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On the Cover: *Otatea glauca* L. G. Clark & Cortés growing at the Quail Botanical Garden in Encinitas,CA (See: "A New Species of *Otatea* from Chiapas, Mexico" by L.G. Clark and G. Cortés R in this issue) Photo: L. G. Clark, 1995.

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A New Species of *Otatea* from Chiapas, Mexico

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Otatea glauca, a narrow endemic from Chiapas, Mexico, is described as new. It is illustrated and compared and contrasted with the other two recognized species of *Otatea, O. acuminata* and *O. fimbriata. Otatea glauca* is named for its bluish-white waxy culms, especially noticeable when young, and it is further distinguished by its hollow culms, culm leaves with sheaths rounded at the summit and blades reflexed, and short, few-flowered synflorescences.

Se describe *Otatea glauca*, una especie nueva, endémica y restringida del estado de Chiapas, México. *Otatea glauca* se ilustra y compara con las otras dos especies del género *Otatea: O. acuminata* y *O. fimbriata. Otatea glauca* está nombrado por sus culmos cerosos de color blanco-azul, y se le distingue ademas por sus culmos huecos, hojas caulinares (o cúlmeas) con las vainas redondeadas en el apice y las láminas reflexas, y sinflorescencias cortas con pocas espiguillas.

Otatea (McClure & E. W. Sm.) C. Calderón & Soderstr. is one of five genera currently recognized in the woody bamboo subtribe Guaduinae, along with Apoclada McClure, *Eremocaulon* Soderstr. & Londoño, *Guadua* Kunth, and Olmeca Soderstr. (Londoño and Clark 2002). *Otatea* is distinguished based on its branch complement of usually three subequal, ascending branches with a promontory at the base, the presence of oral setae on the culm leaves, true (determinate) spikelets, three stamens, two stigmas, and a basic caryopsis. Unlike most bamboos, but like some other members of this subtribe, *Otatea* is adapted to drier habitats; it is found primarily in dry forests in Mexico and parts of Central America and northern Colombia. Most recent treatments (e.g., Judziewicz et al. 1999) have recognized two species of *Otatea*, *O. acuminata* (Munro) C. Calderón & Soderstr. (with two subspecies) and *O. fimbriata* Soderstr. The former species is widespread in cultivation as the Mexican weeping bamboo.

During fieldwork in Mexico in 1989, Clark, accompanied by Gerald Bol, collected an unusual *Otatea* in the state of Chiapas. This plant was clearly an *Otatea* based on its branching and other features, but it had hollow culms and culm leaves that were distinct from those of the two known species. Rhizomes of the unknown *Otatea* were collected by Bol and grown in the Quail Botanic Gardens in Encinitas, California. The plant in cultivation grew well and produced strikingly beautiful bluish-white waxy culms. Clumps of this plant began to flower in 2002, including the original planting at Quail. Cortés, as part of a project to document the native bamboos of Mexico, visited the area of the original collection of this species and found it in flower in 2003. After studying the available material and comparing these collections to the two previously recognized species of *Otatea*, we concluded that this plant represented a distinct but undescribed species. We here describe and illustrate this new species, and provide a comparison with the other species of *Otatea*. We also discuss the morphology of oral setae and fimbriae, which are characters important in the Guaduinae generally and in distinguishing among the three species of *Otatea*.

DISCUSSION

Fimbriae vs. Oral Setae

The terms 'fimbriae' and 'oral setae' have been used interchangeably in much of the literature on bamboos for the robust, hairlike processes found on the margins and shoulders of both culm and foliage leaves in many bamboos. Judziewicz et al. (1999) consistently called these structures 'fimbriae,' but equated the two terms in their glossary. Soderstrom and Londoño (1987), in their original descriptions of *Eremocaulon* and *Criciuma*, applied the term 'oral setae' to these structures, making no distinction between the thinner processes on the margins and shoulders and the thicker processes found around the mouth of the sheath in the ligular area. Based upon closer examination of these processes in *Otatea* for this paper and in *Eremocaulon* (Londoño & Clark 2002), we argue that a distinction should be made and that the two terms should be redefined accordingly.

