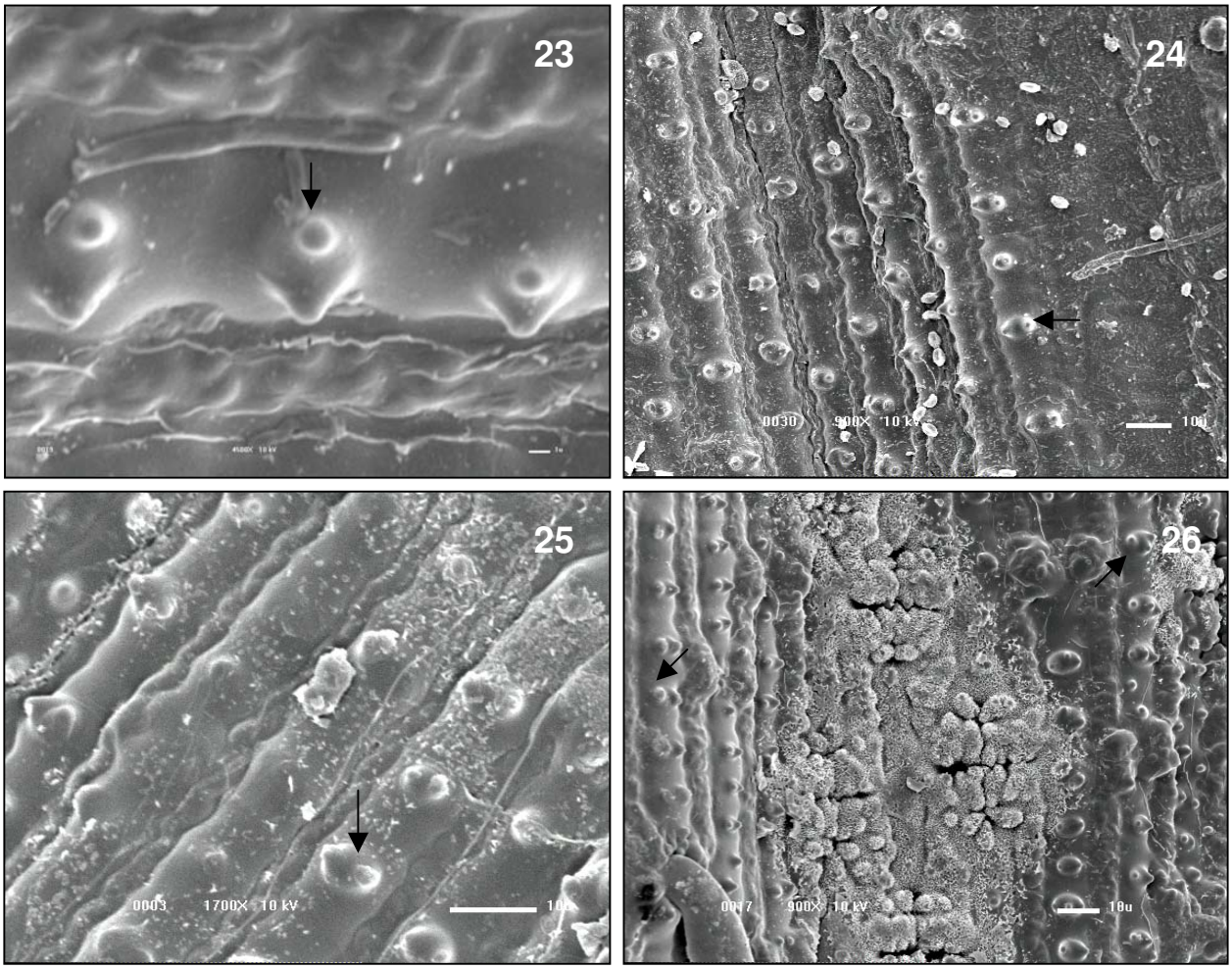
Figures 7-12. Scanning electron micrographs of abaxial foliage leaf epidermises outside the stripe in six *Colanthelia* species showing the shape of the papillae associated with the stomata. Round: 7. *C. distans* (*Riedel, s.n.*) and 8. *C. secundiflora* (*Santos-Gonçalves et al. 372*). Apiculate: 9. *C. cingulata* (*Bernacci 24307*), 10. *C. longifolia* (*Santos-Gonçalves et al. 496*) and 11. *C. intermedia* (*Santos-Gonçalves et al. 553*). Digitiform: 12. *C. itatiaiae* (*Santos-Gonçalves et al. 478*).



Figures 13-16. Scanning electron micrographs of abaxial foliage leaf epidermises inside the stripe in four *Colanthelia* species showing the presence of papillae associated with stomata. 13. *C. itatiaiae* (*Santos-Gonçalves et al. 478*). 14. *C. lanciflora* (*Santos-Gonçalves et al. 563*). 15. *C. longifolia* (*Santos-Gonçalves et al. 513*). 16. *C. secundiflora* (*Santos-Gonçalves et al. 353*). Square indicates one stomate.



Figures 17-22. Scanning electron micrographs of abaxial foliage leaf epidermises inside the stripe in six *Colanthelia* species showing the lack of papillae associated with stomata. 17. *C. cingulata* (*Santos-Gonçalves et al. 554*). 18.*C. rhizantha* (*Morrone et al. 856*). 19. *C. distans* (*Riedel s. n.*). 20. *C. sparsiflora* (*Santos-Gonçalves et al. 496*). 21. *C. intermedia* (*Santos-Gonçalves et al. 554*). 22. *C. macrostachya* (*R. 44497*). Squares indicate one stomate.



Figures 23-26. Scanning electron micrographs of adaxial (23-25) and abaxial (26) foliage leaf epidermises. Silica bodies are indicated by arrows. 23. *C. sparsiflora* (*Santos-Gonçalves et al. 496*). 24. *C. macrostachya* (*Kuhlmann 1920*). 25. *C.intermedia* (*Santos-Gonçalves et al. 553*). 26.*C. longifolia* (*Santos-Gonçalves et al. 510*).

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CAPÍTULO III

SURVEY OF THE BLADES OF FOLIAGE LEAVES OF *COLANTHELIA* (POACEAE:BAMBUSOIDEAE:BAMBUSEAE) IN TRANSVERSE SECTION

ABSTRACT

Anatomical studies of the blades of foliage leaves in transverse section of 12 *Colanthelia spp.* were undertaken to evaluate whether the features surveyed are of any taxonomic value. The results revealed that, generally, the anatomical characters found in the blades of the 12 *Colanthelia* species studied agree with those features traditionally regarded as typical of the Bambusoideae and of the Arthrostylidiinae. In *Colanthelia*, the adaxial and abaxial epidermises are composed of common epidermal cells and the bulliform cells, the latter are present only adaxially. The mesophyll is composed of 2-3 layers of arm cells and by the fusoid cells, and the vascular bundles present typically two sheaths, the inner or mestome and the outer or parenchymatous. Intercostal sclerenchyma fibers are always present, associated with the bulliform cells and with the abaxial epidermis or associated only with the latter. All species of the genus present structural differences in the two leaf margins. Some of the characters surveyed were found to be consistently uniform among the *Colanthelia* species and are regarded as typical of the genus. The presence or absence of fusoid cells, the place of occurrence of the intercostal sclerenchyma fibers, the occurrence of adaxial furrows, the shape of first order vascular bundles and the number of layers of intercostal sclerenchyma fibers associated with the abaxial epidermis are useful to separate species or groups of species.

Key words: Leaf anatomy, arm cells, fusoid cells, intercostal sclerenchyma fibers, Poaceae, Bambusoideae, Bambuseae, *Colanthelia*, bamboos, grasses.

INTRODUCTION

The significance of foliar anatomy for Poaceae taxonomy has been well known since the seminal works of Prat (1932, 1935, 1936), Brown (1958), and Jacques-Félix (1962). In recent decades, anatomical features are routinely used as an integral part of taxonomic descriptions (e.g., Campbell, 1985; Watson et al., 1985; Clayton and Renvoize, 1986; Watson & Dallwitz, 1992). The system of classification for the Poaceae subfamilies proposed by Soderstrom & Ellis (1986), for example, relies greatly on the characters of the leaf anatomy, along with those of macromorphology.

Metcalfe (1960) provided most of the basic information on foliar anatomy of grasses. However, the lack of adequate sampling remains as a problem (Dávila & Clark, 1990). The works of Ellis (1976, 1979) made it possible to standardise the analysis of the blades of the foliage leaves in tranverse section as well as the epidermal in surface view. Ellis (1986) also produced one of the most important revisional works on foliar anatomy of the Poaceae.

The anatomical features of the Bambusoideae leaves were well established by Calderón & Soderstrom (1973), Renvoize (1981) and Soderstrom et al. (1987).

Anatomically, the Arthrostylidiinae, the tribe where *Colanthelia* McClure & E. W. Smith is classified, present a unique suite of characteristics, such as intercostal sclerenchyma fibers, refractive papillae, a general reduction of the midrib with lack of a complex vasculature, an accentuated difference in the anatomical structure of the two leaf margins in most species, and the universal presence of fusoid cells (Soderstrom & Ellis, 1986).

Colanthelia is a genus of South American woody bamboos that includes 12 species, occuring mainly in the Atlantic Forest s.l. in South and Southeast Brazil, from sea level to 2200m altitude (chapter IV of this study). The species of this genus are characterized by having short pachymorph rhizomes, woody fistulose culms, internodes with regular length, occurrence of a promontory, culm leaves with a girdle, branch complement composed of 1-13 branches, one of them dominant, and synflorescences paniculate, racemose or solitary, and spikelets with a terminal reduced anthoecium (chapter IV of this study).

The present work was undertaken to examine the anatomy of the blades of the foliage leaves in transverse section of all the 12 *Colanthelia* spp. to verify whether the features surveyed are of any taxonomic value.

MATERIAL AND METHODS

For this study, samples of foliage leaves of seven *Colanthelia* spp. (*C. cingulata, C. itatiaiae, C. intermedia, C. lanciflora, C. longifolia, C. secundiflora* and *C. sparsiflora*) were taken from live plants in their natural habitats in south and southeast Brazil at the same time that standard botanical material was collected. When fresh material was not available, leaves taken from herbarium specimens were used (*C. burchellii, C. distans, C. gracillima, C. macrostachya* and *C. rhizantha*). The herbarium vouchers used are presented in Table 1. Herbarium acronyms follow Holmgren et al. (1999).

Undamaged, completely expanded blades of the foliage leaves were collected and fixed in FAA (Johansen, 1940) for at least 24 h, placed under a low vacuum to aid the

penetration of the fixative, transferred to 50% ethanol for at least 12 h and then stored in 70% ethanol.

For the tranverse section studies, 5 mm x 5 mm samples from the middle region of the blades of the foliage leaves, including the midrib and the margin were used. Samples from fresh material were dehydrated using the tertiary butyil alcohol series, embedded in paraplast according to the method described by Johansen (1940) and then serial sectioned. Samples from herbarium specimens were dehydrated, embedded in historesin (historesin Leica) according to the method described by Sidman et al. (1961) and then sectioned.

Tranverse sections were cut 15-25 µm thick with a rotary microtome and stained with Safranin O and Astra blue (Gerlach, 1969) or Toluidine blue O 0.05 % pH 4.7 (Feder & O'Brien, 1968). Light microscope observations were carried out in an Olympus BX51 microscope. Photomicrographs were captured with Kodak Pro Image asa 100 and processed using the software Adobe Photoshop 7.0. The descriptive terminology used was adapted from Ellis (1976, 1979).

Table 1. Specimens of *Colanthelia* sampled in this study

Species	Locality	Voucher	Herbarium
Colanthelia burchellii (Munro) McClure	Brazil: São Paulo, Salesópolis, Estação Biológica da Boracéia	*Clark & Morel 831*	SJRP
C. cingulata (McClure & L. B. Sm.) McClure	Brazil: Santa Catarina, Sombrio, Garapuvu	*Santos-Gonçalves et. al. 538*	UEC
	Brazil: Santa Catarina, Florianópolis, Ilha de Santa Catarina, Pântano do Sul	*Santos-Gonçalves et al. 554*	UEC
C. distans (Trinius) McClure	Brasil: Minas Gerais, In umbrosis Montis Itacolumi	*Riedel s.n.*	MO
C. gracillima Santos-Gon. & Filg. ex Dusén	Brazil: Paraná, Cerro Azul, cabeceira do Ribeirão do Tigre	*G. Hatschbach 48104*	MO
C. intermedia (McClure & L. B. Sm.) McClure	Brazil: Santa Catarina, Florianópolis, Ilha de Santa Catarina, Pântano do Sul	*Santos-Gonçalves et al. 553*	UEC
	Brazil: Santa Catarina, Governador Celso Ramos, beira de regato	*Santos-Gonçalves et al. 557*	UEC
C. itatiaiae Santos-Gon. & L. G. Clark	Brazil: Rio de Janeiro, Itatiaia, Parque Nacional de Itatiaia	*Santos-Gonçalves et al. 564*	UEC
	Brazil: Rio de Janeiro, Macaé, Reserva Ecológica de Macaé de Cima	*Santos-Gonçalves et al. 471*	UEC
C. lanciflora (McClure & L. B. Sm.) McClure	Brazil: Rio de Janeiro, Teresópolis, Parque Nacional da Serra dos Órgãos	*Santos-Gonçalves et al. 494*	UEC
C. longifolia Santos-Gon. & Filg.	Brazil: Espírito Santo, Linhares, Reserva Natural da Vale do Rio Doce	*Santos-Gonçalves et al. 510, 513*	UEC
C. macrostachya (Nees) McClure	Brazil: Rio de Janeiro (antiga Guanabara), Morro do Bico do Papagaio, Horto Florestal	*Sucre 5293*	RB
C. rhizantha (Hack.) McClure: Argentina	Argentina: Misiones, Depto. Gral. Manuel Belgrano, Salto Andresito	*Morrone et al. 856*	NY
C. secundiflora Santos-Gon. & Clark	Brazil: São Paulo, Itanhaém, Parque Estadual da Serra do Mar, Núcleo Curucutu	*Santos-Gonçalves et al. 353, 372*	UEC
C. sparsiflora Santos-Gon. & Filg.	Brazil: Espírito Santo, Santa Tereza, cabeceira do Rio Bonito	*Santos-Gonçalves et al. 496, 497*	UEC

RESULTS

As demonstrated in chapter II of this study, the blades of the foliage leaves of all species of *Colanthelia* display four different micromorphological regions: 1) the adaxial surface inside the marginal stripe 2) the adaxial surface outside the stripe 3) the abaxial surface inside the stripe and 4) the abaxial surface outside the stripe.

The adaxial epidermis is covered by a distinct continuous cuticle; it is composed of common epidermal cells (Fig. 1), which present associated conical papillae and by the bulliform cells (Fig. 2) which are tall and narrow, and occur in groups. Stomates are present, but they are confined to a specific region within the stripe. The abaxial epidermis is also covered by a continuous cuticle; it is composed of common epidermal cells and their associated conical papillae; stomates are present throughout the surface.

The mesophyll is composed of arm cells and fusoid cells (Figs. 1,2,3, 5,6). The arm cells are organized in 2-3 adaxial layers and 1-2 abaxial layers. All the species surveyed presented fusoid cells in the mesophyll, except *C. burchellii* (Fig. 4). The fusoid cells are located between the adaxial layers of arm cells and 1-2 abaxial layers of arm cells, one on each side of a vascular bundle; they are always in close contact with cells of the parenchyma bundle sheath. Sometimes the cells of the parenchyma bundle sheath in close contact with the fusoid cells are larger than the remaining cells of the parenchyma sheath. The shape of the fusoid cells range from nearly round to elongate, the extremities vary from round to acute.

First and second order vascular bundles are present in all species. The shape of first order bundles vary from round to oval to elliptic. The vascular bundles are

surrounded by a double sheath: the inner mestome sheath which is always continuous and the outer or parenchyma which can be continuous or interrupted. There are plastids on the outer parenchyma bundle sheath, which can be concentrated near the outer tangential wall, near the inner tangential wall or in a centripetal position. Adaxial and abaxial girders associated with first and second order vascular bundles can be present or absent; if present, they can be conspicuous or not.

Intercostal sclerenchyma fibers are present in all species. These fibers are always present in the mesophyll; they may be associated (Fig.2) or not with the bulliform cells, but they are always present beneath the abaxial epidermis, in a small area directly beneath the bulliform cells (Fig.3). The intercostal sclerenchyma fibers are organized in rows of 1-3 cell layers each.

The two margins of the blades of the foliage leaves of all *Colanthelia* spp. are quite different structurally. In one margin, the furrows and ribs are rather conspicuous (Fig.7) and in the other they are less conspicuous or totally inconspicuous. (Fig. 8).

A compression of the mesophyll is observed in both margins of the leaves of all species (Figs 9,10,11). In one margin, where the stripe occurs, this compression is rather conspicuous. This compression is always associated with the presence of adaxial girders of sclerenchyma. The margins of the leaves of some species may present some sclerenchymatous cells, but the sclerenchyma is neither in contact with the vascular bundle nor overarching them as described and illustrated by Ellis (1976). The arm cells are always present in this region; the fusoid cells may be present or not, or they may be present but very reduced in size (Figs.9,10,11).

Ten characters and their states from the median region of the blade associated with the midrib were selected for an analysis in view of their taxonomic value to separate species or groups of species. These data are summarised in Table 2.

Table 2. Selected anatomical characters from the middle region of the blade of foliage leaves of C*olanthelia* spp.

(character states shown in Appendix 1)

	1	2	3	4	5	6	7	8	9	10
C. burchellii	2	2	1	1	1	2	1	2	2	1
C. cingulata	2	2	1	1	1	2	2	2	1	1
C. distans	2	2	1	1	1	2	3	1	1	1
C. gracillima	2	2	1	1	1	2	2	2	1	1
C. intermedia	2	2	1	1	1	2	1	2	1	1
C. itatiaiae	2	2	1	1	1	2	2	2	1	1
C. lanciflora	2	2	1	1	1	2	1	2	1	2
C. longifolia	2	2	1	1	1	2	1	1	1	1
C. macrostachya	2	2	1	1	1	2	1	2	1	1
C.rhizantha	2	2	1	1	1	2	3	2	1	2
C. secundiflora	2	2	1	1	1	2	1	1	1	2
C. sparsiflora	2	2	1	1	1	2	2	1	1	2

APPENDIX 1. Selected anatomical characters from the middle region of the blade of foliage leaves of C*olanthelia* spp. and their states.

1. Abaxial furrow: 1. Present. 2. Absent
2. Arrangement of different orders of vascular bundles:
    1. Progressively fewer first and more third order bundles toward the margin.
    2. Progressively more first and fewer second and third order vascular bundles toward the margin.
3. Number of adaxial layers of arm cells at the fusoid cells region:
    1. 2-3 layers
    2. More than 3 layers
4. Number of abaxial layers of arm cells at the fusoid region:
    1. 1-2 layers
    2. More than 2 layers
5. Orders of vascular bundles:
    1.First and second order vascular bundles present.
    2. First, second and third order vascular bundles present.
6. Phloem x vascular bundles
    1. Phloem adjoins the inner or parenchyma sheath
    2. Phloem completely surrounded by thick-walled fibers
7. Shape of first order vascular bundles:
    1.Circular or round in outline. 2. Oval in outline. 3. Elliptical in outline
8. Intercostal sclerenchyma fibers associated with bulliform cells
    1. Present. 2. Absent
9. Occurrence of fusoid cells
    1. Present. 2. Absent
10. Adaxial furrow
    1. Present. 2. Absent

DISCUSSION

Generally, the anatomical characters found in the blades of the 12 *Colanthelia* species studied agree with those features regarded as typical for the Bambusoideae by Metcalfe (1960), Calderón & Soderstrom (1973), Renvoize (1981).

In *Colanthelia*, the structural differences in the two leaf margins, a character described by Soderstrom & Ellis (1986) for some species of Arthrostylidiinae, is due to a well-developed adaxial girder of sclerenchyma which occurs associated with the last 3-4 bundles only at one margin of the leaf. This large amount of fibers provides the adaxial surface of one margin of the blade with very conspicuous ribs and furrows. The vascular bundles from the opposite margin present less quantity of sclerenchyma fibers, consequently, the adaxial side of this margin displays no conspicuous ribs and furrows.

When the data from the section of the middle region of the blade of the foliage leaves of the 12 *Colanthelia* spp. were analysed comparatively, it became evident that characters 1-6 (Table 2) are consistently uniform amongst all *Colanthelia* species, whereas the characters 7-10 (Table 2) vary discretely. This variation can be used to separate species or group of species, as discussed below.

Colanthelia lanciflora, *C. rhizantha*, *C. secundiflora* and *C. sparsiflora* present no adaxial furrow in the leaf. In another words, in these species, the bulliform cells are at the same or approximately at the same level as the common epidermal cells, whereas the eight remaining species present slightly deeper adaxial furrows.

The shape of first order vascular bundles can also be used to separate species or group of species. Their forms vary from circular (*C. burchellii, C. intermedia, C.*

lanciflora, C. longifolia, C. macrostachya, and *C. secundiflora*) to oval (*C. cingulata, C. gracillima, C. itatiaiae,* and *C. sparsiflora*) to elliptical (*C. distans* and *C. rhizantha*).

The occurrence of intercostal sclerenchyma fibers, a feature regarded by Soderstrom & Ellis (1986) as apparently unique in the Arthrostylidiinae, was also recorded in all species of *Colanthelia.* These intercostal sclerenchyma fibers can be found in distinct situations: 1) associated with both the bulliform cells and the abaxial epidermal cells opposite the bulliform cells and 2) associated with the abaxial epidermal cells, in a region more or less restricted to the abaxial area bellow the bulliform cells. Again, this character can be used to separate groups of species. Four *Colanthelia* spp. (*C. secundiflora*, *C. sparsiflora*, *C. distans* and *C. longifolia*) present these fibers associated with both the bulliform cells and with the abaxial epidermal cells, whereas the remaining eight species present intercostal sclerenchyma fibers associated only with the abaxial epidermal cell. Two *Colanthelia* species sometimes present intercostal sclerenchyma fibers associated with the abaxial epidermis organized in more than 2 layers: *C. distans* and *C. sparsiflora*. In *C. distans*, a species probably extinct in nature (chapter IV of this study), this feature probably reflects an adaptation to the conditions of the habitat (“Campo de altitude”) where the plants of this species grow.

Three evident anatomical features of the Arthrostylidiinae (Soderstrom & Ellis, 1986) were found in all the species of *Colanthelia*: the occurrence of refractive papillae, a reduced midrib (reduced to a single vascular first order bundle, quite similar to the other bundles in the blade) and intercostal sclerenchyma fibers. In all species, the papillae are found associated with both epidermal long cells and stomata; papillae associated with the epidermal long cells are always conical,

whereas those associated with the stomata are elongate and overarch the stomata. The latter is best visualized under scanning electron microscopy. This topic is discussed in detail in chapter II of this study.

Ellis (1986) described the occurrence of vertically elongated, dumbbell, saddle, cross, and Olyroid silica bodies for the Bambusoideae. However, in all species of *Colanthelia* the silica bodies are equidimensional, i. e., round. Because the silica bodies are better visualized under scanning electron microscopy, this feature is discussed in the chapter II of this study.

The adaxial occurrence of stomates confined to a special region of the blades of the foliage leaves of all *Colanthelia* spp. is a novelty for all species in the Arthrostylidiinae. This character is discussed in the chapter II of this study, because it is better visualized under scanning electron microscopy.

CONCLUSIONS

Several anatomical features were surveyed in this paper. A suite of these features were found to be useful to characterize the whole genus and to separate species or group of species.

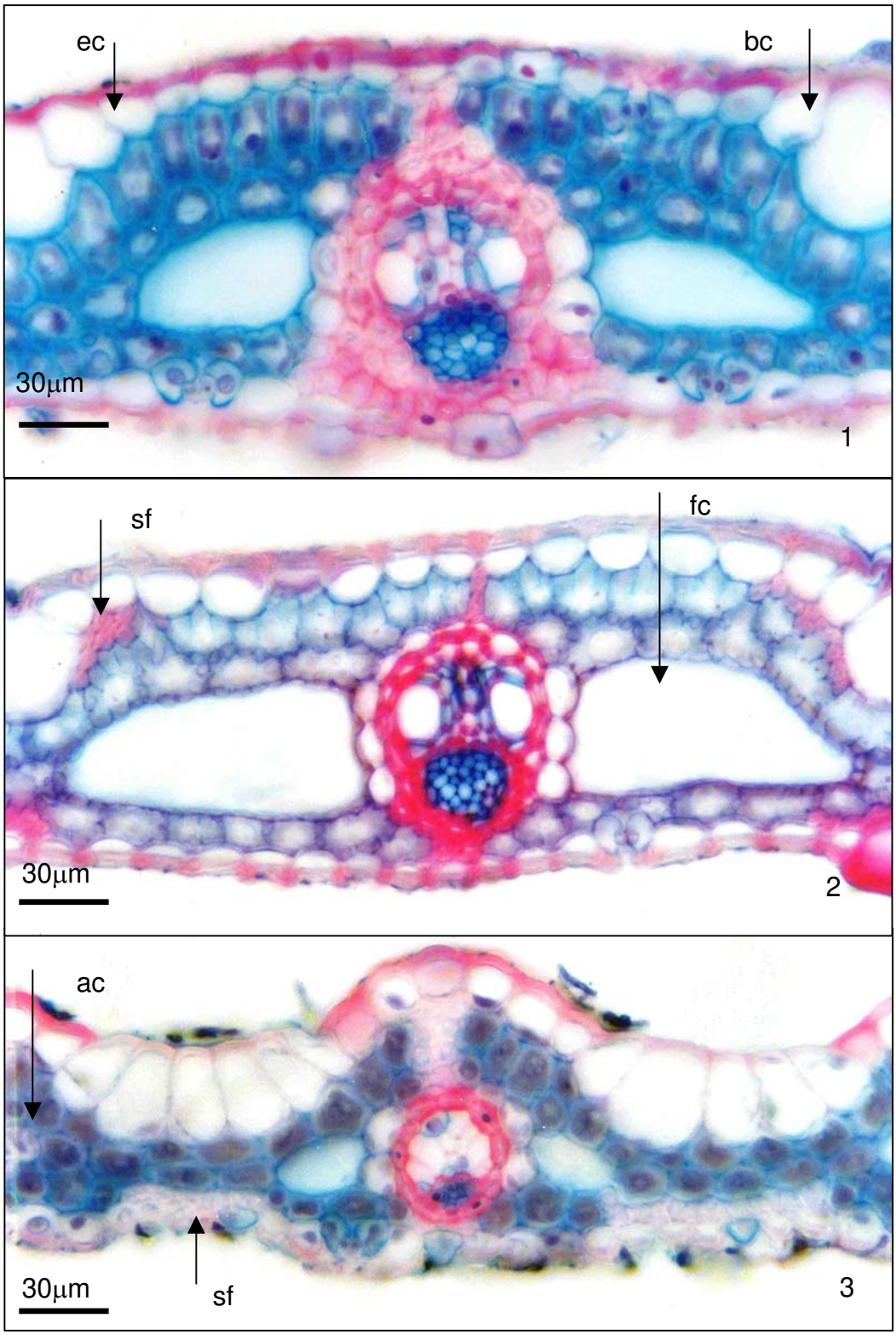
Leaves of all *Colanthelia* species are amphistomatal. However, the stomates of the abaxial surface occur throughout the surface, whereas the stomata of the adaxial surface are restricted to just a narrow region inside the stripe region.

All species of *Colanthelia* present fusoid cells, except *C. burchellii.* So far as known, this is the first record of the absence of this typical bambusoid type cell in the Arthrostylidiinae.

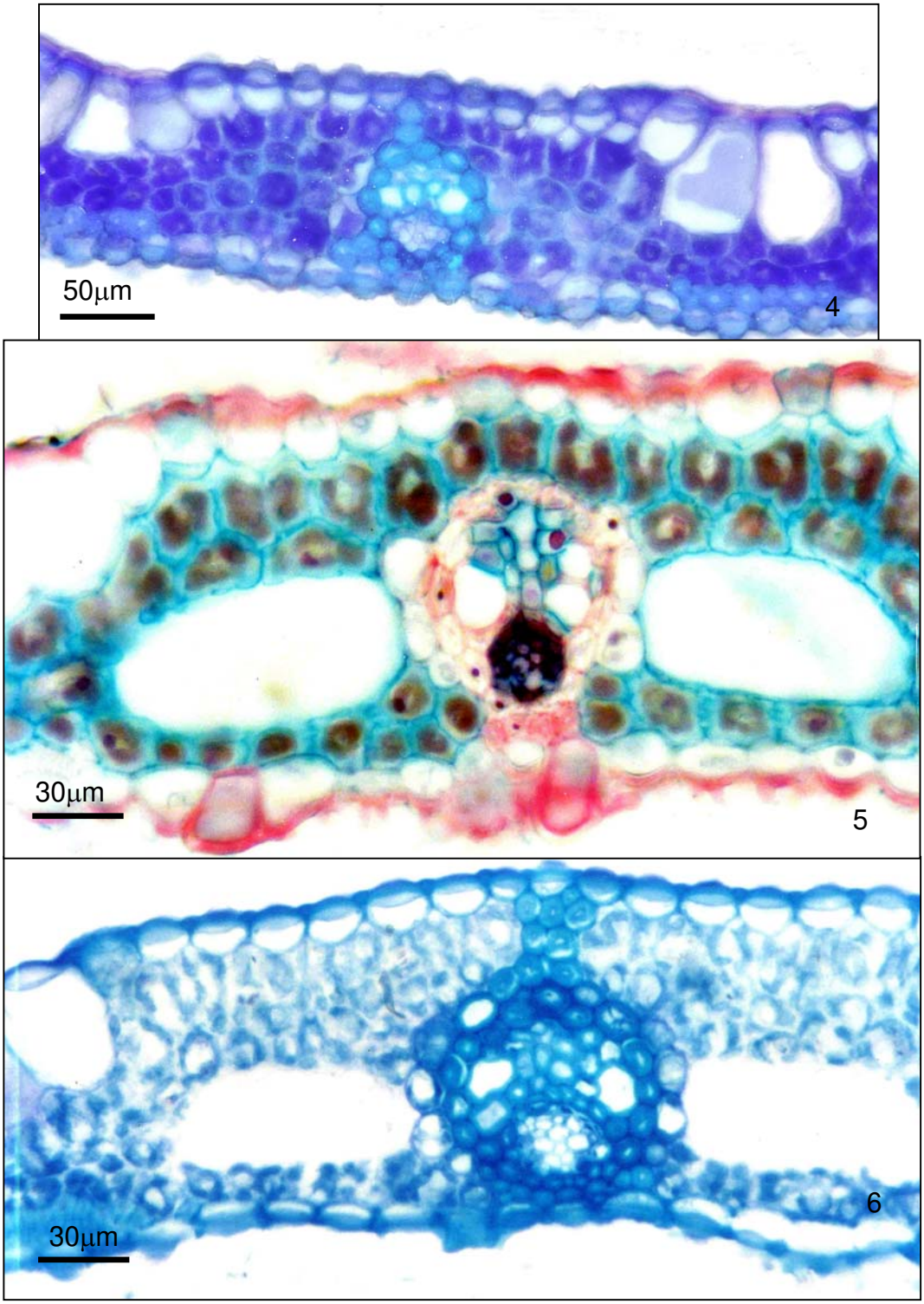
All *Colanthelia* spp. present intercostal sclerenchyma fibers associated with the abaxial epidermis, in a small area directly beneath the bulliform cells. Four *Colanthelia* spp. present intercostal sclerenchyma fibers associated with the bulliform cells, whereas the eight remaining spp. of the genus do not.

The silica bodies found in all *Colanthelia* spp. are equidimensional, round shaped instead of vertically elongated, as described by Ellis (1986) for the Bambusoideae.

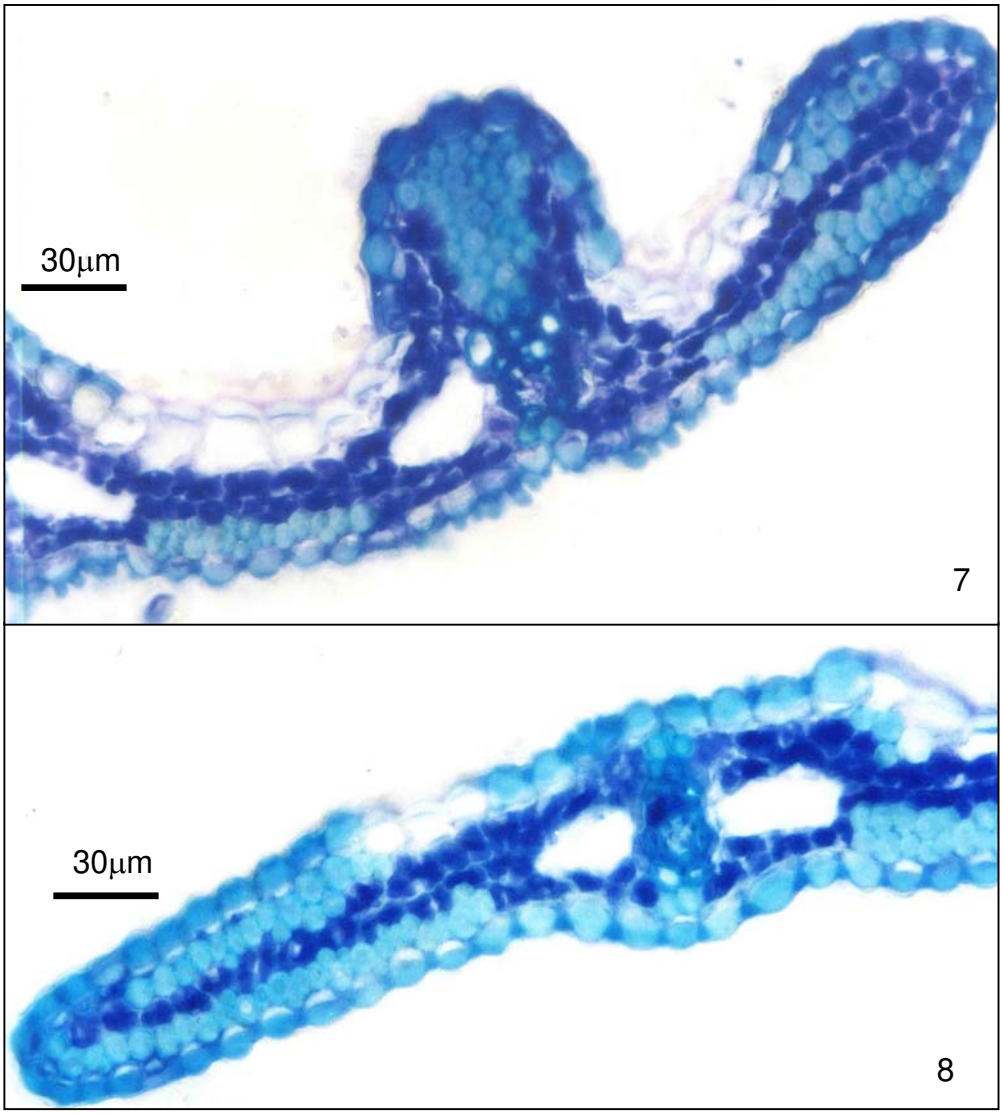
The shape of first order vascular bundles in *Colanthelia* varies from circular (*C. burchellii, C. intermedia, C. lanciflora, C. longifolia, C. macrostachya* and *C. secundiflora)* to oval (*C. cingulata, C. gracillima, C. itatiaiae* and *C. sparsiflora*) to elliptical (*C. distans* and *C. rhizantha*).



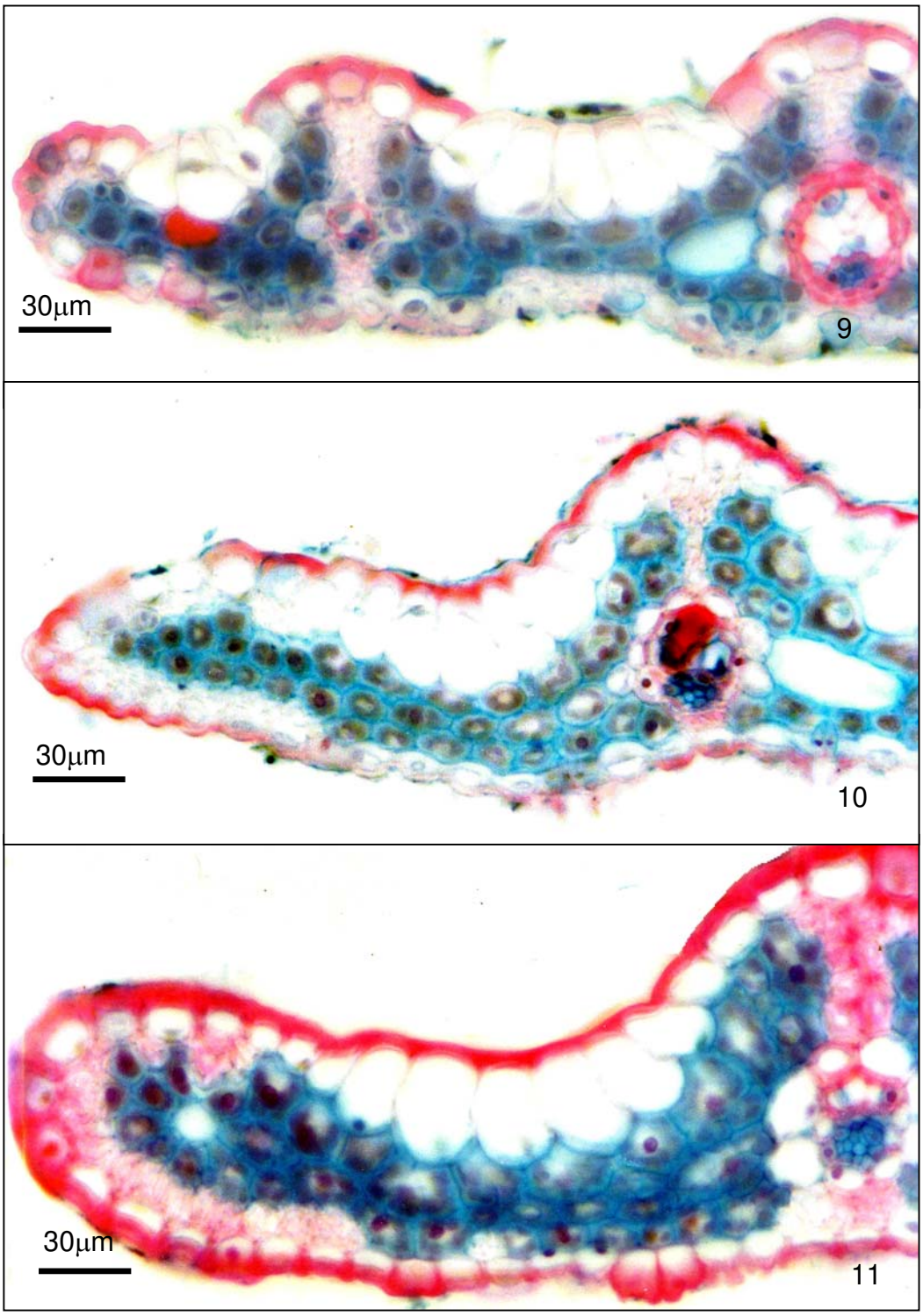
Figures1-3. Transverse section of blades of foliage leaves of three *Colanthelia* species stained using safranin O and astra blue. 1.*C. lanciflora*. 2. *C. longifolia*. 3. *C. secundiflora*. Adaxial epidermis showing common epidermal cells (ec) and bulliform cells (bc). Mesophyll showing arm cells (ac), fusoid cells (fc) and sclerenchyma fibers (sf) .



Figures 4-6.Transverse section of blades of foliage leaves of three *Colanthelia* species. 4,6. Stained using toluidine blue. 5. Stained using safranin O and astra blue. 4.*C. burchellii*. 5. *C. sparsiflora*. 6. *C. macrostachya*.



Figures 7-8.Transversel section of blades of foliage leaves of *Colanthelia distans* stained using toluidine blue showing the two margins of the same blade.



Figures 9-11.Transverse section of blades of foliage leaves of three *Colanthelia* species stained using safranin O and astra blue. 9.*C. secundiflora*. 10. *C. sparsiflora*. 11. *C. longifolia*.

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CAPÍTULO IV

A REVISION OF *COLANTHELIA*

(POACEAE:BAMBUSOIDEAE:BAMBUSEAE)

ABSTRACT.

This chapter represents a taxonomic revision of *Colanthelia*. The genus is characterized by having short pachymorph rhizomes; woody, unarmed culms; internodes with regular length; occurrence of a promontory, culm leaves with a girdle; branch complement composed by 1-13 branches, one of them dominant; and synflorescences paniculate or racemose with a terminal, reduced anthoecium. The genus comprises 12 species, distributed mostly in southern and southeastern Brazil (states of Espirito Santo, Minas Gerais, Rio de Janeiro, Rio Grande do Sul, Paraná, Santa Catarina, and São Paulo). A single species (*C. rhizantha*) occurs in Argentina (Misiones) and Brazil (Rio de Janeiro, and Rio Grande do Sul). The preferred habitat of all known species is the Atlantic Forest, in shady, high humidity areas. A few species also grow at the border of the forest, from sea level to 2,200m altitude. Five new species (*C. gracillima* Dusén ex Santos-Gon. & Filg., *C. Itatiaiae* Santos-Gon. & Clark, *C. longifolia* Santos-Gon. & Filg., *C. secundiflora* Santos-Gon.& Clark, and *C. sparsiflora* Santos-Gon. & Filg.) were discovered during this study. Three of the seven previously described species of *Colanthelia* were collected again during the field trips (*C. lanciflora, C. intermedia* and *C. cingulata*). *Colanthelia. distans*, known only from the Brazilian state of Minas Gerais is considered extinct in nature. *Colanthelia rhizantha*, a species previously known only from the Brazilian state of Rio Grande do Sul, was rediscovered in the Brazilian state of Rio de Janeiro. The name *Colanthelia gracillima* Dusén is validated and the species fully described. A description of the caryopsis of *Colanthelia*, not previously available, is also provided. Full, comparable descriptions, a key for the identification, and distribution maps of all species are presented. All *Colanthelia* species present potential as ornamental plants.

Key words: Atlantic rainforest, Bamboos, Grasses, Brazil, Taxonomy, Revision.

INTRODUCTION

Colanthelia Mcclure & E. W. Smith is a genus of South American woody bamboos. It was described by McClure & E. W. Smith in McClure (1973) based on *Aulonemia cingulata* McClure & L. B. Smith, originally collected in the state of Santa Catarina, Brazil. When established, the genus included seven species: three transferred from *Aulonemia* Goudot, three from *Arundinaria* Michx., one from *Arthrostylidium* Rupr. This is the first attempt to study the entire genus.

Currently, there are twelve species of *Colanthelia*, five of them recently described (chapter I of this dissertation), occurring in South and Southeast Brazil (McClure, 1973; Smith et al., 1981, 1982; Soderstrom et al., 1988; Burman and Filgueiras, 1993; Judziewicz et al., 1999). A single species (*C. rhizantha* (Hack.) McClure) occurs disjunctly in the province of Misiones, Argentina (Judziewicz et al., 1999; Agrasar & Clark, 2000). All known species occur in forest habitats, especially Atlantic Forest s.l., from sea level ("Floresta de Restingas" and "Floresta de Tabuleiros"), throughout the "Floresta Ombrofila Densa" and "Floresta Estacional Semidecidual", up to 2,200 m altitude (*C. lanciflora* (McClure & E. W. Smith) McClure) in the Serra dos Órgaos National Park ("Florestas de Altitude").

Colanthelia is characterized by having short pachymorph rhizomes, woody, unarmed culms, internodes of regular length, occurrence of a promontory, culm leaves with a girdle, branch complement composed of 1-13 branches, one of them dominant, and synflorescences paniculate or racemose with a terminal, reduced anthoecium. However, a few species are known only in their vegetative states.

The suggested affinities between *Colanthelia* and both *Aulonemia* and *Arthrostylidium* are based on a suite of characters in the branch complement and in the type of synflorescences occurring in these genera (McClure, 1973). However, the affinities between *Colanthelia* and other genera of neotropical bamboos are not yet sufficiently clear. Detailed phylogenetic studies are needed to clarify these relationships.

In the New World, 38 genera and about 356 species of bamboos were recognized by Judziewicz et al. (1999). Brazil is certainly the most diverse country in in the New World with regard to bamboo species. A recent survey of brazilian bamboos recognized 34 genera and about 232 species, 204 (c. 83%) of which are endemic (Filgueiras & Santos-Gonçalves 2004). The majority of the species occur in the Atlantic Forest, which represents the preferential habitat for both woody and herbaceous bambusoid grasses (Soderstrom et al., 1988).

Colanthelia is classified in the tribe Bambuseae (woody bamboos) which, according to Soderstrom & Ellis (1986), include nine subtribes. The Bambuseae includes ca. 60-70 genera and ca.1100 species occurring throughout the Old World (Zhang & Clark 2000). Clayton & Renvoize (1986) included *Colanthelia* in the Arundinariinae, whereas Soderstrom & Ellis (1986) classified it in the Arthrostylidiinae.

The Arthrostylidiinae (sensu Soderstrom & Ellis,1986), are characterized by a suite of morphoanatomical features, such as presence of intercostal sclerenchyma fibers, refractive papillae, reduced midrib and the lack of a complex vascularization, well developed fusoid cells and the occurrence of a green stripe along one margin of

the abaxial epidermis of the foliage leaves**.** In most species, there is also an accentuated difference in the anatomical structure of the two leaf margins (Soderstrom & Ellis, 1986).

The main goals of this study were to determine the specific composition of the genus, provide formal, comparable morphological descriptions of all the species, and to gather data on the geographical distribution of the species.

MATERIALS AND METHODS

Very few herbarium specimens of *Colanthelia* were available for study at the beginning of this investigation. For this reason, field work became a priority. Field trips were undertaken throughout 2002-2004 in following Brazilian states: Espírito Santo, Minas Gerais, Paraná, Rio de Janeiro, Rio Grande do Sul, São Paulo, and Santa Catarina. Field techniques followed Soderstrom & Young (1983). Duplicates of the botanical material collected were deposited in the following herbaria: IBGE, ISC, K, MBM, MO, R, RB, SP, UEC, UFMG and US. Additional herbarium specimens were consulted from the following herbaria: CESJ, CVRD, ESA, F, GUA, HBR, ICN, ISC, MBM, MO, NY, R, RB, SJRP, SP, SPF and UEC. Herbarium acronyms follow Holmgren et al. 1990. Distribution maps were done using the Arc View 9.

Terminology for morphological characters was based on Radford et al. (1974), McClure (1966), and Judziewicz et al. (1999).

RESULTS AND DISCUSSION

MORPHOLOGY

HABIT

In bamboos, the term habit refers to the position and growth form of the aerial culms (Judziewicz et al., 1999). In *Colanthelia*, the habit ranges from erect to initially erect (Fig. 1A) and then becoming decumbent to clambering (*C. burchellii*, *C. cingulata*, *C. intermedia*, *C. lanciflora*, *C. sparsiflora*), to scandent (*C. longifolia*), to creeping (Fig. 1B), or clambering to climbing (*C. itatiaiae* and *C. secundiflora*). The habit is not known in four species: *C. distans*, *C. gracillima*, *C. macrostachya* and *C. rhizantha*.

ROOTS

In bamboos, as in the other grasses, the root system is formed by additional adventitious roots that grow from the nodal regions of the underground stem system, including the rhizome and the bases of the aerial culms (Clark & Fisher, 1987). In *Colanthelia*, this system of adventitious roots forms an extensive, delicate network, which, as in other grasses, is essential to help anchor the plant in the substrate. In all specimens where these organs are present, they are abundant, thin and spread in all directions. The root system is not yet known in four species: *C. distans*, *C. gracillima*, *C. macrostachya* , and *C. rhizantha*.