Fimbriae are terete to flattened processes typically ca. 0.1 mm in diameter (perhaps as much as 0.2 mm) and up to several cm in length that may occur only on the summit of the culm leaf sheaths or on the summit and at least the overlapping margin of the sheaths; no bamboos are known to have fimbriae on the margins without also having them on the summit (usually on both sides of the blade). Fimbriae on the culm leaves are widespread among Neotropical woody bamboos, although they are notably absent in *Chusquea* Kunth. Fimbriae may be fused to each other (connate) for some or all of their length, sometimes forming a ruffle as in *Actinocladum* Soderstr. and some species of *Aulonemia* Goudot (Judziewicz et al. 1999). When fimbriae are present on the culm leaves, they are also typically present in the same pattern on the foliage leaves. There are additional, thicker processes in some taxa that occur around the mouth of the culm leaf sheath and usually also the foliage leaf sheath, strictly in the ligular area between the inner ligule and the blade. These structures are usually flattened and range from 0.2 to 1.2 mm in diameter and up to 7 cm in length (although they are typically 1-3 cm long), they are restricted to the ligular area around the mouth of the sheath, and their bases may be adnate to the abaxial surface of the inner ligule. We here apply the term 'oral setae' to these structures to distinguish them from the more widely occurring fimbriae.

Among Neotropical woody bamboos, oral setae on the culm leaves are known only in *Eremocaulon, Olmeca,* and *Otatea*; with the exception of some populations of *Otatea acuminata*, all species of the three genera consistently exhibit this feature. Oral setae and fimbriae are also usually developed on the foliage leaves in *Olmeca* and *Otatea*, again with the exception of *O. acuminata*, and their occurrence in *Eremocaulon* is variable. The oral setae in *Eremocaulon* may be adnate to the inner ligule for a very short distance basally, and the oral setae in *E. asymmetricum* and *E. setosum* are not distinctly thicker than the fimbriae. In *Otatea* a similar degree of adnation between the inner ligule and the oral setae may be observed, but the adnation is often more marked in *Olmeca*.

Morphological comparison of the species of *Otatea*

The features that distinguish the three species of *Otatea* are presented in Table 1. Both *O. acuminata* and *O. fimbriata* have solid or thick-walled culms with the lacuna < 50% of the internode diameter, and both also share more or less rectangular culm leaf sheaths with erect blades. *Otatea glauca* contrasts with these two species in having hollow culms with the lacuna > 50% of the internode diameter and culm leaves with the sheaths more or less triangular due to the rounded shoulders and reflexed blades. The foliage leaf blades of *O. glauca* are narrow like those of *O. acuminata*, but fimbriae and oral setae appear to be consistently present in *O. glauca* whereas these structures are typically absent or poorly developed in *O. acuminata*.

TAXONOMIC TREATMENT

Key to the Species of *Otatea*

1. Foliage leaf blades of primary branches 1.5-3.5 cm wide; oral setae on the foliage leaves 10-15 mm long; synflorescences 10-15 cm long, > 30 spikelets per synflorescence; spikelets ca. 2 cm long. *O. fimbriata*
1. Foliage leaf blades of primary branches 0.3-1 (-1.2) cm wide; oral setae on the foliage leaves absent or up to 6 mm long; synflorescences 4-10 cm long, 2-15 spikelets per synflorescence; spikelets 3-4 cm long. 2
    2. Culms solid or thick-walled, lacuna < 50% of the internode diameter; culm leaf sheaths + rectangular, blades erect; foliage leaves with fimbriae and oral setae absent or the fimbriae poorly developed; synflorescences 6.5-10 cm long, with 6-15 spikelets per synflorescence; glumes abaxially scabrous; lemmas 10-14 mm long including the awns. *O. acuminata*
    2. Culms hollow, lacuna > 50% of the internode diameter; culm leaf sheaths + triangular with the shoulders rounded, blades reflexed; foliage leaves with fimbriae and oral setae present, the oral setae 2.5-6 mm long; synflorescences 4-9 cm long, with 2-7 spikelets per synflorescence; glumes abaxially glabrous; lemmas 14.5-21 mm long including the awns. *O. glauca*

Otatea glauca L. G. Clark & Cortés, sp. nov. TYPE: MEXICO. Chiapas, Mun. Motozintla, Tolimán, km 39 Huixtla-Motozintla, en cañada a la orilla del río, 600 msnm, 20 Jan 2003 (fl), G. Cortés & W. Sánchez 306 (holotype: MEXU; isotypes: ISC, MO, US). Fig. 1.