RHIZOMES

Rhizomes are underground stems with scale leaves and adventitious roots at the nodes, with axillary buds developing into erect leaf shoots, stolons or additional

rhizomes (Clark & Fisher, 1987). They play a significant role as reserve shoots, but are also important in vegetative reproduction (Clark & Fisher, 1987).

Rhizomes are typically well developed in and characteristic of woody bamboos; they may generally be described as pachymorph or leptomorph (McClure 1966, 1973). In pachymorph (or clumping) rhizomes, the rhizomes proper are short and thick, the maximum diameter usually somewhat greater than that of the culm to which it gives rise; the rhizome segments are wider than long and solid; and the neck is short (equal to or shorter than its rhizome proper) or elongated, sometimes up to several meters in length (Judziewicz et al., 1999). In the leptomorph type, the rhizome proper is long and slender and has a maximum diameter no greater and usually somewhat less than the culms originating from it; the segments are longer than wide, and hollow; and the neck is always short (Judziewicz et al., 1999).

In all *Colanthelia* species fro which the rhizome is known, it is always pachymorph, short, thick, and short-necked. It is usually found 2-10 cm deep and concentrated at the center of the clump.

CULMS

All *Colanthelia* species present lignified, delicate culms, that exihibit two phases of growth and development. According to McClure (1966) and Clark & Fisher (1987), these two phases are characteristic of most woody bamboos. In the first phase, the elongating new shoots are unbranched, and bear specialized culm leaves, which are protective and usually non-photosynthetic. Subsequently, after a certain amount of elongation, growth of the leafy branches begins. In *Colanthelia,* the culms are 1-7 m long, 1-7 mm in diameter, lignified, thick-walled, and with a small lumen. In the majority of the species, the apex may present an evident zig-zag termination,

except in *C. burchellii* and *C. gracillima* where it is erect or nearly so. The apex is unknown in *C. rhizantha*, *C. macrostachya* and *C. distans*.

CULM LEAVES

Culm leaves are homologous to the foliage leaves, but they have evolved for protection rather than photosynthesis (Judziewicz et al., 1999). In the *Colanthelia* species where they are known, the culm leaves (Fig. 1C) consist basically of a sheath with a pseudopetiolate blade (*C. cingulata*, *C. gracillima*, *C. intermedia*, *C. lanciflora*, *C. longifolia* and *C. sparsiflora*) or a confluent blade (*C. burchellii*, *C. itatiaiae* and *C. secundiflora*). Fimbriae are always present, but lateral appendages may be present (*C. cingulata*, *C. gracillima*, *C. itatiaiae*, *C. lanciflora* and *C. sparsiflora*), or absent (*C. burchellii*, *C. intermedia*, *C. longifolia* and *C. secundiflora*). The lateral appendages may be conspicuous (*C. cingulata*, *C. itatiaiae* and *C. sparsiflora*) or inconspicuous (*C. gracillima* and *C. lanciflora*). A girdle is always present.

Culm leaves are partially unknown in *C. macrostachya* and *C. rhizantha, and* completely unknown in *C. distans*.

BUDS AND PROMONTORY

All *Colanthelia* species, as most woody bamboos, present a single bud in the nodal region which is located in the axil of a given culm leaf. These buds display a distichous arrangement, i.e., they are disposed alternately along any given vegetative axis from one side to the other, at successive nodes. A bud scale, or prophyll (a modified leaf), is always present. The prophyll encloses and protects the tender branch tip until growth is initiated (Judziewicz et al.,1999).

In woody bamboos, both the bud and branch complement may be elevated on an unsegmented swelling called a promontory (Judziewicz et al., 1999). The origin

and function of the promontory is not well known, but has been suggested that the promontory plus the girdle may be an adaptation for the climbing or vining habit (Soderstrom & Londoño, 1988). In *Colanthelia*, the promontory is generally rather conspicuous, but is inconspicuous in *C. burchelli*, *C. itatiaiae*, *C. secundiflora,* and *C. sparsiflora*.

BRANCH COMPLEMENT

Woody bamboos usually present complex branching, which is an adaptation for light competition. The overall pattern of aerial branching in bamboos is monopodial (Judziewicz et al., 1999). In *Colanthelia*, a complex branching pattern occurs, with the branch complement being composed by 1-13 branches, one of them dominant, sometimes repeating the pattern of the main culm. The relationship of the branches with the main culm is described as either intravaginal, extravaginal or infravaginal (Judziewicz et al., 1999). In the intravaginal pattern, the branch grows more or less appressed to the main culm and emerges from the mouth of the culm leaf without rupturing the sheath; in extravaginal branching, the branches grow divergent to the main culm and emerge through the culm leaf by rupturing the base of the sheath; the infravaginal branching is a modification of the infravaginal branching in which the girdle is well developed and the branches emerge horizontally or downward by rupturing the girdle (Judziewicz et al., 1999). All *Colanthelia* species present an intravaginal branching pattern, as far as is known.

Foliage leaves are the leaves from the aerial branches whose main function is photosynthesis. The leaves are distichously arranged along the branch; the lower nodes tend to have less-developed, bract-like blades, which are often called cataphylls (Judziewicz et al., 1999). In *Colanthelia*, the leaf is composed of a

relatively small sheath, a well-developed blade and a pseudopetiole; there is also an inner (adaxial) ligule and an outer (abaxial) ligule. The sheaths are usually puberulous on the abaxial surface and with overlapping margins, which are also usually ciliolate; pseudopetioles are 1-5 mm long, glabrous to pubescent on both surfaces; the blades are lanceolate to linear, glabrous to pubescent on both surfaces; the abaxial ligule is situated at the juncture of the sheath and the pseudopetiole. The outer ligule is sometimes inconspicuous and shorter than the inner ligule. All *Colanthelia* species present a fimbriate sheath, but the lateral appendages may be absent (*C. burchellii*, *C. distans*, *C. longifolia*, *C. macrostachya*, *C. rhizantha* and *C. secundiflora*), conspicuous (*C. cingulata*, *C. itatiaiae*, *C. lanciflora*) or inconspicuous (*C. gracillima*, *C. intermedia* and *C. sparsiflora*). In *Colanthelia,* the sheath is always persistent but the blade is readily deciduous.

In woody bamboos, the suite of foliage leaves found along one branch is known as leaf complement (Judziewicz et al., 1999).

The Arthrostylidiinae (including *Colanthelia* species) present a characteristic pattern of wax deposition on the abaxial surface of the blades of the foliage leaves. In the species of this subtribe, wax is deposited over most of the abaxial leaf surface except for a green stripe along one margin (Judziewicz et al., 1999).

SYNFLORESCENCES

The term synflorescence may be broadly defined as an aggregation of spikelets (McClure, 1966), although it is possible that a grass synflorescence may be reduced to single spikelet (Judziewicz et al., 1999).

In *Colanthelia* , for far as is known, the synflorescence is a terminal, racemose (Fig.1D) or contracted to densely ramified (*C. lanciflora* (McClure & L. B. Sm.)

McClure) panicle; sometimes, it may be reduced to only 2-3 spikelets. Synflorescences are unknown in *C. itatiaiae* and *C. longifolia*.

SPIKELETS

A spikelet consists of a series of overlapping, distichous bracts some of which bear flowers in their axils (Judziewicz et al, 1999). In all *Colanthelia* species where synflorescences are known, the spikelets consist of two basal empty bracts (glumes), 2 to 16 fertile anthoecia and a terminal, reduced anthoecium.

FLOWERS

In all *Colanthelia* species where spikelets are known, flowers are composed of three lodicules (two of them anterior, asymmetrical, situated side by side, approximately equal length, and one posterior, symmetrical and smaller), three stamens with free filiform filaments, and a very small gynoecium. There are two stigmas, which are commonly plumose (glabrous in *C. distans*). In all species where flowers were available, the ovary is pubescent towards the apex.

FRUITS

The fruit in *Colanthelia* species was not previously known. During these studies, caryopses were found and described, for the first time, in the following species: *Colanthelia intermedia*, *C. lanciflora*, *C. macrostachya*, *C. secundiflora,* and *C. sparsiflora*. In these species, the fruit is a narrowly elliptic, typical caryopsis, light-brown to dark-brown colored, with a linear hilum, as long as the caryopsis, and a brown embryo, 1/10 to 2/10 the length of the caryopsis.

Figure 1A-D. Photographs of two *Colanthelia* species in the field. A and C. *Colanthelia cingulata*. B and D. *C. secundiflora*.

Description of the genus

Colanthelia McClure & E. W. Smith, *In*: McClure, F. A. 1973. Genera of bamboos native to the New World. *Smith. Contr. Bot.,* 9: 77-79p.

Type species: *Colanthelia cingulata* (McClure & L. B. Sm.) McClure (Based on *Aulonemia cingulata* McClure & L. B. Sm)

Plants unarmed, erect or decumbent to scandent, creeping, clambering to scandent, the apex generally in zigzag. Rhizome short-pachymorph. Culms hollow, thick-walled; midculm nodes prominent with a single bud, promontory always present, conspicuous or inconspicuous. Culm leaf fimbriate, lateral appendages present or absent; oral setae typically absent; sheaths with overlapping margins, not fused at the base, girdle prominent, sometimes dark; pseudopetiole present or absent; external ligule absent; blade triangular, erect, horizontal or more or less reflexed to reflexed, early deciduous or falling with the sheath. Branching intravaginal; branch complement composed of 1--13 branches, one of them dominant. Foliage leaves 2--21 per branch; Sheaths bearing fimbriae, these short to inconspicuous; lateral appendages present or absent; lamina linear to lanceolate, with a green stripe on one margin of the abaxial side. Synflorescence a terminal, racemose to ramified panicle, sometimes reduced to only 2-3 spikelets; rachilla segments sometimes pulvinate, easly disarticulating at maturity; spikelets short to long pedicellate; glumes two, awnless, equal to unequal; lower

glume 3-5-nerved, the nerves conspicuous to inconspicuous; upper glume 3-5-7-nerved, the nerves conspicuous to inconspicuous; anthoecia 2--16; anthecium narrow, slightly to strongly navicular; apical anthoecium reduced; lemma awnless to mucronate, 5-7-nerved; palea 2-nerved, awnless, strongly sulcate on the back, apex blunt or notched. Lodicules 3, two anterior, more or less asymmetric and side by side, one posterior, symmetrical and usually shorter than the others. Stamens three, with free filiform filaments. Ovary puberulous to pubescent towards the apex; style one, stigmas two, plumose or glabrous. Caryopsis narrowly elliptic, light brown to dark brown; hilum linear, as long as the caryopsis; embryo brown, ca. 1/10 to 2/10 the length of the caryopsis.

Morphoanatomical description of the blades of foliage leaves of *Colanthelia* spp.

ADAXIAL EPIDERMIS. Composed of short cells, long cells and bulliform cells; outer wall thickened; hooks present or absent; unicellular micro-hairs present or absent; bicellular micro-hairs present; papillae associated with epidermal long cells present, more than one per cell, all similar, centrally positioned, arranged in a single row, conical, apex simple or bifurcate; papillae associated with the stomates present or absent; if present, typically overarching the stomates, round, apiculate or digitiform; bulliform cells present, arranged in fan-shaped groups, the cells narrow, rectangular, their number increasing towards the margins; stomates present, confined to a narrow line in the stripe region. ABAXIAL EPIDERMIS. Composed of short cells, long cells and bulliform cells; outer wall thickened; hooks present or absent; unicellular micro-

hairs present or absent; bicellular micro-hairs present; macro-hairs present or absent; papillae associated with the epidermal long cells present, more than one per cell, all similar, centrally positioned, arranged in a single row, conical, apex simple or bifurcate; papillae associated with the stomates present or absent; if present, typically overarching the stomates, round, apiculate or digitiform; stomates present throughout the surface. MESOPHYLL. Vascular bundles of first and second order present; bundle-sheaths always two; the inner or mestome bundle sheath continuous; outer or single bundle sheath parenchymatous, interrupted adaxially and abaxially; plastids of the outer sheath concentrated at the outer tangential wall or in centripetal position; intercostal sclerenchyma fibers associated with the bulliform cells present or absent; intercostal sclerenchyma fibers opposite to the bulliform cells present; arm cells present, the cells with walls deeply invaginated or not; fusoid cells present, rarely absent.

Key to the species of *Colanthelia*

1. Plants robust, initially erect, then arching in the apex; culms 3-7 mm diameter.....2

1’. Plants delicate, decumbent, creeping, clambering, climbing to scandent; culms 1-4 mm diameter.....4

2. Upper and lower portions of the internodes with tomentose-velvety ochre trichomes; girdle with hirtellous-hispid dark-brown trichomes.....*Colanthelia longifolia*

2’. Upper and lower portions of the internode glabrous; girdle without hirtellous-hispid dark-brown trichomes.....3

3. Fimbriae of the foliage leaves spreading; girdle pubescent; sheath of the foliage leaves densely pubescent; culm internodes smooth .....*Colanthelia cingulata*

3’. Fimbriae of the foliage leaves erect; girdle glabrous; sheath of the foliage leaves glabrous to puberulous; culm internodes papillose .....*Colanthelia lanciflora*

4. Mesophyll not provided with fusoid cells.....*Colanthelia burchellii*

4'. Mesophyll provided with fusoid cells.....5

5. Fimbriae of the foliage leaves spreading.....*Colanthelia itatiaiae*

5'. Fimbriae of the foliage leaves creet (not spreading).....6

6. Synflorescences racemose, spikelets always widely spaced.....7

6'. Synflorescences racemose or paniculate, spikelets always closely spaced.....8

7. Palea notched at the apex.....*Colanthelia distans*

7' Palea not notched at the apex.....*Colanthelia sparsiflora*

8. Spikelets secund.....*Colanthelia secundiflora*

8' Spikelets not secund.....9

9. Lodicules pubescent on the upper third.....10

9'. Lodicules pubescent only at the tip.....11

10. Spikelets 1.8-6.2 cm long.....*Colanthelia intermedia*

10'. Spikelets 9-12 cm long.....*Colanthelia macrostachya*

11. Lower glume 3-nerved.....*Colanthelia rhizantha*

11'. Lower glume 5-nerved.....*Colanthelia gracillima*

Description of the species

1. *Colanthelia burchellii* (Munro) McClure, Smithsonian Contr. Bot. 9:79.1973. *Arthrostylidium burchellii* Munro. Trans. Linn. Soc. London, Bot. 26 (1): 43. 1868. Type (syntypes): Brazil. [Rio de Janeiro] Corcovado Mts., *Burchell 1434* (K, 2 sheets, not seen, photo!). São Paulo, [Cubatão], Serra de Cubatao, *Burchell 3696* (K, 2 sheets, not seen photo!, P, not seen, photo!, US-00078837, not seen). *Arundinaria burchellii* (Munro) Hack. Oesterr. Bot. Z. 53 :69. 1903 (Based on *Arthrostylidium burchellii* Munro). Figure 2A-D.

Plants initially erect, then arching over. Culms ca. 1--1.5 m long, apex terminating erect or nearly so. Internodes cylindrical, green, glabrous, smooth, 8.4--28 cm long, 2--3 mm in diam., wall thickened, lumen inconspicuous. Nodes of the lower portion not taking root; supranodal line conspicuous, infranodal line inconspicuous; intranodal area 1.5--2.5 mm long, promontory inconspicuous; upper and lower portions of the internode glabrous to glabrescent. Culm leaves 5.7--6.5 cm long; sheaths 3.2--3.6 cm x 5--8 mm, glabrous, margins not ciliolate, lateral appendages null; girdle inconspicuous, glabrous; blade erect, continuous with the sheath, falling as a unit, 2--3 cm x 1.0--1.5 mm, glabrous on both surfaces; internal ligule membranous, 1.5--2 mm long; fimbriae 3--7 mm long, erect, straw-yellow. Branch complement with 1--4 branches, the branches 8.5--20 cm long, sometimes rebranching at the lower nodes; lower nodes sometimes geniculate. Foliage leaves 7--21 per branch; sheaths 8--9 mm x 1.5--2.0 mm, puberulous on the abaxial surface

when young, margins not ciliolate; lateral appendages null; internal ligule membranous, 0.1--0.2 mm long; fimbriae 4--8 mm long, erect, light-brown; pseudopetioles 1--1.5 mm long, puberulent on both surfaces, brown to dark brown on both surfaces; blades lanceolate, 4.1--5.6 cm x 6--8 mm, the base round to slightly asymmetrical, apex acuminate, glabrous on both surfaces; margins with angular prickles. Synflorescence paniculate, terminal, 3.0--4.5 cm x 4--5 cm, with 2--5 branches; branches not secund, 2--3 cm long; pedicels 3--4 mm long, puberulous to glabrous. Spikelets closely spaced, not secund, 2.0--3.5 cm long, 2--4-flowered; glumes 2, unequal, awnless; lower glume 2.5--3.4 mm x 1.3--2.5 mm, 3-nerved, pubescent; upper glume 4--5.0 mm, 1.5--3.0 mm, 5-7-nerved, puberulous; anthoecium slightly navicular; lemma 7--8 mm x 0.2--0.3 mm, glabrous to puberulous towards the apex, awnless, surface brown without dark spots, 5-7-nerved, nerves conspicuous to inconspicuous; palea 7.0--8.0 mm x 2.0--2.5 mm, 2-nerved, glabrous to puberulous, surface brown without dark spots; lodicules 3, two similar, one narrower, thick, pubescent towards the apex. Stamens 3; anther 3--3.5 mm, yellowish. Ovary 1--1.3 x ca.0.2 mm, puberulous toward the apex, light-yellow; style 1, glabrous, puberulent towards the apex, 0.2--0.3 mm; stigmas 2, slightly plumose. Caryopsis not seen.

Comments. The name *C. burchelli* (Munro) McClure has to be leptotypified because Munro (1868) cited two syntypes (*Burchell 1434, 3696*). There are several duplicates of these collections in different herbaria (K, P, US) which were not yet examined by the present author. As soon as these collections are carefully studied, a lectotype will be selected amongst the available syntypes.

In its vegetative state, *C. burchellii* is morphologically close to *C. itatiaiae* because of the number of branches per branch complement (1--4 in *C. burchellii* versus 1--5 in *C. itatiaiae)* and the length of blades of foliage leaves (4.1--5.6 cm long in *C. burchellii* versus 5.1--8.9 cm long in *C. itatiaiae*). Anatomically, this species is very distinctive because it presents no fusoid cells in the mesophyll (chapter IV of this study).

Phenology. More flowering material is quite desirable to fully understand its morphological affinities.

Distribution and habitat. It is known only in the Brazilian state of São Paulo (Fig.5), where occurs in two distinct habitats of the Atlantic Forest ecosystem: "Floresta Ombrófila Densa Atlântica" and "Floresta Mesofítica Estacional Semidecidual". The species is apparently rare in nature.

Specimens examined. **BRAZIL**. **São Paulo**: Município de Salesópolis, Estação Biológica da Boracéia, Reserva Hidrológica de Rio Claro, SABESP, Trail to Campos da Boracéia, 800-850 m, 45^{o} 54' W, 22^{0} 36' S, 25 Feb. 1991 (veg.), Clark & Morel 831 (ISC, MBM, MO, NY, SJRP); Município de Bofete, mata mesofítica semidecídua, 700m, 23^{o} 11' 24.5"S, 48^{o} 14' 41"W, 23 Jan. 1996 (fl.), V. C. Souza, J. P. Souza, V. R. Scalon and A.astorino 10373 (ESA).

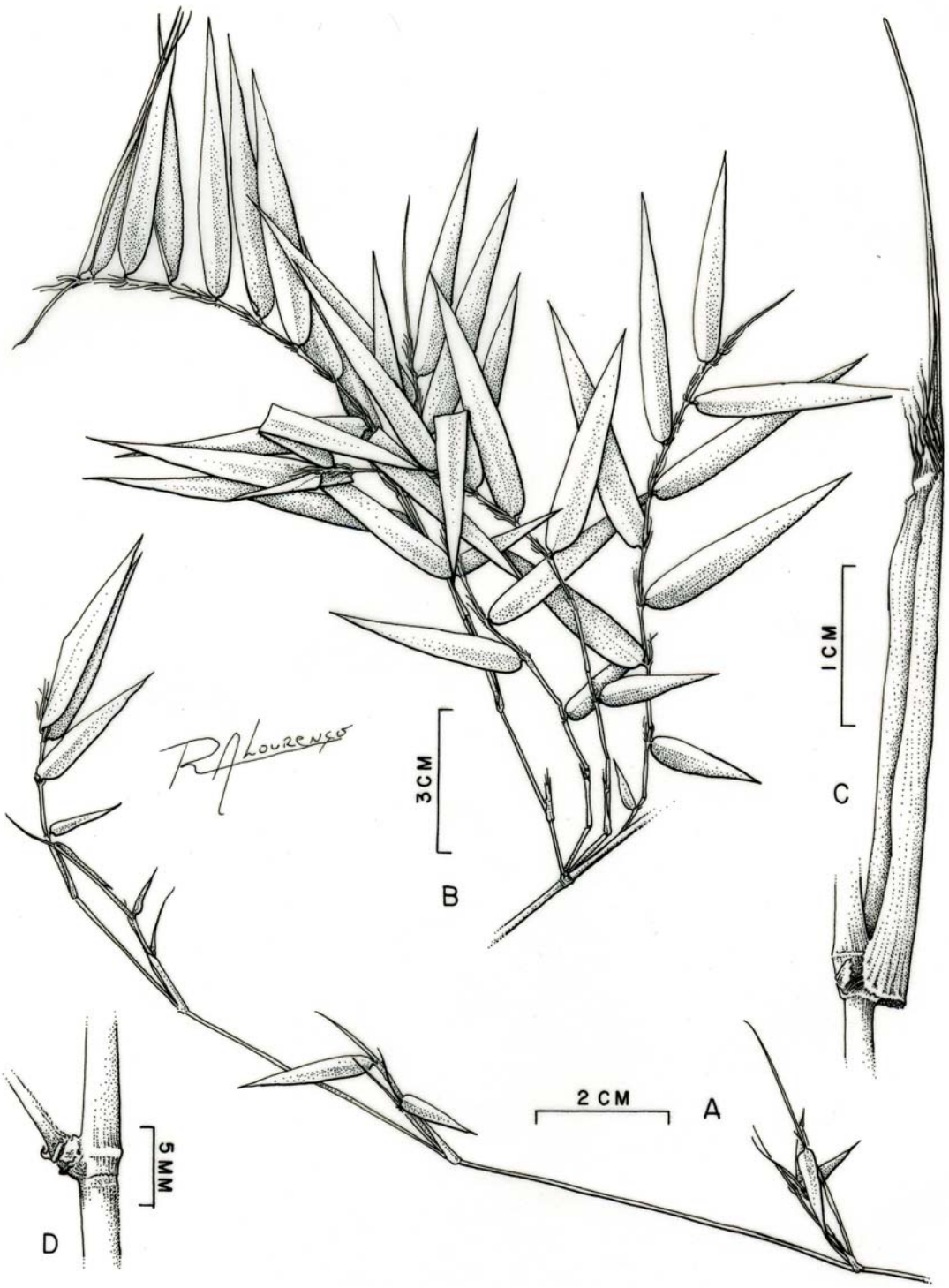


Figure 2.A-D. *Colanthelia burchellii* (based on *L. G. Clark* & *Morel 831*). A. Apex of the culm. B. Branch complement in the vegetative state. C. Culm leaf. D. Nodal region.

2. *Colanthelia cingulata* (McClure & L. B. Sm.) McClure, Smithsonian Contr. Bot. 9: 79. 1973. *Aulonemia cingulata* McClure & L. B. Sm., Fl. Il. Catarin. Gram. Suppl. Bambúseas: 50. 1967. Type: Brazil: Santa Catarina: Sombrio, Garapuvu, Vista Alegre, Orla da mata, 30 m, 14 May 1960, *Reitz & Klein 9679* (holotype, US-2380712, not seen, photo!, isotypes, HBR 33021!, MBM 51.200!, US-2380713, not seen, photo!, US-2380714 not seen, photo!, US-2909111 not seen, photo!). Figure 3 A-I.