Culmi usque ad 3 cm diam., usque ad 8 m alti, erecti; internodia glauca, cava. Folia culmorum 18-30 cm longa; vaginae 14-22 cm longae, 2.4-5.2-plo longior quam laminae, plus minusve triangulares, abaxialiter hispidae in dimidio superiore; setae orificis 2.5-11.5 mm longae, 0.4-0.8 mm latae, connatae ad basim; laminae 3.5-8.2 cm longae, reflexae, deciduae, adaxialiter pubescentes. Folia ramorum cujusquisque in complemento 4-5; vaginae glabrae; setae orificis 2.5-6 mm longae; laminae 10-16 cm longae, 0.3-1 cm latae, lineares vel lineari-lanceolatae, abaxialiter dense pubescentes ad basim. Synflorescentiae 4-9 cm longae, racemosae vel paniculatae, 2-7 spiculis. Spiculae 3-4 cm longae, flosculis 3-5 et flosculis rudimentariis terminalis 1; internodia rachillorum 3.5-5 mm longa; glumae aristatae, abaxialiter glabrae; lemmata 14.5-21 mm longa aristis inclusis, abaxialiter scabro-pubescentia.

Rhizomes sympodial, pachymorph, the necks at least slightly elongated. Culms to 3 cm in basal diameter, to 8 m tall, erect; internodes 27-30 cm long, terete, glabrous, glaucous especially when young, hollow with the walls 1.5-2 mm thick, the lacuna occupying > 50% of the total diameter. Culm leaves 18-30 cm long; sheaths 14-22 cm long, 8-17 cm wide at the base, 2.4-5.2 times as long as the blades, + triangular, abaxially hispid for the upper 1/2 to 2/3, the shoulders rounded, the margins glabrous; inner ligule 0.4-0.5 mm long, truncate, ciliolate; oral setae 2.5-11.5 mm long, 0.4-0.8 mm wide, free from the inner ligule, flattened, connate at the bases for up to 2 mm, splitting into narrower segments above, these straight to gently curving and retrorsely scabrous-hispid; fimbriae at sheath summit on either side of the blade, 1.5-4 mm long, 0.1-0.3 mm long, more or less terete, free, curly, retrorsely scabrous; blades 3.5-8.2 cm long, triangular, reflexed, deciduous, adaxially densely pubescent, abaxially glabrous, apex attenuate-subulate. Branching infravaginal; three main, subequal branches per node borne on a promontory, these diverging from each other and rebranching, up to 80 cm long, diverging from the main culm at 45-90(; supranodal ridge pronounced; nodal line more or less horizontal. Foliage leaves 4-5 per complement; sheaths glabrous, weakly keeled at the summit, sheath summit extension absent; outer ligule an irregular glabrous or ciliolate rim to 0.2 mm long; inner ligule 0.2-0.5 mm long, truncate; oral setae 2.5-6 mm long, 0.1-0.2 mm wide, slightly flattened, scabrid, free from the inner ligule; fimbriae on either side of the blade at