Plants initially erect, sometimes becoming decumbent. Culms 3--4 m long, apex sometimes terminating in zig-zag. Internodes cylindrical, green, glabrous, smooth to slightly striated, 12.5--24 cm long, 4.5--6 mm in diam., wall thickened, lumen inconspicuous. Nodes of the lower portion rarely rooting; supranodal line conspicuous, infranodal line conspicuous; intranodal area 3--9 mm long; promontory conspicuous; upper and lower portions of the internode glabrous.
Culm leaves 11--17 cm long; sheaths 4.6--7.4 cm x 0.9--2.5 cm, deciduous to sometimes persistent, densely pubescent when young, glabrous on margins of the submarginal region; lateral appendages conspicuous; girdle conspicuous, pubescent; blade reflexed, pseudopetiolate, early deciduous, 4.5--10 cm x 3--5 mm, puberulous on both surfaces, margins with angular prickle hairs; internal ligule membranous, 1.5--2 mm long; fimbriae 4--10 mm long, spreading, straw-yellow. Branch complement with 1--13 branches, the branches 15--56 cm long, sometimes rebranching at the lower nodes; lower nodes sometimes geniculate. Foliage leaves 7--17 per branch; sheaths 2.9--3.7 cm x 4--6 mm, glabrous on the abaxial surface, margins ciliolate; lateral appendages conspicuous; internal ligule membranous, 0.1--0.15 mm long; fimbriae 4--6.5 mm long, spreading, light-brown; pseudopetioles 1.8--2.5 mm long,

hispidulous, dark brown on the adaxial surface, to glabrous, light green to brown on the abaxial; blades lanceolate, 3--14.8 cm x 0.5--2 cm, the base round to slightly asymmetrical, apex acuminate, glabrous on the adaxial surface, except for a narrow line of hispid trichomes along one submarginal basal region towards the apex, pubescent on the abaxial, margins with angular prickle hairs. Synflorescence paniculate, terminal, 3.4--4.5 cm x 5.5--8 cm, with 7--11 branches; branches not secund, 2.6--4.5 cm long; pedicels 4--4.5 mm long, puberulous to glabrous. Spikelets closely spaced, not secund, 2.6--4.1 cm long, 4--8-flowered; glumes 2, unequal, mucronate; lower glume 3--3.9 mm x 1.3--2.7 mm, 3-nerved, pubescent towards the apex; upper glume 4--5.1 mm, 1.5--2.8 mm, 5-7-nerved, puberulous towards the apex; anthoecium navicular; lemma 8--10 mm x 0.2--0.3 mm, 5-7-nerved, nerves conspicuous to inconspicuous, glabrous to puberulous towards the apex, surface brown without dark spots; palea 7.5--8.5 mm x 2.2--2.4 mm, 2-nerved, glabrous to puberulous, with a few scattered hairs at the tip of the nerves, surface brown without dark spots. Lodicules 3, two similar, one narrower, thick, pubescent towards the apex. Stamens 3; anther 3.3--4.5 mm, yellowish. Ovary 1.2--1.3 x ca.0.2 mm, puberulous toward the apex, light-yellow; style 1, glabrous, puberulent towards the apex, 0.2--0.3 mm; stigmas 2, slightly plumose. Caryopsis not seen.

Comments. The holotype of *Arundinaria cingulata* was not examined, but a photo of it was.Two isotypes not cited in the original publication (McClure & Smith, 1967) were found in two different herbaria (HBR 33021, MBM 51.200). The collection *Klein & Souza 6676* (HBR) cited as a paratype in the original publication (l.c.), does not

belong to *C. cingulata*. However, it was correctly identified as *C. intermedia* by L. B. Smith in 1978.

Colanthelia cingulata is morphologically close to *C. intermedia* because of the high number of branches in the branch complement (1--13 in *C. cingulata* versus 2--13 in *C. intermedia*), but differs from it because of the occurrence of conspicuous lateral appendages on the sheaths of the culm leaves and those of the foliage leaves, by the evident and spreading fimbriae of the sheaths of the culm leaves and of the foliage leaves, the tomentose indument of the sheath of the culm leaves in the abaxial side, the pubescent indument on the abaxial surface of the blades of the foliage leaves, and spikelets with 4--8 anthoecia (5--16 in *C. intermedia*). This species has a high ornamental value.

Phenology. This species has been collected in flower in the South of Brazil (Rio Grande do Sul and Santa Catarina states) in 1972 and 1977, and in Southeast Brazil (Rio de Janeiro and São Paulo states) in 1976, 1977, 1991 and 2003. These long collecting intervals do not allow any conclusion regarding its flowering cycle. Apparently it is fairly common in its preferred habitat (see below).

Distribution and habitat: Known from the Brazilian states of Rio Grande do Sul, Santa Catarina, São Paulo and Rio de Janeiro (Fig. 5), in the interior or at the border of the Atlantic rainforest, in well preserved areas or not. In the state of São Paulo this species also occurs in the “Floresta Mesofítica Estacional Semidecidual”.

Specimens examined. **BRAZIL**: **Rio de Janeiro**: Cabo Frio, Mata do Rio São João, Parque Municipal Mico Leão Dourado, 31 July 2003 (fl.), D. Araújo 10832 (GUA). Rio das ostras, Mata de Restinga, 7 July 1976 (fl.), P. L. Krieger 10.500 (CESJ). **Rio Grande do Sul**. Município de Torres, 1 km ao Norte de Itapeva em mata inundada, a

oeste da faixa de dunas da praia, 12 July 1972 (fl.), Ana Girardi & Bruno Irgang s.n. (CEN). **Santa Catarina**. Município de Sombrio, Garapuvu, idem, 49º 39' 34."W, 29º 01' 44."S, c. 20 m, 30 July 2003 (veg.), Santos-Gonçalves et al. 538 (ISC, IBGE, MBM, RB, SP, UFMG, UEC, US). Município de Florianópolis, Ilha de Santa Catarina, Cachoeira do Peri, Pântano do Sul, 350m, 08 July 1977 (fl.), A. Bresolin 1288 (HBR); idem, Lagoinha do Leste, Pântano do Sul, trilha de Acesso ao Pântano, 48º 32' 57." W, 27º 35' 48."S, 02 July 2003 (veg.), Santos-Gonçalves et al. 554 (ISC, IBGE, MBM, RB, SP, UFMG, UEC, US). **São Paulo**: Município de Campinas, Fazenda São Vicente, trilha no Interior da Mata, 1 May 1991 (fl.), L. C. Bernacci 24.307 (UEC, ESA); idem, Nov. 2001 (veg.), Santos-Gonçalves et al. 371A (IBGE, ISC, UFMG, UEC).

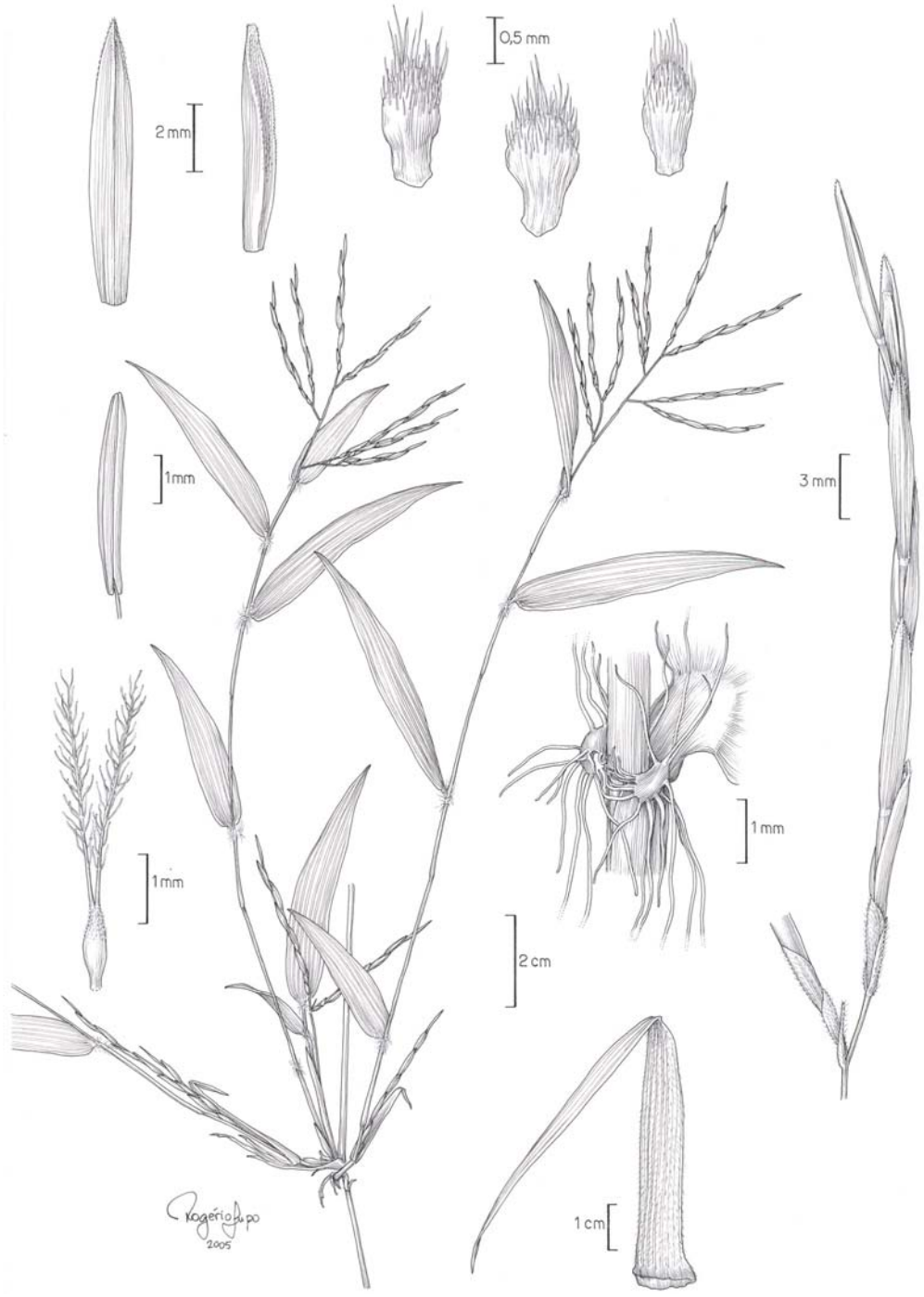


Figure 3. A-I. *Colanthelia cingulata*. (based on *Santos-Gonçalves et al. 538*, *D. Araújo 10832*). A. Branch complement in a floriferous state. B. Culm leaf. C. Lateral appendages of the sheath. D. Spikelets with basal glumes. E. Lemma F. Palea. G. Lodicules. H. Stamen. I. Gynoecium.

3. *Colanthelia distans* (Trin.) McClure, Smithsonian Contr. Bot. 9:79. 1973. *Arundinaria distans* Trin., Mem. Acad. Imp. Sci. Saint-Petersbourg, Ser. 6, Sci. Math., Seconde Pt. Sci. Nat. 3, 1 (6): 621. 1835. Type: Brazil: in sylvaticis umbrosis Montis Itacolumi [Itacolomi], *Riedel s. n.*, Aug. 1824 (holotype, LE, not seen; isotypes: MO!, P, not seen, photo!, US-2808840, not seen, photo!, US-2808839 [mixed collection made up of *Riedel s. n.* plus *Riedel 419*, the latter is not part of the type collection], not seen, photo!). Figure 4 A-I.

Plants known only by fragments. Middle culm sections not seen. Culm leaves not seen. Branch complement with 1--2 branches, the branches 10--13 cm long, not rebranching at the lower nodes; lower nodes not geniculate. Foliage leaves 5--6 per branch; sheaths 1.5--3 cm x 1.5--2 mm, glabrous to puberulous on the abaxial surface, margins ciliolate towards the base, lateral appendages null; internal ligule 0.1--0.2 mm; fimbriae 2--2.5 mm long, erect, light-brown. Pseudopetioles 1--1.5 mm long, hispidulous on both surfaces, light-brown on both surfaces; blades lanceolate, 1.2--5.9 cm x 2--4.5 mm, the base round, apex acuminate, glabrous on both surfaces; margins with angular prickle hairs. Synflorescence racemose, terminal, 3.5--5.5 cm long, with 4-5 branches; branches not secund, 1.1--1.9 cm long; pedicels ca. 1 mm long, glabrous. Spikelets widely spaced, not secund, 1--1.8 cm long, 2--4 flowered, with a prominent internode below the first anthoecium; glumes 2, subequal, reduced to scales ca. 0.2 mm long; anthoecium navicular; lemma 0.9--1.3 cm x 2--2.6 mm, 7-nerved, nerves inconspicuous, puberulous, mucronate, surface purplish without dark spots; palea ca. 9 mm x 3 mm, 2-nerved, puberulous, apex notched, surface purplish without dark spots. Lodicules 3, two similar, one narrower, thick, puberulous towards

the apex. Stamens 3; anther 5.5--6 mm, purplish. Ovary apparently not mature, ca. 0.7 x 0.3 mm, puberulous at the tip, light-yellow; style 1, glabrous, ca.2.5 mm; stigmas 2, glabrous. Caryopsis not seen.

Comments. The holotype of *C. distans* deposited at LE was not examined, but the isotype deposited at MO was. Photos of the isotypes at US (US-2808840, US-2808839) were also examined. The former is an isotype of *Riedel s. n.* whereas the latter is a mixed collection made up of two fragments of *Riedel s. n.* plus a fragment of *Riedel 419*, which is not part of the type collection.

The species was collected once. Because of this, four field trips were specifically undertaken with the objective to collect *C. distans* again in the type locality (Parque Estadual do Itacolomi, Minas Gerais state) but all attempts to locate new populations of said species failed. Consequently the species remains known only by its type collection.This unique and very handsome plant is here considered as probably extinct in nature.

Colanthelia distans is morphologically close to *C. sparsiflora* Santos-Gon. & Filg. because of the synflorescences with short branches, which are widely separated from each other, because of the prominent internode below the first anthoecium and the much reduced glumes. Clark (pers. comm.) recorded the occurrence of branches with five spikelets in a collection of this species from the herbarium of the Smithsonian Institution (US) which was not yet examined by the present author. Phenology. *Colanthelia distans* was collected in flower in 1824.

Distribution and habitat. The type locality is Monte Itacolomi, near Belo Horizonte (Fig. 5), now a State Park in the state of Minas Gerais, probably in high altitude campo.

Specimens examined. No additional material of this species was examined.

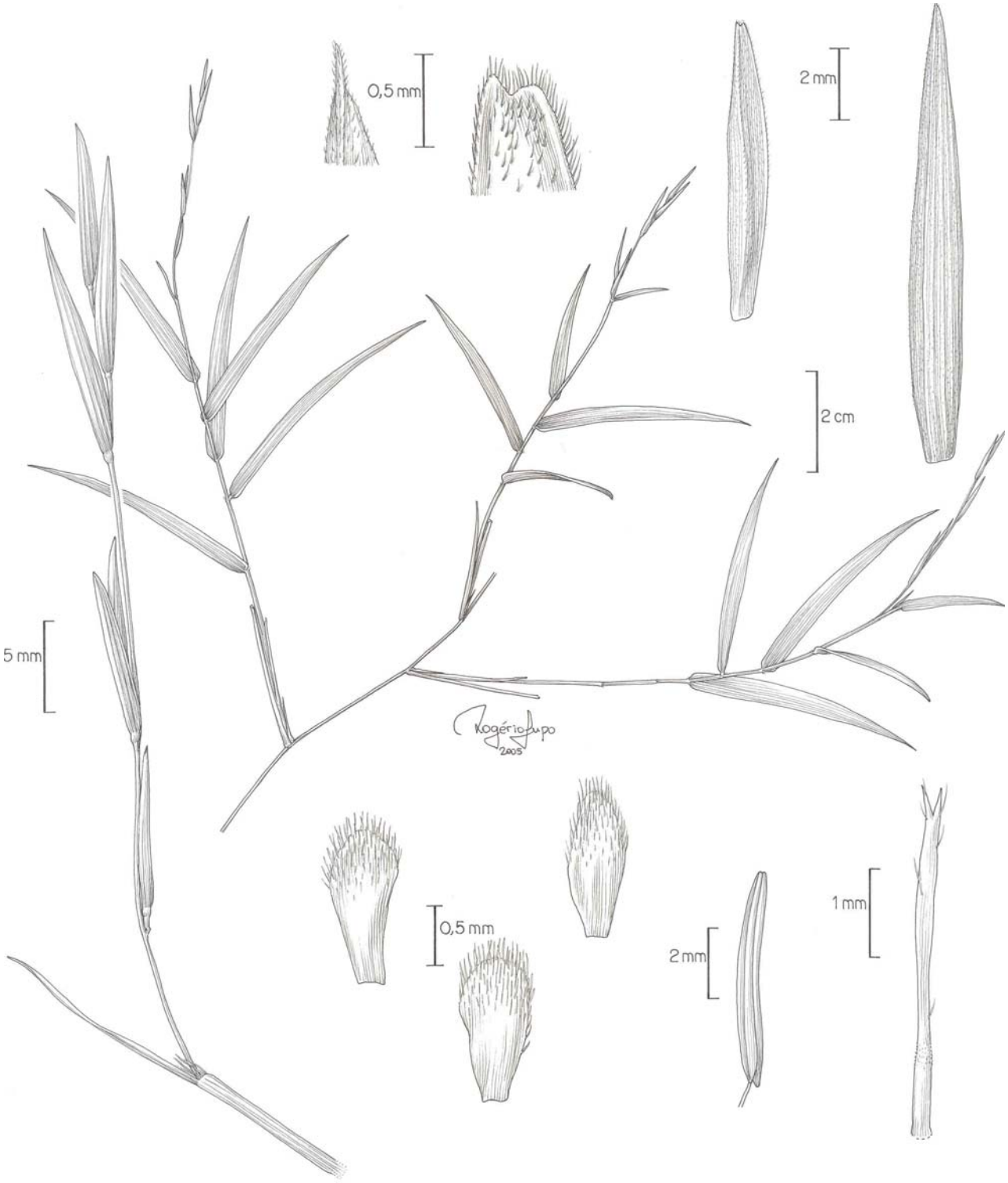
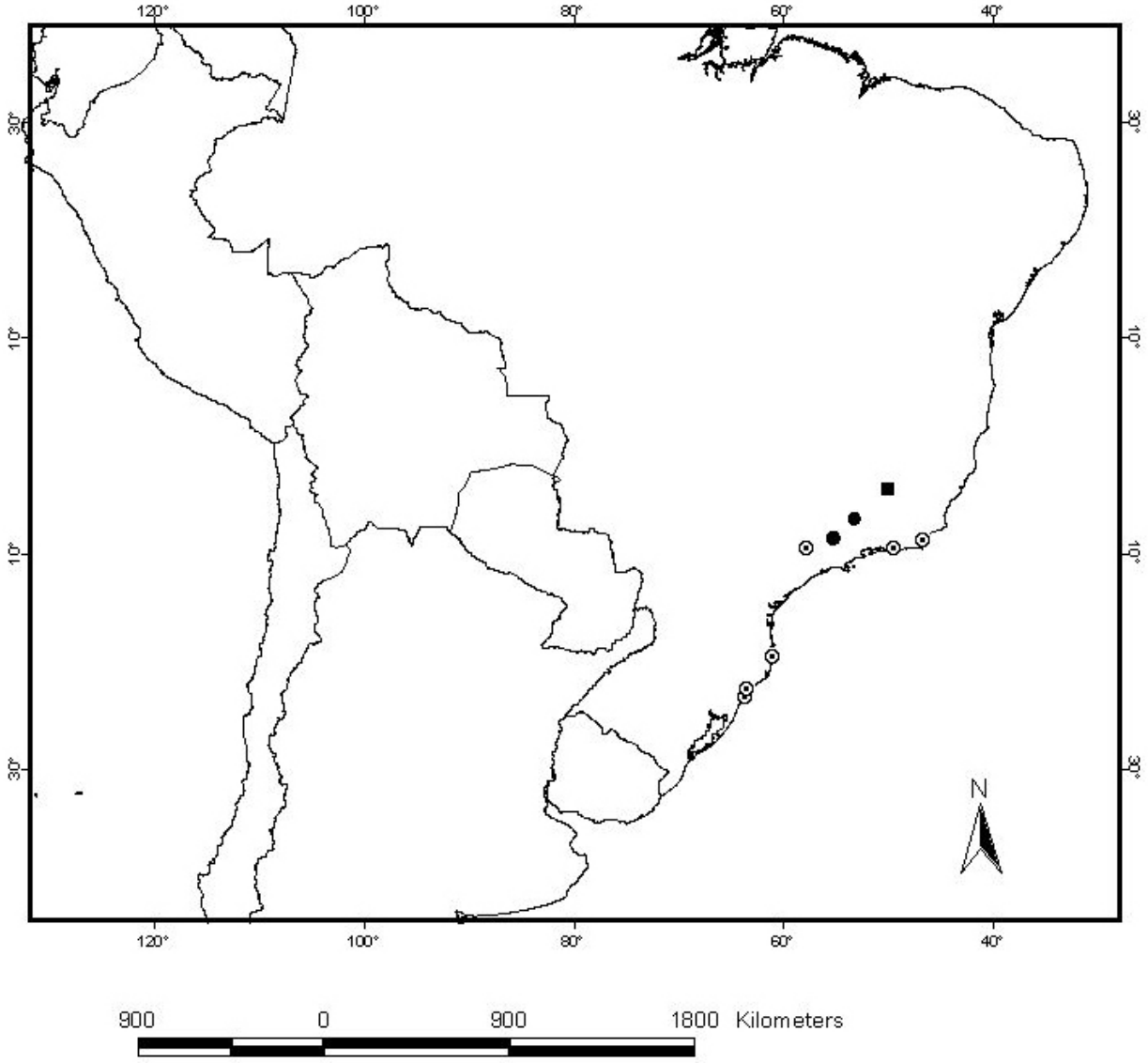


Figure 3.A-I. *Colanthelia distans* (based on *Riedel s.n.,* MO). A. Terminal portion of one branch in the floriferous state. B. Synflorescence. C. Lemma. D. Mucronate apex of the lemma in detail. E. Palea. F. Notched puberulous apex of the palea in detail. F. Lodicules. G. Stamen. H. Gynoecium.

Figure 5. Distribution of the examined material of *Colanthelia* species



● *C. burchellii*

⊙ *C. cingulata*

■ *C. distans*

4. *Colanthelia gracillima* Dusén ex Santos-Gon.& Filg.. sp. nov. INED.Type: Brazil. Paraná: Município de Cerro Azul, Cabeceira do Ribeirão do Tigre, 18 July 1984 (fl.), *G. Hatschbach 48104* (holotype, MBM!, isotypes: NY!, F!). Figure 6A-J.

Habit unknown. Culms ca. 3m long, apex straight or nearly so, not terminating in zig-zag. Internodes cylindrical, green, glabrous, striate, 4--13.9 cm long, 1--2.1 mm in diam., upper and lower portions of the internode glabrous,wall thickened, lumen inconspicuous. Nodes of the lower portion not seen; intranodal area 0.8--2 mm long; promontory conspicuous. Culm leaves ca. 6.8 cm long; sheaths 3--3.7 cm x 0.45--0.5 mm, sometimes persistent, glabrous, margins ciliolate, lateral appendages inconspicuous; girdle conspicuous, light straw-colored, glabrous; blade apparently reflexed, pseudopetiolate, deciduous, ca. 2.5 cm x 2.3 mm, glabrous on both surfaces, margins with prickle hairs; internal ligule membranous, apex ciliolate, 0.2--0.3 mm long; fimbriae only known by small fragments, erect, straw-yellow colored. Branch complement with 2--10 branches, the branches 4--22 cm long, sometimes rebranching at the lower nodes; lower nodes sometimes geniculate. Foliage leaves 2-6 per branch; sheaths 1.3-1.8 cm x 1.5--2 mm, glabrous, margins ciliolate; lateral appendages inconspicuous; internal ligule membranous, apex ciliolate, 1.0--1.5 mm long; fimbriae 2.0--2.5 mm long, erect, light-brown; pseudopetioles 1-1.5 mm long, puberulent on both surfaces, dark brown on the adaxial surface, green-yellow on the abaxial; blades lanceolate, 1.5--5.9 cm x 3--6 mm, the base round, apex acuminate, puberulent toward the apex on the adaxial surface, pubescent on the abaxial surface, the margins with angular prickle hairs. Synflorescences paniculate, terminal, 3--7.5 x 1.5--5.8 cm, with 2-5 branches; branches not secund, 1--4.3 cm long; pedicels 2.5--13

mm, pubescent. Spikelets closely spaced, not secund, 0.8--2.8 cm long, 2-6-flowered; glumes 2, unequal, awnless; lower glume 3--3.3 mm x 1--1.5 mm, 5-nerved, puberulent towards the apex; upper glume 3.9--4.2 mm x 1.5--2 mm, 5-nerved, puberulent towards the apex; anthoecium slightly navicular; lemma 6--6.2 mm x 2.2--2.4 mm, puberulous towards the apex, awnless, surface purplish, 5-nerved, 3 conspicuous, 2 inconspicuous; palea 5.1--5.5 mm x 2.2--2.4 mm, 2-nerved, puberulous towards the apex, surface green-yellow. Lodicules 3, two similar, one narrower, thin, glabrous, transparent, ciliate at the tip. Stamens 3; anther 2.5--2.8 mm, yellowish. Ovary 0.3--0.4 mm x 0.1--0.15 mm, glabrous, light-yellow; style 1, glabrous, 0.1--0.2 mm; stigma 2, plumose, light yellow. Caryopsis not seen.

Comments. This fairly delicate plant was first collected by Dusén who named it *Arundinaria gracillima* on a herbarium sheet (F). Later, Renvoize annotated the name "*Colanthelia gracillima* Dusén" on a sheet in the Hatschbach herbarium (MBM). However, neither of these names was ever published. Therefore, both names (*Arundinaria gracillima* Dusén and *Colanthelia gracillima* Dusén) are here considered as *nomina nuda*. The name *Colanthelia gracillima* Dusén is validated (see chapter I of this study).

Colanthelia gracillima is morphologically close to *C. secundiflora* Santos-Gon. & L. G. Clark by the number of branches of the branch complement, the size of blades of foliage leaves, the fimbriate culm leaves without lateral appendages and the small number of anthoecia per spikelet. However, it differs from it because of the non-

secund branches of the synflorescence, the length of the pedicels of the spikelets and by the anthoecium without dark spots.

Phenology. This species was collected in flower in 1916 by Dusén and in 1984 by Hatschbach. This long collecting interval does not allow any conclusion regarding its flowering cycle.

Distribution and habitat. The species is known only from the Brazilian state of Paraná (Fig. 9), in Atlantic rainforest. It is apparently rare in nature.

Specimens examined. **BRAZIL**: **Paraná**: Jaguariahyva [Jaguariaíva], ad marginem silvae primaevae, 710 m, 25 March 1916, Dusén s.n. (F, K, NY).

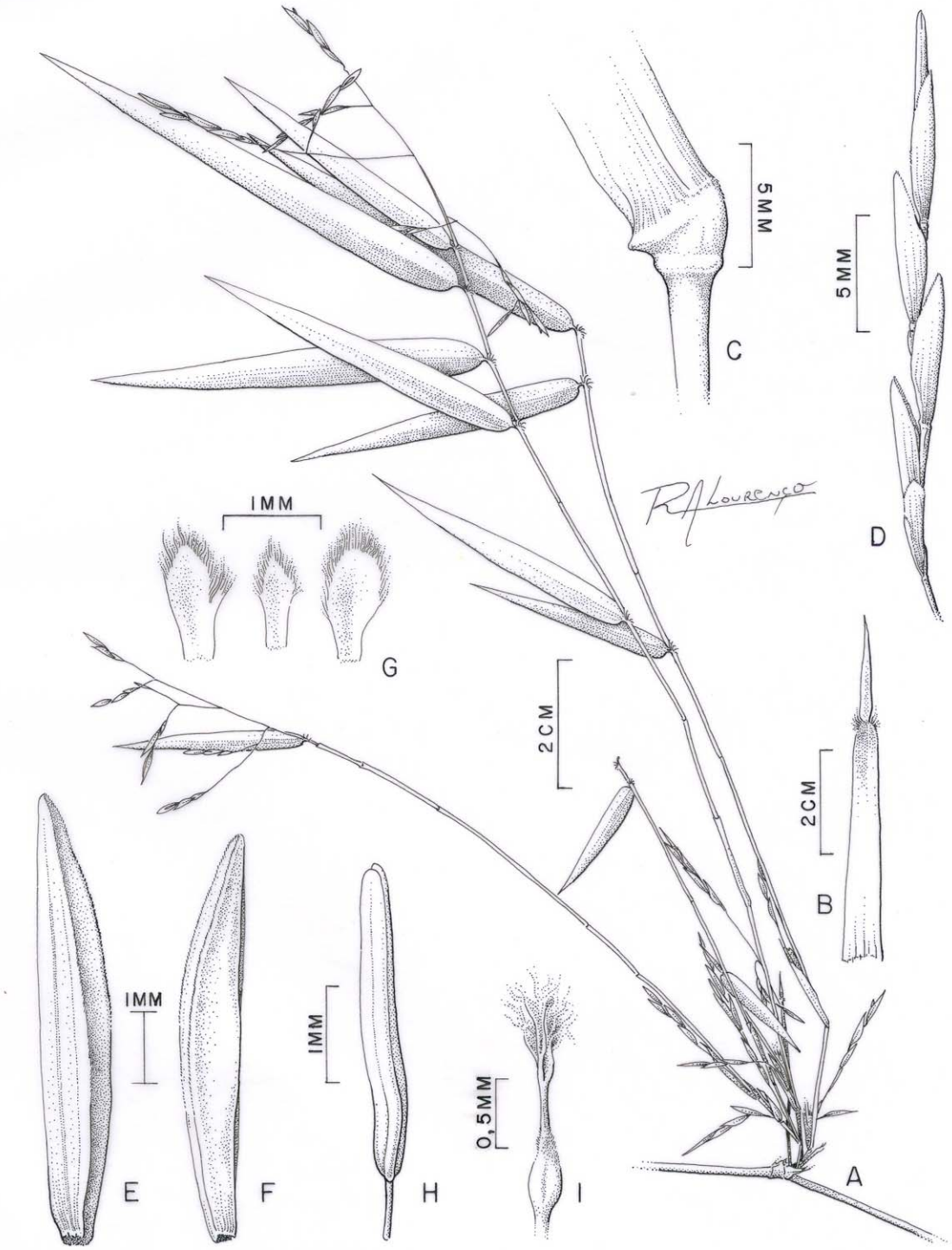


Figure 6. A-J. *Colanthelia gracillima* (based on *Hatschbach 48104*). A. Branch complement in a floriferous state. B. Culm leaf. C. Nodal region and promontory. D. Spikelets. E. Lemma. F. Palea. G. Lodicules. H. Stamen. I. Gynoecium.

5. *Colanthelia intermedia* (McClure & L. B. Sm.) McClure, Smithsonian Contr. Bot. 9:79. 1973. *Aulonemia intermedia* McClure & L. B. Sm., Fl. Il. Catarin. Gram. Suppl. Bambúseas. 52. 1967. Type: Brasil: Santa Catarina: Rio do Sul, Serra do Matador, mata, 550m, 25 Fev. 1964, *Klein 4612* (holotype: US-2434526, not seen, photo!, isotypes: HBR!, US-2434525, not seen, photo!, US-2434528, not seen, photo!). Figure 7 A-I.

Plants initially erect, becoming decumbent to clambering. Culms 3--4 m long, apex terminating in zig-zag. Internodes cylindrical, green, glabrous, striate, 8.3--21 cm long, 3--4 mm in diam., wall thickened, lumen inconspicuous. Nodes of the lower portion not rooting; supranodal line conspicuous; infranodal line conspicuous; intranodal area 1.5--6 mm long; promontory conspicuous; upper and lower portions of the internode glabrous. Culm leaves 5.8--6.2 cm long; sheaths 3.6--4 cm x 0.7--0.8 mm, sometimes persistent, glabrous to puberulous, the margins ciliolate, lateral appendages null; girdle conspicuous, glabrous; blade reflexed, pseudopetiolate, early deciduous, 2.2--2.5 cm x 0.2--0.3 cm, glabrous to puberulous on the adaxial surface, glabrous on the abaxial; internal ligule membranous, 1.5--2 mm long; fimbriae 2--2.5 mm long, erect, straw-yellow. Branch complement with 2--13 branches, the branches 10--42 cm long, sometimes rebranching at the lower nodes; lower nodes sometimes geniculate. Foliage leaves 3--13 per branch; sheaths 1.3--1.83 cm x 2--3 mm, puberulous on the submarginal region of the abaxial surface, margins glabrous; lateral appendages inconspicuous; internal ligule membranous, 1--1.5 mm long; fimbriae 1.8--6 mm long, erect, light-brown; pseudopetioles 1--1.5 mm long, green on

the adaxial surface, glabrate, light green on the abaxial; blades lanceolate, 1.9--13.3 x 0.2--1.4 cm, the base round, apex acuminate, glabrous to pubescent on the adaxial, with a narrow line of hispid trichomes along one submarginal region, puberulous to pubescent on the abaxial; margins with angular prickle hairs. Synflorescence racemose, terminal, 4--8.7 cm x 1.6--6.6 cm, with 2-6 branches; branches not secund, 2--6.6 cm long; pedicels 2--8 mm long, puberulous. Spikelets closely spaced, not secund, 1.8--6.2 cm long, 5-16 flowered; glumes 2, unequal, mucronate; lower glume 2.5--3.5 x 1--1.3 mm, 3-5-nerved, glabrous to puberulous; upper glume 3.5--4.5 x 1.2--1.3 mm, 3-5nerved, glabrous; anthoecium slightly navicular; lemma 5.8--8.8 x 1.8--3 mm, glabrous to glabrescent, awnless, surface light brown, without dark spots, 5-7-nerved, nerves conspicuous or not; palea 5.5--6.5 x 1.5--2 mm, 2-nerved, puberulous, surface brown without dark spots. Lodicules 3, two similar, one narrower, 0.5--1 mm, thick, tomentose, brown. Stamens 3; anther 2--2.6 mm, yellowish. Ovary 0.8--1 x 0.2--0.3 mm, puberulous towards the apex, brown; style one, puberulous, 1.0--2 mm long; stigmas 2, plumose, light yellow-colored. Caryopsis narrowly elliptic, 5.8--6 x 0.6--1.3mm long, dark brown; hilum linear, as long as the caryopsis; embryo brown, ca. 1/10 the length of the caryopsis.

Comments. The holotype of this name, deposited at US, was not examined. One isotype not cited in the original publication (McClure & Smith, 1967) was found at HBR (HBR 33.018). The collection *Klein & Souza 6676* (HBR 42814), cited in the original publication (l.c.) as a paratype of *C. cingulata* does not belong in that taxon. However, it was correctly identified as *C. intermedia* by L. B. Smith in 1978.

Colanthelia intermedia is morphologically close to *C. macrostachya* because of the number of anthoecia per spikelet (5--16 in *C. intermedia* versus 5--11 in *C. macrostachya*) but differs from it because of the length of he spikelets (1.8--6.2 cm in *C. Intermedia* x 9--12 cm in *C. macrostachya*)

Phenology. This species was only collected in flower in Rio de Janeiro state in 1964. In the south of Brazil (Santa Catarina state), it was collected in flower in 1964, 1966, 1969, 1970, 1971, 1972 and 2003. These data suggest that, apparently, this species presents a relatively short flowering cicle. The long interval between the two last flowering periods may be due to a lack of collecting. All the flowering populations seen by the present author in southern Brazil in August 2003 were dying.

Distribution and habitat. *Colanthelia intermedia* is known to occur in the Brazilian states of Rio de Janeiro, Rio Grande do Sul, and Santa Catarina (Fig. 9). The species was collected only in primary Atlantic rainforest, near rivers, in wet and relatively shady spots. It appears to be relatively frequent in its preferred habitat.

Specimens examined. **BRAZIL**: **Rio de Janeiro**: Rio de Janeiro, Guanabara, Silvestre Corcovado, ca. 200 m, 18 Nov. 1964, (fl.), T.R.Soderstrom, 1175 (MO). **Rio Grande do Sul**: Torres, Limoeiro, 21 Apr. 1978, (veg.), V. Citadini 328 (ICN). **Santa Catarina**: Blumenau, Parque Ecológico Spitzkopf, trail to the peak, 280 m, 27^{o} 01'S, 49^{o} 08'W, 18 Feb.1992, (veg.), L. Clark, X. Londoño & W. de Oliveira 1030 (ISC, NY, SJRP, MO, MBM). Florianópolis, Ilha de Santa Catarina, Lagoinha do Leste, Pântano do Sul, Trilha Principal de acesso, 27^{o} 46' 42"S, 48^{o} 30' 24"W, 02 Aug. 2003 (st.), Santos-Gonçalves et al. 553 (IBGE, ISC, RB, MBM, UEC, US); idem, matinha, 50m altitude, 13 Apr. 1971 (fl.), Klein & Bresolin 9280 (ICN, RB);idem, Jurerê, Mata, 06 May 1970 (fl.), R. M. Klein 8685 (HBR); idem, Morro do Ribeirão, 300 m, 21 May

1969 (fl.), R. M. Klein 8329 (RB); idem, Capoeirão e Matas de Encostas, 400 m, 21 May 1969 (fl.), R. M. Klein 8327 (HBR); idem, 300 m, 21 May 1969 (fl.), R. M. Klein 8329 (HBR). Governador Celso Ramos, trilha em Borda de Regato, 27° 20' 35"S, 48° 35' 42"W, 03 Aug. 2003 (fl., fr.), Santos-Gonçalves et al. 557, (IBGE, HBR, ISC, MBM, RB, UEC, UFMG, US); idem, Jordão, mata, Beira de Regato, 100 m, 19 May 1971 (fl.), Klein & Bresolin 9450 (HBR); idem, Beira de Rio, 50 m, 28 Mar. 1972 (fl.), R. M. Klein 10.143 (HBR). Laurentino, 3 km ao norte de Laurentino, Mata, 400 m, 28 Mar. 1970 (fl.), R. M. Klein 9171 (HBR). Palhoça, Morro do Cambirela, 200m altitude, 14 Apr. 1971 (fl.), Klein & Bresolin 9371 (RB); idem, Restinga de 2 m de altitude, (fl.), 16 Feb. 1966, Klein & Souza 6676 (HBR, US, photo!). Rio do Sul, Serra do Matador, Mata, 550 m, 25 Feb. 1964 (fl.), R. M. Klein 4615 (HBR).

Figure 7. A-I. *Colanthelia intermedia* (based on *Santos-Gonçalves et al. 557*). A. Branch complement in the floriferous state. B. basal portion of the sheath of a culm leaf. C. Spikelets. D. Lemma. E. Palea. F. Lodicules. G. Stamen. H. Gynoecium. I. Caryopsis.

6. *Colanthelia itatiaiae* Santos-Gon. & L. G. Clark, sp. nov. INED.Type: Brazil: Rio de Janeiro: Município de Itatiaia, Parque Nacional de Itatiaia, 1.100m, 22º 25' S, 44º 37'S, trilha para a cachoeira Véu da Noiva e Itaporani, 5 Nov. 2003 (veg.), *Santos-Gonçalves et al. 565* (holotype, UEC!; isotypes, IBGE!, ISC!, K!, MBM!, MO!, RB!, SP!, UFMG!, US!). Figure 8A-E.

Plants creeping, clambering to climbing. Culms 2-3 m long, apex terminating in zig-zag. Internodes cylindrical, green, sometimes purplish when young, puberulent when young, striate, 9--22 cm long, 1.5--1.8 mm in diam., wall thickened, lumen inconspicuous. Nodes of the lower portion sometimes rooting; intranodal area 1.5--2.4 mm long; promontory inconspicuous; upper and lower portions of the internode glabrescent. Culm leaves 4.9--6.1cm long; sheaths 3.1--4 cm x 4--9 mm, sometimes persistent, puberulent on the abaxial surface, margins ciliolate, lateral appendages conspicuous; girdle inconspicuous, glabrous; blade erect to more or less reflexed, continuous with the sheath, deciduous, 1--2.1 cm x 1.5--3 mm, puberulent on both surfaces; margins with prickle hairs; internal ligule membranous, 0.2--0.3 mm long; fimbriae 2--4 mm long, spreading, first reddish then becoming brown. Branch complement with 1-5 branches, the branches 13--21.5 cm long, sometimes rebranching at the lower nodes; lower nodes sometimes geniculate. Foliage leaves 5--13 per branch; sheaths 1.7--2.1 cm x 3.5--4.1 mm, puberulent on the abaxial surface, margins ciliolate; lateral appendages conspicuous; internal ligule membranous, 1.5--2 mm long; fimbriae 5--8 mm long, spreading, first reddish then becoming straw-yellow; pseudopetioles 1--1.5 mm long, puberulent on both surfaces, dark green on both surfaces; blades lanceolate, 5.1--8.9 cm x 0.9--2.2 cm, the base asymmetrical,

sometimes round, apex acuminate, glabrescent on the adaxial surface, puberulent towards the apex on the abaxial surface; margins with pickle hairs. Synflorescences not seen.

Comments. In its vegetative state, *C. itatiaiae* is morphologically close to *C. burchellii* because of the number of branches per branch complement (1--5 in *C. itatiaiae* X 1--4 in *C. burchellii*) and the size of blades of foliage leaves (5.1--8.9 cm long in *C. itatiaiae* versus 4.1--5.6 cm long in *C. burchellii*).

Phenology. This species was collected only in its vegetative state. Flowering material is quite desirable to better understand its true morphological affinities.

Distribution and habitat. Known only from the Brazilian state of Rio de Janeiro (Fig. 9) where it appears to be fairly frequent, especially in the Parque Nacional de Itatiaia and neighbouring areas. No flowering specimen has ever been collected.

Specimens examined: **BRAZIL**: **Rio de Janeiro**: Itatiaia, Parque Nacional de Itatiaia, 1,100m. 22^{o} 25' S, 44^{o} 37'S, trilha para a Cachoeira Véu da Noiva e Itaporani, 5 Nov. 2003 (veg.), Santos-Gonçalves et al. 565 (UEC, IBGE, ISC, RB, K, MBM, MO, SP, UFMG, US); idem, Santos-Gonçalves et al. 566 (ICN, R, SP, UEC, UFMG); idem, 12 Feb. 1990 (veg.), L. Clark et al. 672. (ISC, MO, NY, SJRP). Município de Macaé de Cima, Reserva Ecológica de Macaé de Cima, Sítio do David Miller, trilha do Bambu, 1572 m, 22^{o} 22' 25"S, 42^{o} 30' 17"W, 9 Mar. 2002 (veg.), Santos-Gonçalves et al. 477 (ISC, UEC, UFMG, US); idem, 1636m, 22^{o} 22' 26"S, 42^{o} 30' 20"W, 9 Mar. 2002 (veg.), Santos-Gonçalves et al. 478 (ICN, R, SP, UEC).

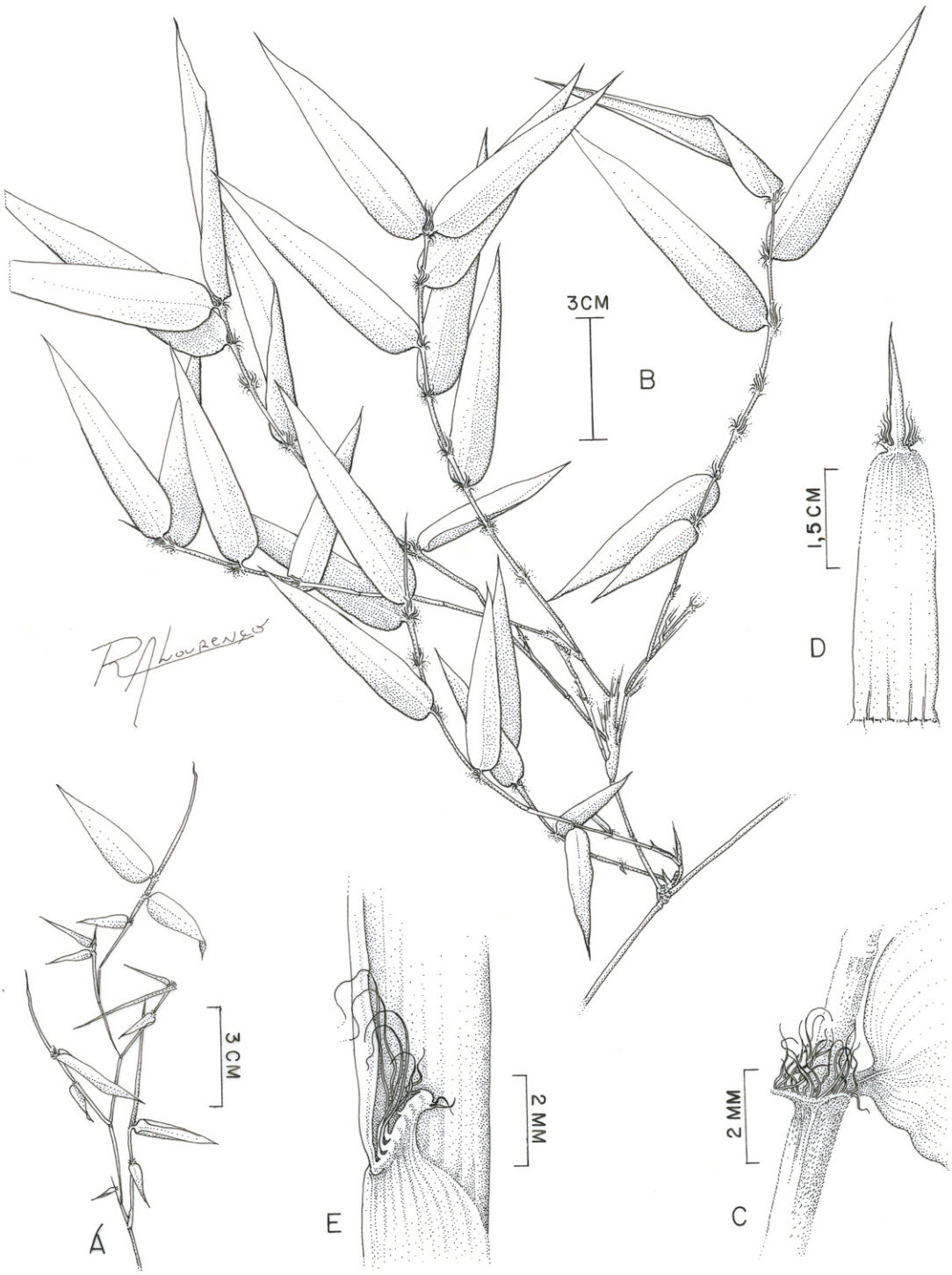
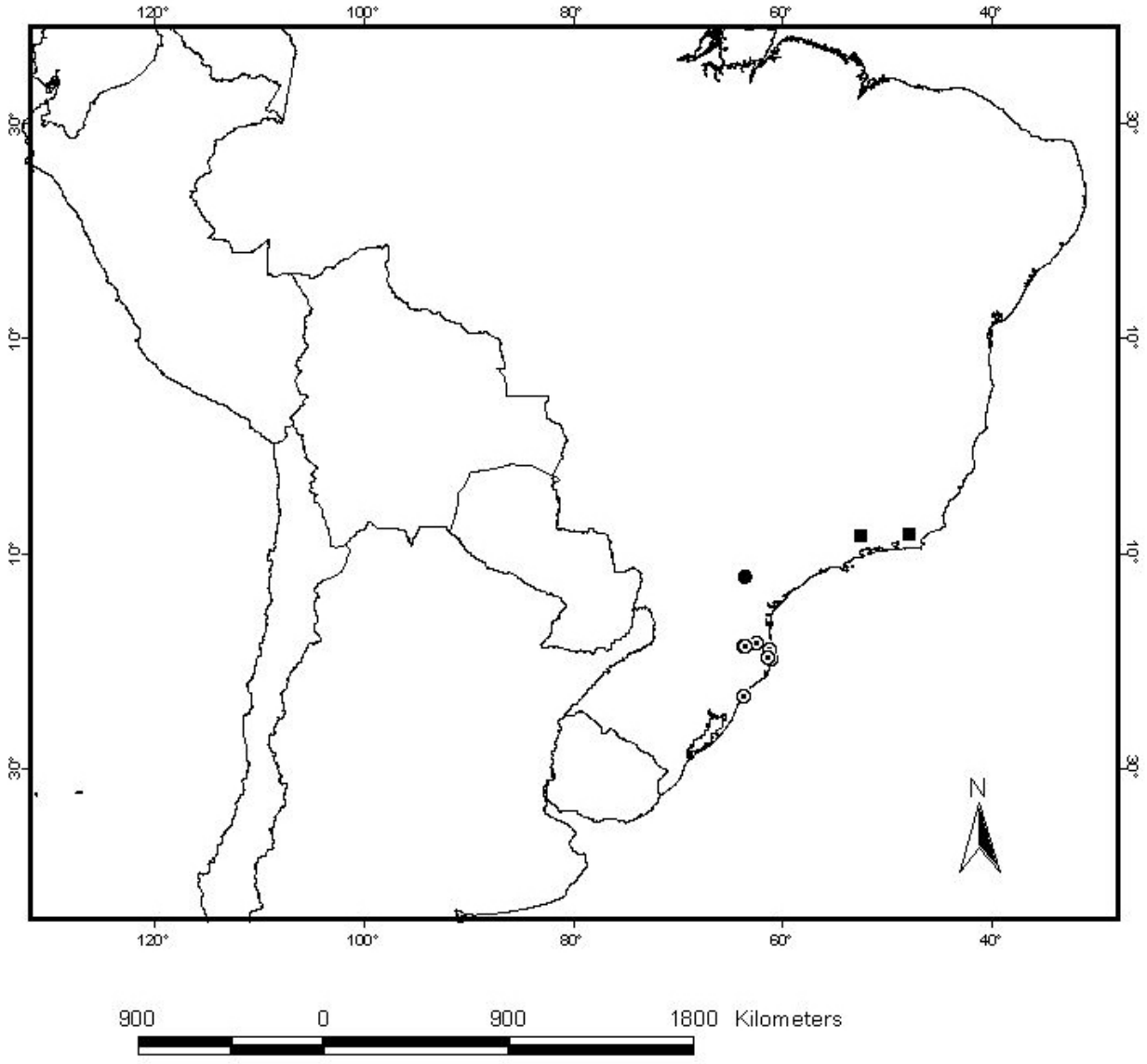


Figure 8. A-E. *Colanthelia itatiaiae* (based on *Santos-Gonçalves et al. 565*, *L. Clark et al. 672*). A. Apex of a vegetative culm terminanting in zig-zag. B. Branch complement in the vegetative state. C. Lateral appendages of the sheath of the foliage leaves. D. Culm leaves. E. Culm leaf in detail evidencing the lateral appendages of the sheath.