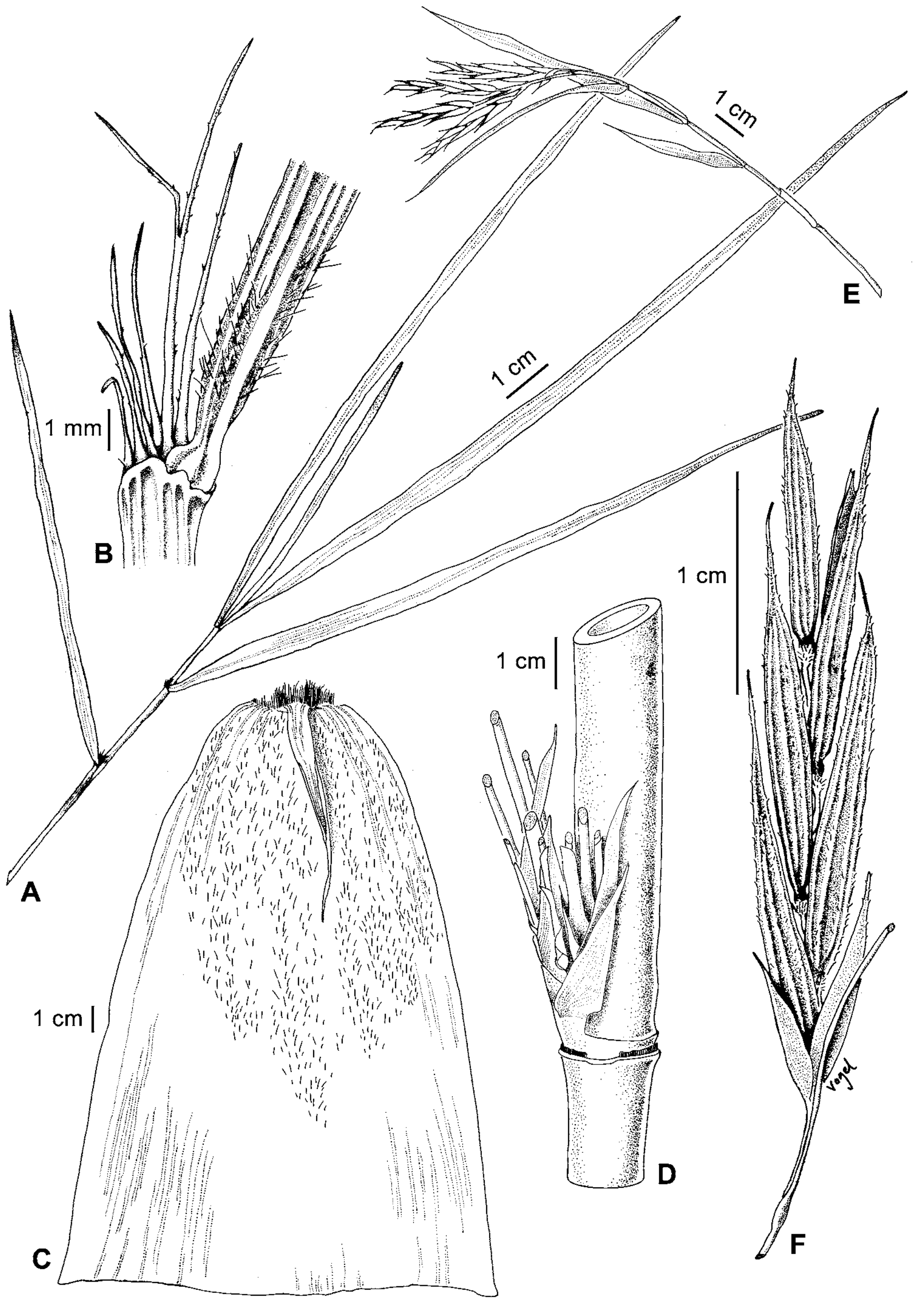

Figure 1. *Otatea gaslauca.* A. Foliage leaf complement. B. Ligular area of foliage leaf showing fimbriae, oral setae. C. Culm leaf, abaxial view. D. Branch complement. E. Synflorescence. F. Spikelet. (A-D. based on Clark 1334; E-F. based on Cooper s.n.)