Figure 9. Distribution of the examined material of *Colanthelia* species



- *C. gracillima*
- *C. intermedia*
- *C. itatiaiae*

7. *Colanthelia lanciflora* (McClure & L. B. Sm.) McClure Smithsonian Contr. Bot. 9:79. 1973. *Aulonemia lanciflora* McClure & L. B. Sm., Fl. Il. Catarin. Gram. Suppl. Bambúseas: 47. 1967. Type: Brazil: Santa Catarina: Bom Retiro, Mato, 1600m, 15 Dec. 1948, *P. R. Reitz 2346* (holotype, US, not seen, photo!. isotype, HBR 3728!). Figure 10A-L. Synonym: *Chusquea effusa* Renvoize kew Bull., 42(4):924. 1987. Typus: Paraná, hatschbach 12098 (holotypus MBM; isotypus K).

Plants initially erect, becoming decumbent. Culms 2--3 m long, apex terminating in zig-zag. Internodes cylindric al to laterally compressed, green, glabrous, striate when young to papillose, 9--23 cm long, 3--7 mm in diam., wall thickened, lumen inconspicuous. Nodes of the lower portion sometimes rooting; supranodal line conspicuous; infranodal line conspicuous; intranodal area 3--12 mm long; promontory conspicuous; upper and lower portions of the internode glabrous. Culm leaves 10--24.8 cm long; sheaths 4.2--15.3 cm x 1.3--5.2 mm, sometimes persistent, glabrous, the margins not ciliolate, lateral appendages inconspicuous; girdle conspicuous, glabrous; blade reflexed, pseudopeciolate, early deciduous, 2--11.2 cm x 0.2--2.7 cm, glabrous on both surfaces; internal ligule membranous, 0.8--1 mm long; fimbriae 5--12 mm long, erect, straw-yellow. Branch complement with 2--9 branches, the branches 17--41 cm long, sometimes rebranching at the lower nodes; lower nodes sometimes geniculate. Foliage leaves 6--15 per branch; sheaths 2.2--3.8 cm x 2.4--5 mm, glabrous to puberulous on the abaxial surface, sometimes with a narrow line of puberulent trichomes, the margins ciliolate; lateral appendages conspicuous; internal ligule membranous, conspicuous, ciliate, 1--2 mm long, fimbriae 1.5--9 mm long, erect, light-brown; pseudopetioles 1.5--4 mm long, hispidulous on the adaxial surface,

glabrous on the abaxial, green to brown, sometimes sometimes purplish on both surfaces; blades lanceolate, 3--15.1 cm x 0.5--2.5 cm, the base round to slightly asymmetrical, apex acuminate, glabrous on the adaxial surface except for a narrow line of small hard trichomes on the base along one submarginal region; margins with angular prickle hairs. Synflorescence paniculate, densely ramified, 6--8 cm x 5--6 cm, with 5--19 branches; branches not secund, 1.1--2.7 cm long; pedicels 0.2--3.2 cm long, glabrous to glabrescent. Spikelets closely spaced, not secund, 6--10 mm long, 2--3 flowered; glumes 2, unequal, mucronate; lower glume 2.1--5 mm x 1--1.3 mm, 3-nerved, glabrous to puberulous on the abaxial surface; upper glume 4--5.5 mm x 1.9--2.2 mm, 5-nerved, glabrous; slightly navicular; lemma 4.5--6.4 mm x 2.2--3 mm, glabrous, mucronate, surface brown without dark spots to sometimes purplish; palea 5--6 mm x 2--3 mm, 2-nerved, glabrous to puberulous on the sulcus, awnless, surface brown without dark spots to sometimes purplish, 7-nerved, nerves sometimes inconspicuous. Lodicules 3, two similar one narrower, puberulent towards the apex. Stamens 3; anthers 3.3--3.5 mm, yellowish. Ovary 0.9--1 mm x 0.3-0.4 mm, puberulent towards the apex, light-yellow; style 1, glabrous to glabrescent, 0.3--0.4 mm; stigmas 2, slightly plumose, cream-colored. Caryopsis narrowly elliptic, 2.5--4 mm x 1--1.5 mm, brown to dark brown; hilum linear, as long as the caryopsis; embryo brown, 1/10--2/10 the length of the caryopsis.

Comments. The original publication (McClure & Smith, 1967) cited only the holotype, but an isotype was located at the Reitz's herbarium (HBR 3728). Two paratype collections (*Smith & Klein 7837*, *Reitz & Klein 17052*) were also examined.

In its vegetative state, *C. lanciflora* is closest to *C. longifolia* because of the diameter of the culm (3--7 mm in *C. lanciflora* versus 3.5--6.2 mm in *C. longifolia*), but it differs from it in the shorter blades of the foliage leaves (3.0--15.1 cm long in *C. lanciflora* versus 13.7--26.3 long in *C. longifolia*), by the glabrous culms (*C. longifolia* presents culms with tomentose-velvety ochre trichomes) and glabrous girdle (*C. longifolia* presents a girdle with hirtellous-hispid dark-brown trichomes). In the flowering state, this species is quite remarkable because of the densely branched synflorescence and the small number of anthoecia per spikelets (2-3). The species has a high ornamental value.

Phenology. This species was collected in flower in the south of Brazil in 1964, 1965, 1980 and 1996.

Distribution and habitat. *Colanthelia lanciflora* is known from the Brazilian states of Santa Catarina, Paraná, and Rio de Janeiro (Fig. 13), where it was collected in the interior or at the border of the Atlantic rainforest, sometimes near rivers.

Specimens examined. **BRAZIL**: **Paraná**: Balsa Nova, Serra São Luiz by the Rodovia de café, 1100 m, 25° 30'S, 49° 40'W, 14 Jan. 1965 (fl.), L.B. Smith, R. M. Klein & G. Hatschbach 14442 (MO, SP); idem, Serra São Luís do Purunã Rod. Br-277, 7 Oct. 1996 (fl.), I. Cordeiro & E. Barbosa 1315 (SPF); Idem, Alto Purunã, 25 Oct. 1980, (fl., fr.), G. Hatschbach 43238 & G. L. Smith (MO, ISC); idem, Alto Purunã, em beira de estrada, 25° 26' 23"S, 49° 41' 18"W, 07 Aug. 2003 (veg.), Santos-Gonçalves et al. 563 (IBGE, ISC, SP, UEC, UFMG, US). **Rio de Janeiro**: Macaé de Cima, Estrada Dona Castourina, ca. 5 km próximo à guarita, 410 m, 22° 57'S, 43° 15'W, 28 Feb. 1994 (veg.) L. S. Sarahyba, L. Clark & M. Alves da Silva 1065 (ISC, MO, NY). Teresópolis, Parque Nacional da Serra dos Órgãos, trail to Pedra do Sino, 43° 01'W,

22° 27'S, 2000 m, 11 Feb. 1991 (veg.), L. Clark, M. Morel & L. S. Sarahyba 794 (ISC, NY, SJRP); idem, Santos-Gonçalves et al. 494; idem, Santos-Gonçalves et al. 495. Rio de Janeiro, Guanabara, Silvestre Corcovado, ca. 200 m, 18 Nov.1964 (fl.), T. R. Soderstrom 1175 (ISC, NY). **Santa Catarina**: Bom Retiro, Between Fazenda Santo Antônio and the falls of the Rio Canoas, Campo dos Padres, 1300-1400 m, 22 Nov. 1956 (fl.), L. B. Smith & R. Klein 7837 (RB, NY, R). Rio do Sul, Alto Matador, 800 m, 07 July 1964 (fl.), Reitz & Klein 17.052 (NY, HBR); idem, Beira de Cachoeira, interior de mata, 27° 14' 49"S, 49° 33'45.5"W, 5 Aug. 2003 (veg.), Santos-Gonçalves et al. 558 (IBGE, ISC, SP, UEC, US).

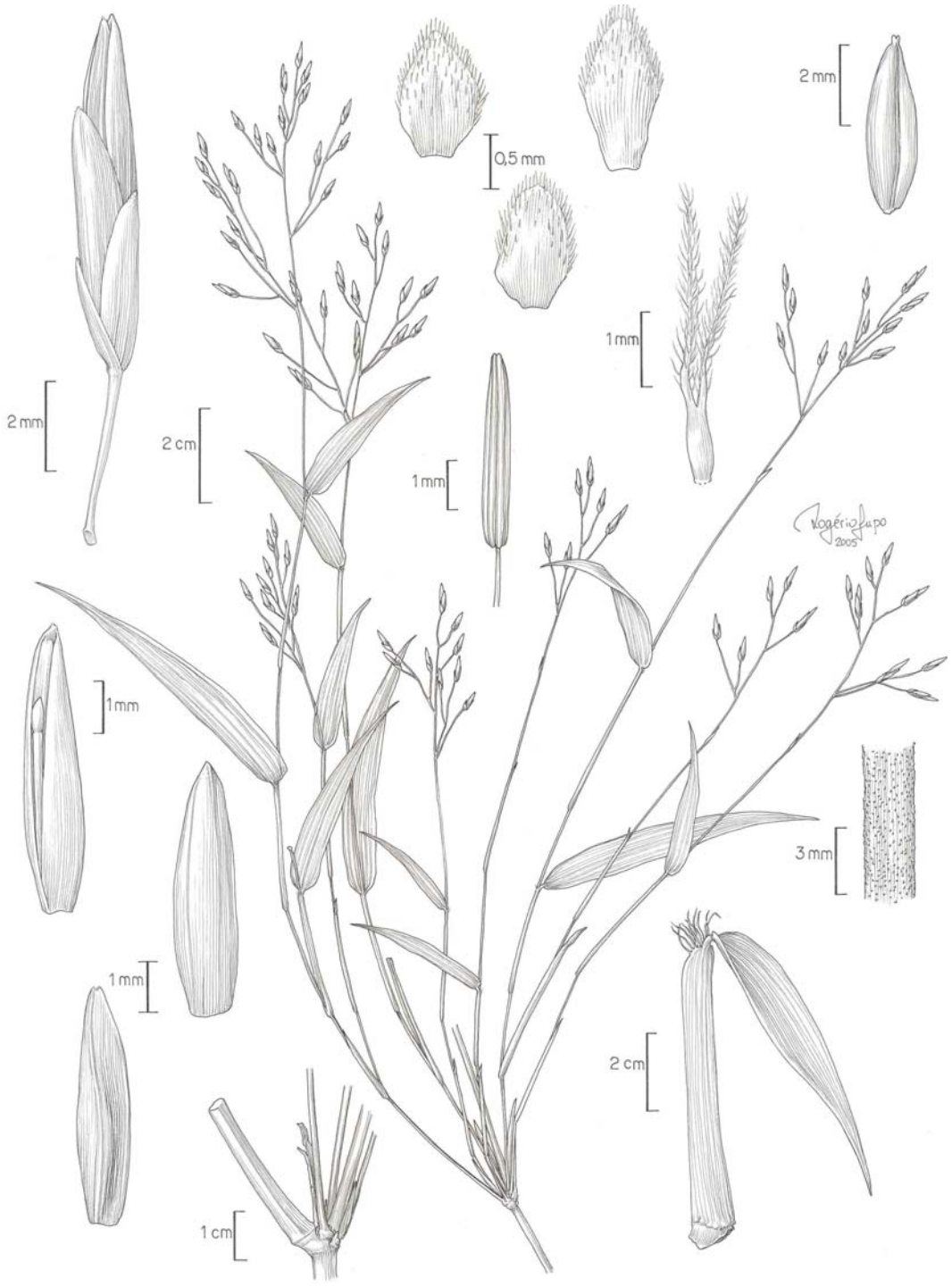


Figure 10. A-L. *Colanthelia lanciflora* (based on *Santos-Gonçalves et al. 563 I. Cordeiro & E. Barbosa 1315*). A. Branch complement in the floriferous state. B. Base of the branch in detail. C. Papillose surface of the culm. D. Culm leaf. E. Spikelet. F. Terminal anthoecium with a reduced spikelet. G. Lemma. H. Palea. I. Lodiculae. J. Stamen. K. Gynoecium. L. Caryopsis.

8. *Colanthelia longifolia* Santos-Gon. & Filg., sp. nov. INED.Type: Brazil. Espírito Santo: Linhares, Reserva Natural da Vale do Rio Doce, 19º 23' 27.96"S, 40º 4' 19.92"W, Estrada Jacarandá próximo ao Aceiro da Aracruz, ca. 60m, 14 Oct. 2002 (veg.), *Santos-Gonçalves et al. 510* (holotype, UEC!; isotypes IBGE!, ISC!, K!, MBM!, MO!, SP!, RB!, UEC!, UFMG!, US!). Figure 11A-G.

Plants initially erect then becoming scandent to clambering. Culms 6-7 m long, apex terminating in zig-zag. Internodes cylindrical, green, glabrous, smooth, 14--81 cm long, 3.5--6.2 mm in diam., wall thickened, lumen inconspicuous. Nodes of the lower portion not rooting; intranodal area 0.5--0.7mm long; promontory conspicuous; upper and lower portions of the internode when young with tomentose-velvety ochre trichomes. Culm leaves 12.1--38.6 cm long; sheaths 8--21 cm x 5--8 mm, sometimes persistent, glabrous, margins densely ciliate, lateral appendages null; girdle conspicuous, 3.15--6.54 mm long, with hirtellous-hispid dark-brown trichomes; blades erect at first and then reflexed, pseudopetiolate, readily deciduous, 4.1--9.6 cm x 3--7 mm, glabrous on both surfaces; margins with prickle hairs; internal ligule membranous, 0.3--0.4 mm long; fimbriae 1.1--2,2 cm long, erect, dark brown. Branch complement with 1-3 branches, the branches 16--44 cm long, sometimes rebranching at the lower nodes; lower nodes sometimes geniculate. Foliage leaves 6--15 per branch; sheaths 3.5--6.5 cm x 8--11 mm, glabrous on the abaxial surface, margins densely ciliolate; lateral appendages null; internal ligule membranous, 0.4--0.5 mm long; fimbriae 0.8--1.3 cm long, erect, dark brown; pseudopetioles 3--5 mm long, with hispid, brown trichomes on the adaxial surface, glabrous on the abaxial surface, dark brown; blades lanceolate, 13.7--26.3 x 2.1--4.3 cm, the base asymmetrical, apex

acuminate, glabrous on the adaxial surface, except for a narrow submarginal stripe of brown small hard trichomes at one side of the base, glabrescent on the abaxial surface; margins with angular prickle hairs. Synflorescences not seen.

Comments. The species is known only in its vegetative state. Vegetatively, *C. longifolia* is closest to *C. lanciflora* because of the diameter of the culm (3.5--6.2 mm in *C. longifolia* versus 3--7 mm in *C. lanciflora*), but it differs from it because of the longer blades of the foliage leaves (13.7--26.3 long in *C. longifolia* versus 3--15.1 cm long in *C. lanciflora*), by the occurrence of tomentose-velvety ochre trichomes on the young internodes, and the conspicuous girdle, provided with hirtellous-hispid dark-brown trichomes.

Phenology. This species was only collected in its vegetative state, in Atlantic rainforest in the habitat called "Restinga arbórea" (arboreal restinga).

Distribution and habitat. Known only from the Brazilian state of Espírito Santo (Fig. 13).

Specimens examined. **Brazil: Espírito Santo**: Município de Linhares, Reserva Natural da Vale do Rio doce, 19^{o} 23’ 27.96”S, 40^{o} 4’ 19.92”W, ca. 60m, Estrada Jacarandá, próximo ao Aceiro da Aracruz, 14 Oct. 2002 (veg.), Santos-Gonçalves et al. 510 (HT: UEC; IT: IBGE, ISC, K, MBM, MO, RB, SP, UFMG, US); idem, 14 Oct. 2002 (veg.), Santos-Gonçalves et al. 511 (IBGE, K, R, SP, UEC, US); idem, Estrada Jureiana Vermelha, próximo ao km 1,5, 14 Oct 2002 (veg.), Santos-Gonçalves et al. 513 (ICN, K, MO, SP, UEC, UFMG).

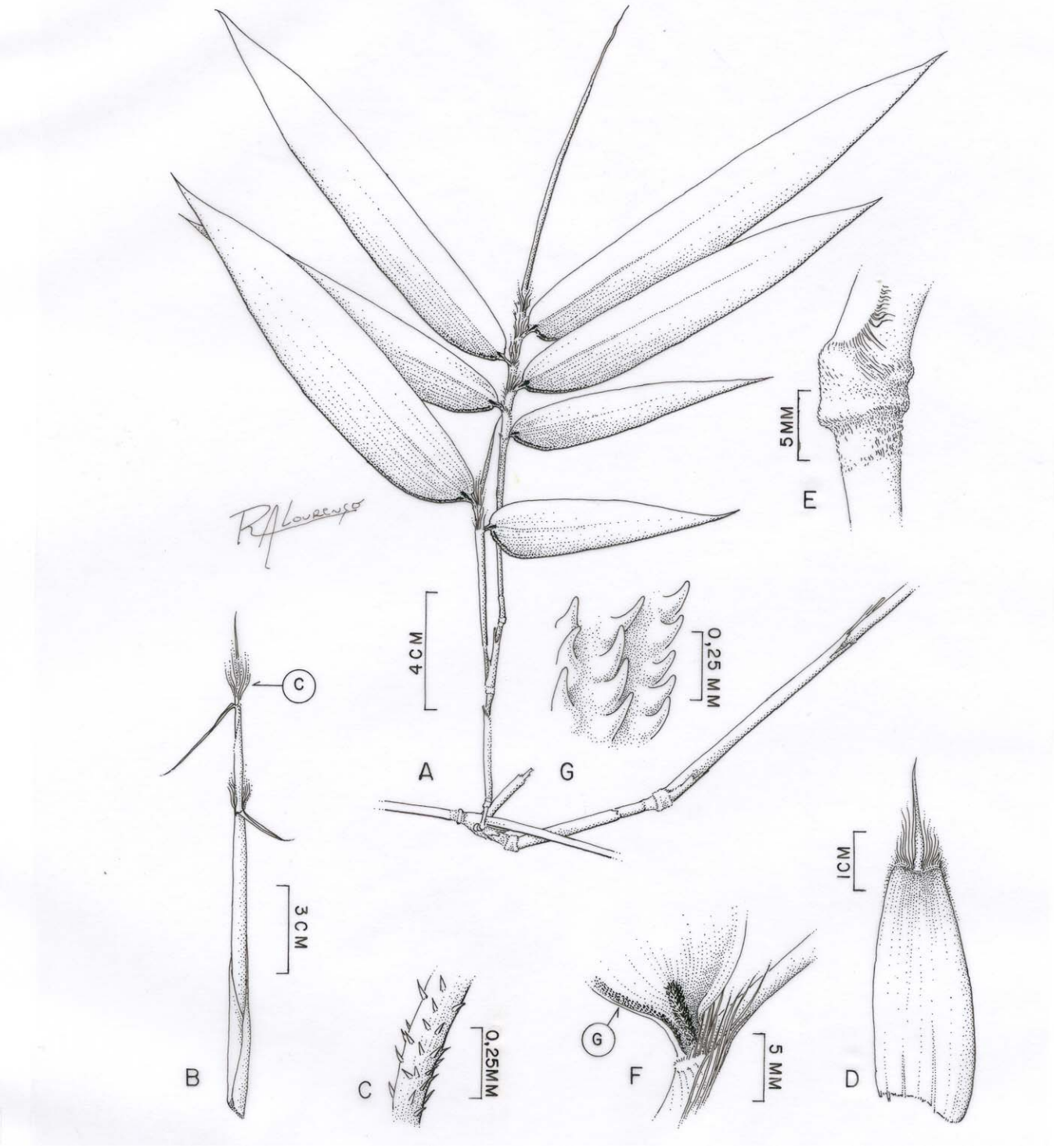


Figure 11. A-G. *Colanthelia longifolia* (based on *Santos-Gonçalves et al. 510*). A. Branch complement in the vegetative state. B. Apex of a young culm. C. Fimbriae in detail. D. Culm leaf. E. Nodal region. F. Blade of a foliage leaf evidencing the trichomes of the submarginal stripe and the hispid trichomes on the adaxial surface of the pseudopetiole. G. Short, hard trichomes in detail.

9. *Colanthelia macrostachya* (Nees) McClure, Smithsonian Contr. Bot. 9:79. 1973. *Arundinaria macrostachya* Nees, Linnaea 9 (4): 481. 1834. Type: Brazil: In Brasilia, [lignified ?], Sellow s. n., s. a. (holotype, B, not seen; isotype, US- 2809017 not seen, photo!, US-557550, not seen, photo!, LE, not seen). Figure 12A-I.

Plants known only by fragments. Apex termination not seen. Internodes cylindrical, green, glabrous, smooth to papillose, 16--18 cm long, 2.5--4 mm in diam., wall thickened, lumen inconspicuous. Nodes of the lower portion taking root; supranodal line conspicuous; infranodal line conspicuous; intranodal area 2--3,5 mm long; promontory conspicuous; upper and lower portions of the internode glabrous. Entire culm leaves not seen; sheaths known just by fragments; blades not seen.
Branch complement with 2--10 branches, the branches 12--20 cm long, sometimes rebranching at the lower nodes; lower nodes sometimes geniculate. Foliage leaves 6--9 per branch; sheaths 1.8--2.5 cm x 1.5--1.8 mm, glabrous on the abaxial surface, margins not ciliolate; lateral appendages null; internal ligule membranous, 0.1--0.2 mm long; fimbriae 2--4 mm long, erect to slightly spreading, light-brown; pseudopetioles 1--1.5 mm long, glabrous on both surfaces, light green on both surfaces; blades lanceolate, 6--8 cm x 5.5--8 mm, the base round to slightly asymmetrical, apex acuminate, glabrous on both surfaces; margins with angular prickle hairs. Synflorescence racemose to paniculate, terminal, 3.5--4 x 4--4.5 cm, with 4--10 branches; branches not secund, 2.0--3.4 cm long; pedicels 1--7 mm long, glabrous to puberulous. Spikelets closely spaced, not secund, 9-12cm long, 5--11 flowered; glumes 2, unequal, mucronate; lower glume 2.8--3 x 1.5--2 mm, 3-nerved,

puberulous ,towards the apex; upper glume 3.3--3.6 x 1.8--2.2 mm, 5-nerved, occasionally few scattered hairs at the tip; anthoecium slightly; lemma 6--7 x 2--3 mm, glabrous, mucronate, surface brown without dark spots, 5--7-nerved, nerves inconspicuous or conspicuous; palea 6--6.8 mm x 1.8--2.2 mm, 2-nerved, glabrous with a line of hairs at the neves, surface brown without dark spots. Lodicules 3, thick, puberulous towards the apex. Stamens 3; anther 3--3.5 mm. Ovary 1--1.5 x 0.3--0.4 mm, puberulous towards the apex, light-yellow; style 1 puberulous, 0.1--0.2 mm; stigmas 2, slightly plumose, light yellow. Caryopsis narrowly elliptic, 6--6.5 mm x 1.2--1.6 mm, light brown; hilum linear, as long as the caryopsis; embryo brown, ca. 1/10--2/10 the length of the caryopsis.

Comments. The holotype of *Arundinaria macrostachya* (B) was not examined, but a photo of one isotype deposited at US (US-2809017) was. This photo shows two small fragments and two large photos of two flowering specimens. According to a note in Chase's script, the two fragments shown on this photo (US-2809017) were taken from a specimen from Trinius´ herbarium (LE).

Colanthelia macrostachya is morphologically close to *C. intermedia* because of the number of anthoecia per spikelet (5--11 in *C. macrostachya* versus 5--16 in *C. intermedia*) but differs from it because of the length of he spikelets (9--12 cm in *C. macrostachya* x 1.8--6.2 cm in *C. Intermedia*)

Phenology. The plants were collected in flower in 1891, 1920, and 1990. The type collection, a flowering specimen, bears no collecting date. This long collecting interval does not allow any conclusion regarding its flowering cycle.

Distribution and habitat. *Colanthelia macrostachya* is known only from the Brazilian states of Rio de Janeiro and São Paulo (Fig. 13), in forest habitat. The origin of the type specimen (Sellow s. n.), is not certain, but it appears to come from Rio de Janeiro because that is where the majority of Sellow´s collections from Brazil come from. Likewise, the collections cited below as without locality (s.l.), probably originated in the state of Rio de Janeiro. No specimen from the Brazilian state of São Paulo was examined, and the occurrence of *C. macrostachya* in this state was only based on the literature (Clark, 2001).

Specimens examined. **BRAZIL**: **Rio de Janeiro**: Alto Macaé, 21 Nov. 1891 (fl.), A. Glaziou s.n. (F 18648); (antiga Guanabara), [old name for the state of Rio de Janeiro], Morro do Bico do Papagaio, João Borges, reserva de mata secundária do Horto Florestal, 14 Jun. 1990 (fl., fr.), Sucre 5293 (RB). Idem, s.l., Jun. 1920 (fl.), Kuhlmann 1920 (RB); idem, s.l., s.d.,(fl.), s. col., (RB 44.497); idem, s.l., s.d., (fl.), s. col. (RB 44.489); idem, s.l., s.d., (fl.), s. col. (RB 44.491).

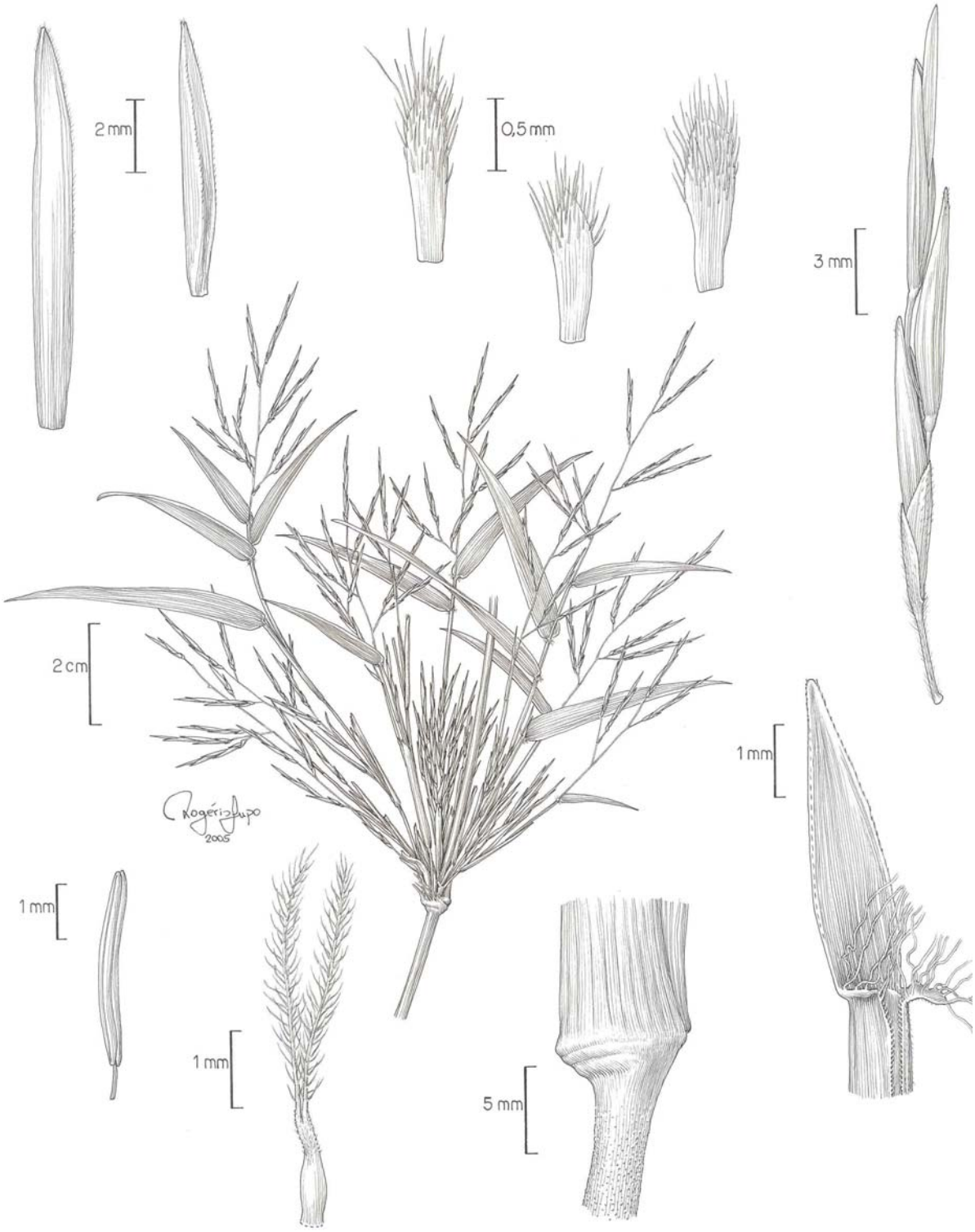
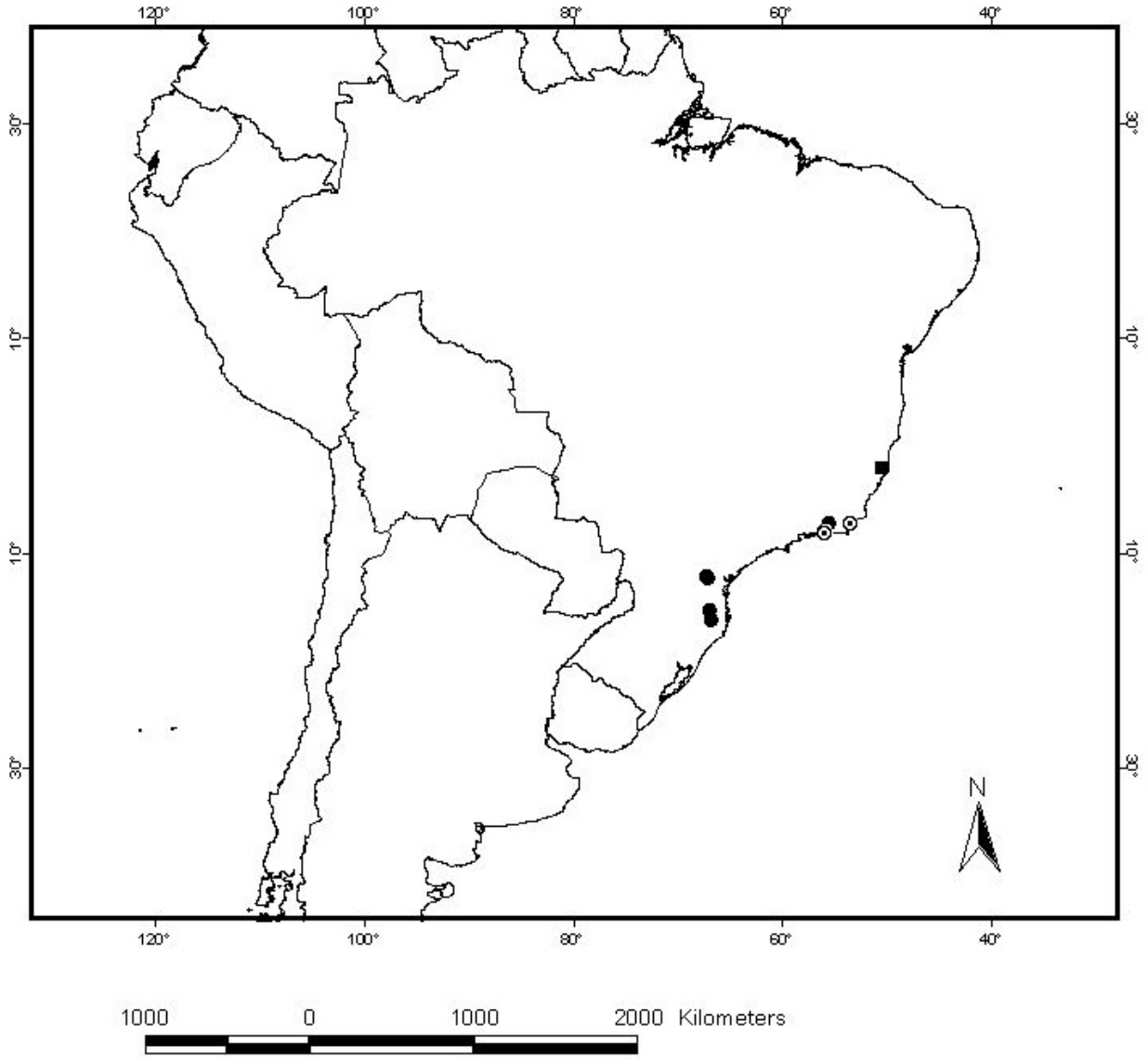


Figure 12. A-I. *Colanthelia macrostachya* (based on *Kuhlmann 1920*). A. Branch complement in a floriferous state. B. Detail of the girdle and of the papillose culm. C. Apex of the sheath of culm leaf. D. Spikelet. E. Lemma. F. Palea. G. Lodicules. H. Stamen. I. Gynoecium.

Figure 13. Distribution of the examined material of *Colanthelia* species



- *C. lanciflora*
- *C. longifolia*
- *C. macrostachya*

10. *Colanthelia rhizantha* (Hack.) McClure, Smithsonian Contr. Bot. 9:79. 1973. *Arundinaria rhizantha* Hack., Repert. Spec. Nov. Regni Veg., 7: 323. 1909. Type: Brazil: Rio Grande do Sul, Rio Pardo, Prope Fasenda [Fazenda] Soledade, 100m s. m., Sept. 1906, *C. Jürguens 314*. (holotype, W, not seen; isotype, US-865389, not seen, photo!) Figure 14A-F.

Habit unknown. Culms ca. 1-3 m long, apex not seen. Internodes cylindrical, green, glabrous, slightly striate, 8.4--13 cm long, 2--3.5 mm in diam., wall thickened, lumen inconspicuous. Nodes of the lower portion not seen; supranodal line conspicuous; infranodal line conspicuous; intranodal area 2--3 mm long; promontory conspicuous; upper and lower portions of the internode glabrous. Culm leaves known just by fragments; girdle conspicuous, only known by fragments, glabrous. Branch complement with 4--8 branches, the branches 9--20 cm long, sometimes rebranching at the lower nodes; lower nodes sometimes geniculate. Foliage leaves 5--8 per branch; sheaths 1.8--2 cm x ca.1.5 mm, puberulous on the abaxial surface when young, margins ciliolate; lateral appendages null; internal ligule membranous, apparently inconspicuous (less than 0.1 mm long); fimbriae 3--4 mm long, erect, light-brown; pseudopetioles ca. 1 mm long, glabrous to glabrate on both surfaces, light brown on both surfaces; blades lanceolate, 4--6 cm x 4--6 mm, the base round, apex acuminate, glabrous to glabrescent on the adaxial surface except by a narrow line of small hard brown trichomes along one margins towards the apex; margins with angular prickle hairs. Synflorescence paniculate, terminal, 3--4.5 cm x 3--4 cm, with 4--6 branches; branches not secund, 1.6--3.5 cm long; pedicels 3--9 mm long,

puberulous. Spikelets closely spaced, not secund, 1.3--3.1 cm long, 1--6-flowered; glumes 2, unequal, awnless; lower glume 2.5 --3.5 x 1.0--1.2 mm, 3-nerved, puberulous towards the apex; upper glume 4--6 mm x 1.4--1.6 mm, 3-nerved, puberulous towards the apex; anthoecium slightly navicular; lemma 7--8 mm x 6--7 mm, puberulous towards the apex, awnless, surface light-brown without dark spots, 5-7-nerved, nerves sometimes inconspicuous; palea 3--4 mm x c 3 mm, 2-nerved, puberulous towards the apex, surface light-brown without dark spots. Lodicules 3, thin, with a few scattered hairs at the tip. Stamens 3; anther ca. 2 mm, light-yellow. Ovary ca. 0.5 x ca. 0.3 mm, puberulous towards the apex, light cream; style 1, pubescent, 0.9--1 mm; stigmas 2, plumose, light cream. Caryopsis not seen.

Comments. Only a photo of an isotype of *Arundinaria rhizantha* was examined, but it was sufficient to verify that it agrees with the original description (Hackel, l.c.). Although there are several specimens of this species available in different herbaria, it is only partially known: there is no information either on its habit nor on its caryopsis. More field work is still necessary to fill the missing data on its morphological characterization.

Colanthelia rhizantha is morphologically close to *C. macrostachya* because of the type of synflorescences, pedicelled spikelets, and general spikelet morphology. They differ principally because of the more or less reflexed spikelets in *C. macrostachya* as pointed out by Nees (1835) in the original description, versus spikelets straight in *C. rhizantha*. The number of anthoecia per spikelet can also be used to separate them, because *C. rhizantha* has 1-6 anthoecia per spikelet, whereas *C. macrostachya* has 5-11.

Phenology. In Brazil, *C. rhizantha* was collected in flower (Glaziou, 1891; Jürgens, 1906; Londoño et al., 1992). According to Agrasar & Clark (2000), in Argentina it was collected in flower in 1992, 1995 and 1996.

Distribution and habitat. In Brazil, *C. rhizantha* occurs in the states of Rio Grande do Sul, and Rio de Janeiro (Fig.17). In Argentina, it occurs in the Province of Misiones. (Fig. 17). This apparently disjunct occurrence seems to be probably due to absence of field work.

Specimens examined. **ARGENTINA**: **Misiones**: Dpto. Libertador Gral San Martín: Salto Andresito, 26^{o} 12'S 53^{o} 40'W, 15 Feb. 1996 (fl.), Morrone et al. 856 (NY). **BRAZIL: Rio de Janeiro**: Alto Macaé [Macaé de Cima], 21 Nov. 1891 (fl.), Glaziou 18648 (F, P-photo); Macaé de Cima, Reserva Ecológica, 1030m, a 1,5 km de la casa sede del proyecto "Macaé de Cima", 9 Mar. 1992 (fl.), X. Londoño & S. Sarahyba 722 (NY, ISC); s.l., s. a., s. col., RB, 44.491/44.497 (fl.); s.l., s. a., s.col., RB 44.489 (fl.).

Figure 14. A-F. *Colanthelia rhizantha* (based on *Morrone et al. 856*). A. Branch complement in the floriferous state. B. Nodal region showing fragments of the girdle. C. Part of a spikelet. D. Lemma. E. Palea. F. Stamen.

11. *Colanthelia secundiflora* Santos-Gon. & L. G. Clark, sp. nov. INED.Type: Brazil: São Paulo: Município de Itanhaém, Parque Estadual da Serra do Mar, Núcleo Curucutu, 23° 59' 44"S, 46° 44' 13" W, Trilha do Mambu, 14 Apr. 2001 (fl., fr.), *Santos-Gonçalves et al. 353* (holotype, UEC!; isotypes, IBGE!, ISC!, RB!, K!, MBM!, MO!, SP!, UFMG!, US!). Figure 15A-K.

Plants creeping, clambering to climbing. Rhizome short pachymorph. Culms 1-6 m long, apex terminating in slight zig-zag. Internodes cylindrical, green, glabrous, smooth, 9--21.5 cm long, 1.--2.4 mm in diam., wall thickened, lumen inconspicuous. Nodes of the lower portion sometimes rooting; supranodal line conspicuous; infranodal line conspicuous; intranodal area 2--3 mm long; promontory inconspicuous; upper portion of the internode glabrous; lower portion of the internode glabrous. Culm leaves 5.1--7.2 cm long; sheaths 3.2--4 cm x 5--8 mm, deciduous, glabrous, margins ciliolate, lateral appendages null; girdle inconspicuous, glabrous; blade erect, continuous with the sheath, falling as a unit, 2.6--3.1 cm x 10--15 mm, glabrous on both surfaces; internal ligule membranous, 0.5--0.6 mm long; external ligule null; fimbriae 3.5--4 mm long, erect, straw-yellow. Branch complement with 1--4 branches, the branches 10--25 cm long, sometimes rebranching at the lower nodes. Foliage leaves 3--21 per branch; sheaths 8--10 mm x-1.5--2 mm, puberulent in the adaxial surface when young, margins ciliolate; lateral appendages null; internal ligule membranous, inconspicuous (less than 0.1 mm long); fimbriae 3--5 mm long, erect, light-brown; pseudopetioles 1--1.5 mm long, hispidulous on both surfaces; blades lanceolate, 2.5--6.6 cm x 4--8 mm, the base round, apex acuminate, glabrous in both surfaces except for a narrow line of hispid trichomes along one margin of the stripe;

margins with prickle hairs. Synflorescence racemose, 1.5--4 cm x 1--2.5 cm, with 3-7 branches; branches secund, 1.8--2.8 cm long; pedicels 1--3 mm long, puberulent. Spikelets closely spaced, secund, 1.7--2.7 cm long, 2-6-flowered; glumes 2, subequal, mucronate; lower glume 2--3.5 mm x 1.2--1.5 mm, 1-nerved, puberulent towards the apex; upper glume 3.2--4 mm x 1.2--2 mm, 1-nerved, puberulent towards the apex; anthoecium navicular; lemma 6--7 mm x 2.2--2.4 mm, puberulent, surface brown with dark spots, 5-nerved, nerves inconspicuous; palea 5.5--6.3 mm x 2--2.2 mm, 2-nerved, puberulent, surface brown with dark spots. Lodicules 3, two similar one narrower, thin, glabrous, transparent, with a few scattered hairs at the tip. Stamens 3; anther 3.1--4 mm long, yellowish. Ovary 0.3--0.4 mm x 0.1--0.15 mm, glabrous, light-yellow; style 1, glabrous, 0.5--0.7 mm; stigmas 2, plumose, light-yellow. Caryopsis narrowly elliptic, ca. 3 x 4 mm, light brown; hilum linear, as long as the caryopsis; embryo brown, ca. 1/10 the length of the caryopsis.

Comments. *Colanthelia secundiflora* is morphologically close to *C. gracillima* by the number of branches of the branch complement, the small size of blades of foliage leaves, the fimbriate culm leaves without lateral appendages and the small number of anthoecia per spikelet. However, it differs from it because of the secund branches of the synflorescence, the lower length of the pedicels of the spikelets and by the anthoecia with dark spots. This species is one of the most delicate in the genus. It has a clear potential as an ornamental species.

Phenology. This species was collected in flower in April 2001, and in February 2002 at the same locality . The two dates probably suggest a long flowering cycle for *C. secundiflora*.

Distribution and habitat: Known only from the Brazilian state of São Paulo (Fig. 17), in "Parque Estadual da Serra do Mar", in Atlantic rainforest, in two contrasting vegetation types, i.e., "Florestas Montanas" (mountain forest) and "Campos de Altitude" (high plateau with open field formation).

Specimens examined. **BRAZIL**: **São Paulo**: Itanhaém, Parque Estadual da Serra do Mar, Núcleo Curucutu, 23° 59' 44"S, 46° 44' 13"W, Trilha do Mambu, Santos-Gonçalves et al. 352 (IBGE, UFMG); idem, trilha do Mirante, 13 Feb. 2002 (fl.), Santos-Gonçalves et al. 372 (ISC, SP, UEC); idem, trilha do Mirante, 13 Feb. 2002 (st), Santos-Gonçalves et al. 377 (RB, SJRP, UEC); idem, trilha do Mirante, 13 Feb. 2002 (fl.) Santos-Gonçalves et al. 378 (UFMG, UEC); idem, trilha à direita do Marco, 15 Feb 2002 (fl.), Santos-Gonçalves et al. 384 (IBGE, UEC); idem, Mata à esquerda da Estrada de Entrada, 15 Feb. 2002 (fl.), Santos-Gonçalves et al. 385 (RB, UEC); idem, Mata à esquerda da Estrada de Entrada, 15 Feb. 2002 (fl.), Santos-Gonçalves et al. 386 (ISC, UEC); idem, Mata à esquerda da Estrada de Entrada, 15 Feb. 2002 (fl.), Santos-Gonçalves et al. 387 (ISC, US, UEC).

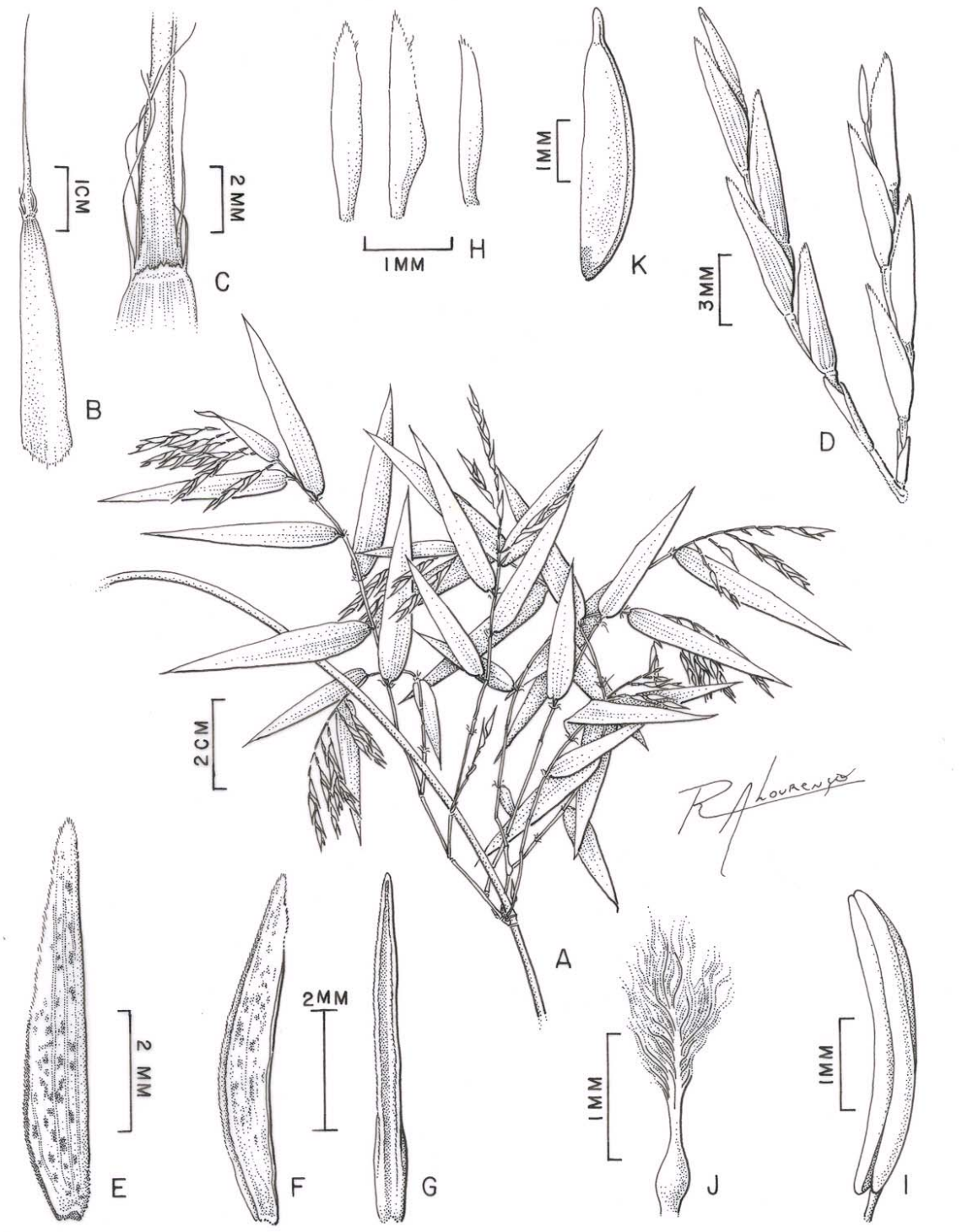


Figure 15. A-K. *Colanthelia secundiflora.* (based on *Santos-Gonçalves et al. 353*). A. Branch complement in the floriferous state. B. Culm leaf, abaxial side. C. Culm leaf in detail showing the fimbriae and internal ligule. D. Spikelets. E. Lemma. F-G. Palea. H. Lodiculae. I. Stamen. J. Gynoecium. K. Caryopsis.

12. *Colanthelia sparsiflora* Santos-Gon. & Filg., sp. nov. INED.Type: Brazil: Espírito Santo, Santa Tereza, cabeceira do Rio Bonito, 19º 50' 8.16"S, 40º 36' 1.08"W, 9 Oct. 2002 (veg.), *Santos-Gonçalves et al. 496* (holotype, UEC!; isotypes, IBGE!, ISC!, MO!, SP!, UFMG!, US!,). Figure 16A-K.

Plants initially erect, then becoming decumbent to clambering. Culms 5-6 m long, apex terminating in zig-zag. Internodes cylindrical, green, glabrous, striate, 14.3--21 cm long, 1.8--3.8 mm in diam., wall thickened, lumen inconspicuous. Nodes of the lower portion sometimes rooting; intranodal area 3--7 mm long; promontory inconspicuous; upper and lower portions of the internode glabrous. Culm leaves 5.3--7.8 cm long; sheaths 2.8--3.8 cm x 4.5--5 mm, sometimes persistent, glabrescent on the abaxial surface, margins ciliolate, lateral appendages conspicuous; girdle inconspicuous, glabrous; blade first erect then reflexed, readily deciduous, pseudopetioles 2.5--3.9 cm x 6--7 mm, glabrous on both surfaces; margins with prickle hairs; internal ligule membranous, 0.2--0.3 mm long; external ligule inconspicuous (less than 0.1 mm long); fimbriae 5--12 mm long, erect, spreading, purplish becoming brown. Branch complement with 1--5 branches, the branches 23--45 cm long, sometimes rebranching at the lower nodes; lower nodes sometimes geniculate. Foliage leaves 6--12 per branch; sheaths 2.2--3.5 cm x 3--5 mm, glabrous on the adaxial surface, margins glabrous; lateral appendages inconspicuous; internal ligule membranous, 1.5--2 mm long; fimbriae 4--9 mm long, spreading, purplish becoming brown; pseudopetioles 2--3 mm long, hispidulous on the adaxial surface, glabrous on the abaxial, dark-purple on both surfaces; blades lanceolate, 7.5--17.8 cm x 1.7--3.0 cm, the base asymmetrical, apex acuminate, glabrous on both surfaces,

except for a narrow stripe of brown prickles along one submarginal side of the base; margins with angular prickle hairs. Synflorescences racemose, terminal and lateral, 7.1--12.9 cm long, with 4--7 branches; branches not secund, glabrous, 1.5--2.5 cm long; pedicels 0.8--1.5 mm long. Spikelets widely spaced, not secund, 1.4--2.3 cm long, 2--4 flowered; glumes 2, unequal, reduced to scales, 1-2 mm each, sometimes with a few hairs scattered at the tip, nerves inconspicuous; anthoecium slightly navicular; lemma 0.5--1.6 cm x 2.5--3.2 mm, puberulent toward the apex, awnless, surface brown with dark spots, 5--7 nerved, nerves inconspicuous; palea 0.5--1.4 cm x 2.3--2.6 mm, 2-nerved, puberulent on the sulcus, glabrescent on the margins, surface brown. Lodicules 3, two similar, one narrower, thick, tomentose, brown. Stamens 3; anther ca. 5.5 mm. Ovary ca. 4 mm x 0.2 mm, pubescent, light-yellow; style 1, puberulous, c 0.1 mm; stigmas 2, light yellow, slighty plumose. Caryopsis narrowly elliptic, 6--7 x 1 --1.5 mm, light brown; hilum linear, as long as the caryopsis; embryo brown, ca. 1/10--2/10 the length of the caryopsis.

Comments. *Colanthelia sparsiflora* is morphologically close to *C. distans* because of the synflorescences with short branches, which are widely separated from each other, the prominent internode lower to the first anthoecium, and the much reduced basal glumes.

Phenology. This species was collected in late flowering state in October 2002.

Distribution and habitat: Known only from two collections, both from the Brazilian state of Espírito Santo (Fig. 17). The habitat is Atlantic forest s.l. (“Floresta mesofítica”).

Specimens examined: **BRAZIL**: **Espírito Santo**: Santa Tereza, Cabeceira do Rio Bonito, 19º 50' 8.16"S, 40º 36' 1.08"W, 9 Oct. 2002 (veg.), Santos-Gonçalves et al. 497 (IBGE, ICN, K, MO, R, UFMG, UEC).

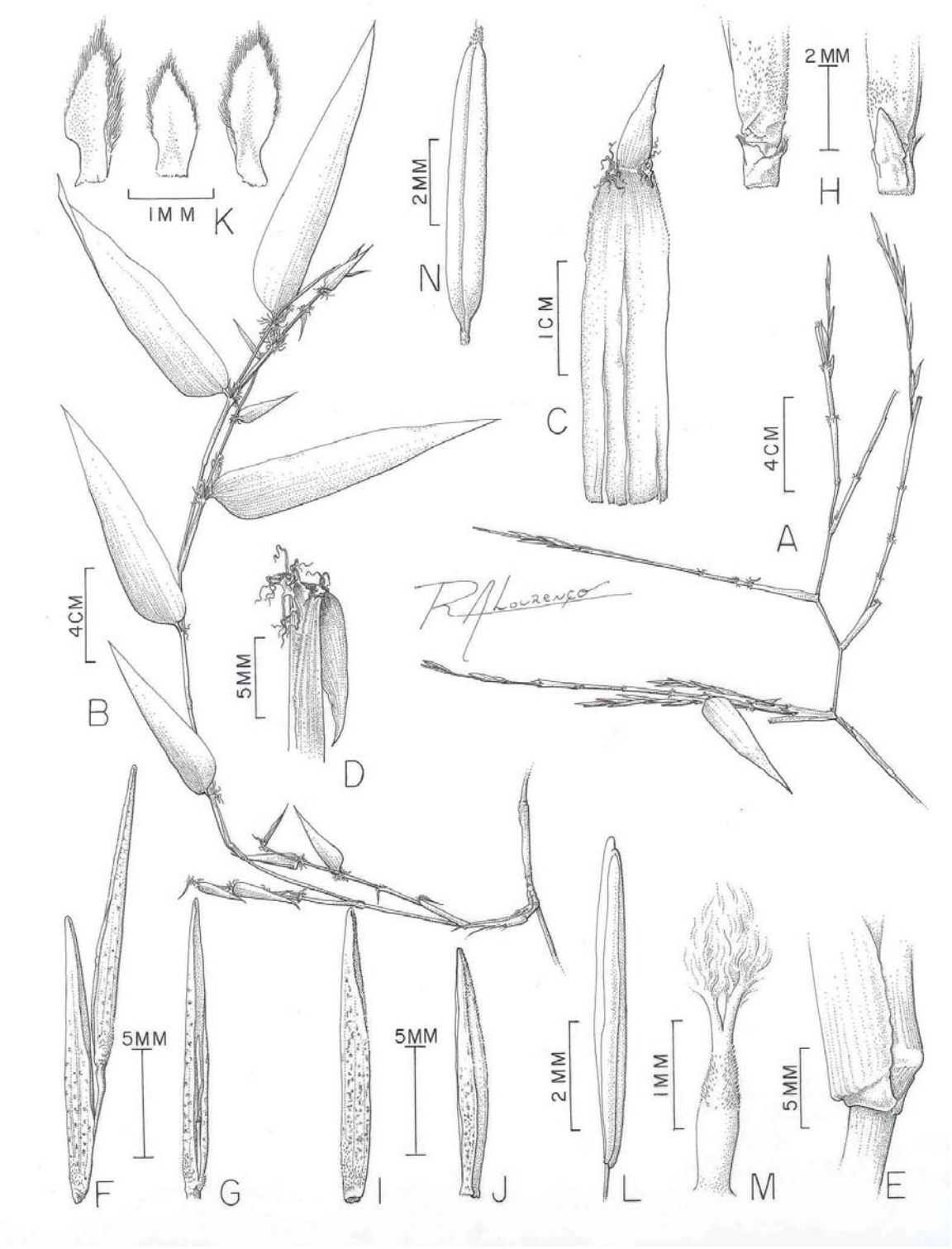
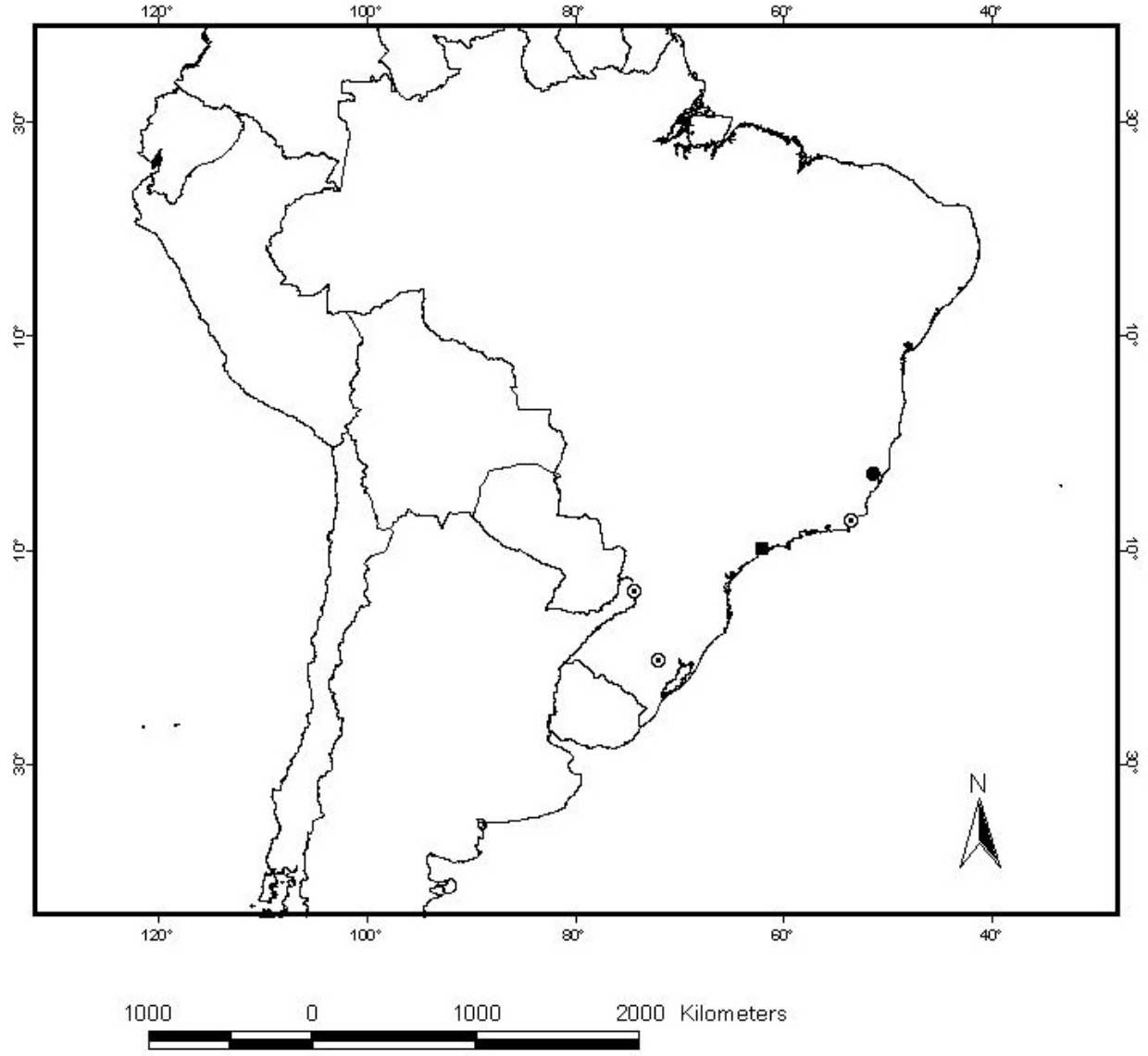


Figure 16. A-K. *Colanthelia sparsiflora* (based on *Santos-Gonçalves et al. 496*). A. Apex of a floriferous culm. B. Branch complement. C-D. Culm leaves. E. Nodal region evidencing the girdle. F. Spikelet. G. Anthoecium with a terminal reduced spikelet. H. Base of spikelet showing the glumes. I. Lemma. J. Palea. K. Lodicules. L. Stamen. M. Gynoecium. N. Caryopsis.

Figure 17. Distribution of the examined material of *Colanthelia* species



⊙ *C. rizantha*

■ *C. secundiflora*

● *C. sparsiflora*

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DISCUSSÃO GERAL

Neste trabalho cada um dos estudos realizados foi tratado em capítulos separados, entretanto, a discussão integrada das informações obtidas por meio destas diversas fontes permite uma visão de conjunto do trabalho realizado, bem como dos resultados obtidos.

São reconhecidas 12 espécies para o gênero *Colanthelia (C. burchelli, C. cingulata, C. distans, C. gracillima, C. intermedia, C. itatiaiae, C. lanciflora, C. longifolia, C. macrostachya, C. rhizantha, C. secundiflora* e *C. sparsiflora),* das quais cinco são novas para a ciência. Quando *Colanthelia* foi descrito por McClure (1973), ele foi constituído a partir da transferência de sete espécies pertencentes a três gêneros distintos (*Arthrostylidium, Arundinaria* e *Aulonemia).* As cinco espécies novas descritas neste trabalho são as primeiras a serem descritas em *Colanthelia*, e representam um acréscimo de 41 % no número de espécies do gênero.

Praticamente todas as espécies de *Colanthelia* são endêmicas do Brasil, com exceção de *C. rhizantha*, que apresenta ocorrência disjunta na Argentina (Agrasar e Clark, 2000). As espécies brasileiras estão distribuídas nas regiões Sul (*C. cingulata, C. graciliima, C. intermedia, C. lanciflora* e *C. rhizantha*) e Sudeste (*C. burchelli, C. cingulata, C. distans, C. itatiaiae, C. lanciflora, C. macrostachya* e *C. rhizantha*). *Colanthelia distans*, uma espécie endêmica de Minas Gerais, conhecida apenas através da coleção típica, está provavelmente extinta na natureza. *Colanthelia rhizantha*, uma espécie anteriormente conhecida apenas do Rio Grande do Sul e Argentina, foi descoberta no Estado Rio de Janeiro. Os limites de distribuição

geográfica do gênero foram ampliados com a descoberta de duas espécies novas (*Colanthelia longifolia* e *C. sparsiflora*) no Estado do Espírito Santo.

Um grupo de espécies (*Colanthelia burchellii, C. itatiaiae* e *C. longifolia*) é conhecido apenas vegetativamente. Estudos de campo posteriores deverão ser conduzidos com o objetivo de se obter material fértil dessas espécies. Um fato a ressaltar é que a cariopse de *Colanthelia* é descrita pela primeira vez nestes estudos. Até então, suas características eram totalmente desconhecidas. No entanto, o fruto da maioria das espécies ainda permanece desconhecido. Cabe ressaltar aquí a importância das coletas de material vegetativo adequadamente feitas.

Os estudos de morfologia externa, micromorfologia e anatomia realizados sugerem que se trata de um grupo natural, com muitas características em comum. Estes estudos revelaram a existência de um padrão relativamente uniforme, nos aspectos estudados, para as espécies do gênero. Alguns dos caracteres aqui levantados têm implicações taxonômicas e/ou ecológicas , podendo ser utilizados para separar espécies ou grupos de espécies.

Dois caracteres morfológicos analisados neste estudo se mostraram de distribuição mais complexa do que o esperado: a ocorrência de estômatos na face adaxial da lâmina foliar em todas as espécies e a ausência de células fusóides em *C. burchellii*. Estas novidades são discutidas abaixo.

As folhas dos ramos das espécies da subtribo Arthrostylidiinae apresentam, caracteristicamente, na face abaxial da lâmina foliar, uma região discolor (melhor evidenciada em material fresco, embora claramente visível em material herborizado), denominada estria (“striae”) (capítulo II desta tese). Este caráter é considerado por Soderstrom e Ellis (1986) como um dos marcadores morfológicos importantes para

as Arthrostylidiinae. A diferença em coloração nesta região, até então atribuída principalmente à deposição irregular de cera na superfície da lâmina foliar (Clark & Londoño, 1991), quando investigada utilizando-se MEV e microscopia fotônica (capítulos II e III desta dissertação), revelou-se como a expressão de um conjunto de fatores. Esta região da lâmina foliar difere, visualmente, do restante da lâmina, tanto adaxial quanto abaxialmente. Esta diferença visual é percebida com maior facilidade na face abaxial, onde realmente é mais conspícua, porém ela ocorre também na face adaxial. Em MEV, verifica-se que, adaxialmente, ocorre um aumento na quantidade de cera epicuticular, bem como na densidade das papilas associadas às células longas da epiderme, além de pequenos tricomas especializados ("prickles"). Surpreendentemente, ocorrem estômatos nesta mesma região, porém eles estão restritos apenas a uma faixa estreita. Abaxialmente, ocorre uma redução na quantidade de cera epicuticular, bem como na quantidade de papilas associadas tanto aos estômatos quanto às células longas da epiderme. Em microscopia fotônica (corte transversal), observa-se que, nesta região, o mesofilo é mais comprimido, a quantidade de esclerênquima associada aos feixes vasculares é maior, e o número de células buliformes é maior tanto em relação à região da nervura mediana quanto em relação à outra margem da folha.

Estas adaptações parecem estar ligadas ao fato de que, em condições ecológicas subótimas (p. ex., seca) as folhas das gramíneas sofrem enrolamento. Esta questão foi investigada com certo detalhe em *C. secundilfora*. Nesta espécie, antes de emergirem da bainha, as lâminas foliares são convolutas, sendo a margem mais internamente posicionada aquela na qual todas estas condições anteriormente discutidas ocorrem. Em condições ambientais subótimas (p. ex., seca), a lâmina

foliar sofre enrolamento e a região da estria fica inteiramente protegida. Quando a lâmina fica completamente expandida, os estômatos da face adaxial estão relativamente "protegidos" pela cera epicuticular, tricomas (prickles), papilas associadas aos estômatos e esclerênquima adaxial associado ao feixe vascular. Este mecanismo merece ser investigado em profundidade para outros gêneros de Arthrostylidiinae com o objetivo de se entender melhor os fatores que condicionam o seu funcionamento. De acordo com Clark (comumicação pessoal), em Bambuseae, a ocorrência de estômatos na face adaxial da lâmina foliar é rara, sendo comum apenas em Guaduinae.

Todas as espécies de *Colanthelia* apresentam células fusóides, com exceção de *C. burchellii*. De acordo com Metcalfe (1960), Ellis (1979) e Soderstrom & Ellis (1986), as células fusóides são características dos bambus. Entretanto, a ausência deste tipo de célula já foi registrado anteriormente em duas outras subtribos de Bambuseae: Guaduinae (exclusiva do Novo Mundo) e Shibataeinae (exclusiva do Velho Mundo), sendo este o primeiro registro da ausência de células fusóides na subtribo Arthrostylidiinae.

A ocorrência de estômatos na face adaxial da estria em todas as espécies de *Colanthelia* e a ausência de células fusóides em *C. burchellii* são caracteres morfológicos que unem as Arthrostylidiinae e Guaduinae. Estas novidades vêm a corroborar um estudo filogenético recente (Zhang & Clark, 2000) no qual estas duas subtribos emergem como um único clado. As características acima discutidas sugerem que: 1) a distribuição destes caracteres nestas subtribos é bem mais ampla do que se supunha anteriormente e 2) estudos morfoanatômicos mais abrangentes nestas duas subtribos são necessários para que se possa avaliar melhor a

circunscrição das Arthrostylidiinae e Guaduinae e estabelecer seus limites taxonômicos em bases mais sólidas.

A ocorrência de fibras intercostais de esclerênquima, um caráter reconhecido por Soderstrom & Ellis (1986) como típico das Arthrostylidiinae, foi registrado em todas as espécies de *Colanthelia*. Grupos de espécies podem ser reconhecidos com base na ocorrência desse caracter: *Colanthelia distans, C. longifolia, secundiflora* e *C. sparsiflora* apresentam fibras intercostais de esclerênquima associadas tanto às células buliformes quanto às células epidérmicas da face abaxial. *Colanthelia burchelli, C. cingulata, C. gracillima, C. itatiaiae, C. intermedia, C. lanciflora, C. macrostachya* e *C. rhizantha* apresentam fibras intercostais de esclerênquima apenas associadas às células epidérmicas da face abaxial.

As espécies de *Colanthelia* podem também ser agrupadas com base na presença ou ausência de papilas associadas aos estômatos na região da estria, na face abaxial da lâmina foliar: *Colanthelia itatiaiae*, *C. lanciflora*, *C. longifolia* e *C. secundiflora* apresentam papilas associadas aos estômatos, ao passo que as oito espécies restantes (*Colanthelia burchellii*, *C. cingulata*, *C. distans*, *C. gracillima, C. intermedia*, *C. macrostachya, C. rhizantha* e *C. sparsiflora)* não apresentaram papilas associadas aos estômatos nesta região da lâmina foliar.

Colanthelia longifolia e *C. secundiflora* apresentam em comum a ocorrência de fibras intercostais de esclerênquima associadas tanto às células buliformes quanto às células da epiderme abaxial como também papilas associadas aos estômatos na face abaxial da estria.

Colanthelia burchelli, C. cingulata, C. gracillima, C. intermedia, C. macrostachya e *C. rhizantha* apresentam em comum a ocorrência de fibras intercostais de esclerênquima associadas apenas às células da epiderme abaxial como também a ausência de papilas associadas aos estômatos na face abaxial da estria.

O conjunto de dados sobre *Colanthelia* apresentados nesta tese representa uma contribuição inicial para a compreensão total do gênero. No entanto, os dados levantados suscitaram novas perguntas que deverão ser investigadas em estudos posteriores, tanto para *Colanthelia* quanto para os demais gêneros do clado Arthrostylidiinae + Guaduinae.

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