the summit, 1-4 mm long, 0.05-0.1 mm in diameter, more or less terete, scabrid; blades 10-16 cm long, 0.3-1 cm wide, L:W = (14-) 21-47, linear to linear-lanceolate, green, adaxially glabrous, rarely pilose, not tessellate, abaxially densely pubescent at the base, with hairs extending along the midrib for several mm and the rest glabrous or pilose over much of the surface, weakly tessellate, the base attenuate, the apex attenuate-subulate, the margins serrulate, sometimes weakly so; pseudopetioles ca. 1 mm long, whitish, pulvinate at the base. Synflorescences 4-9 cm long, racemose or paniculate, 2-7 spikelets per synflorescence; rachis + flattened to angular, scabrous-pubescent; pedicels 2.5-5 mm long, angular, scabrous-pubescent. Spikelets 3-4 cm long, laterally compressed, 3-5 florets per spikelet with an additional apical rudimentary floret; rachilla joints 3.5-5 mm long, minutely pubescent, densely pubescent at the apex of each joint; glumes 2, narrowly triangular and navicular, abaxially glabrous, awned; glume I 6-9.5 mm long including the awn, 7-9-nerved, the awn 1.3-3.6 mm long; glume II 9.5-14 (-17) mm long including the awn, 9-11-nerved, the awn 2-5 mm long; lemmas 14.5-21 mm long including the awn, narrowly triangular and navicular, abaxially scabrous-pubescent, cross-veins evident, awned, 11-15-nerved, the awn 3-4.7 mm long, antrorsely scabrous; paleas 14-15.4 mm long, 6-nerved, 2-keeled, the keels scabrous, sulcate for the full length, the sulcus pubescent on the upper half, scabrid below, wings glabrous, apex bifid, the teeth acute. Lodicules 3, hyaline, vasculated, apically ciliate, basally slightly thickened; the anterior pair 1.5-2 mm long, the posterior one narrower, ca. 1.6 mm long. Ovary glabrous; stigmas 2, plumose. Fruit not seen.

Otatea glauca is named for the bluish-white waxy coating on the culms, which is especially noticeable on the new shoots. Other distinguishing features of this species include hollow culms, culm leaves with rounded shoulders and reflexed blades, foliage leaves with both fimbriae and oral setae developed, few-flowered synflorescences, and spikelets with the glumes glabrous and the lemmas scabrous-pubescent. This species appears to be a narrow endemic in Chiapas, Mexico, growing in *selva baja caducifolia* or dry secondary vegetation derived from the original dry forests at 600 to 1,000 m in elevation. The plants are usually found in *cañadas* (small canyons) along rivers or streams. Little is known about the phenology of this species, as only one flowering collection (the type) from a wild population is known. This flowering was apparently gregarious and monocarpic because all of the plants in the area were flowering and dying. In cultivation, this species is known as the Mayan silver bamboo, and in the 2004 American Bamboo Society Source List it is listed as a cultivar of *O. acuminata*.

Additional specimens examined. MEXICO. Chiapas: 37 km before Huixtla, Hwy. 190, between Motozintla de Mendoza and Huixtla, 1,000 m, 4 Feb 1989, L. Clark, P. Tenorio & G. Bol 481 (ISC, MEXU, US). CULTIVATION. California: Encinitas, Quail Botanical Garden, from Mexico, material vouchered as Clark et al. 481, Aug 1995, L. Clark 1334 (ISC, MEXU, US, XAL); alrededores de Los Angeles, a partir de estacas traídas del Jardín Botánico de Quail, 29 Apr 2002 (fl), G. Cortés & G. Cooper 333 (ISC, MEXU, MO); Los Angeles area, Garden Grove, property of Don Binnix, source material from Quail Botanical Garden, 8 Apr 2003 (fl), G. Cooper s.n. (ISC).

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Table 1. Morphological comparison of the three species of Otatea.

Character	*O. acuminata*	*O. fimbriata*	*O. glauca*
Internodes	solid or thick-walled	solid or thick-walled	hollow
Culm leaf sheath shape	+/- rectangular	+/- rectangular	+/- triangular
Culm leaf blade position	erect	erect	reflexed
Oral setae on the foliage leaves	absent	present	present
Foliage leaf blade width (cm), 1° branches	0.3-0.7 (-1.2)	1.5-3.5	0.3-1
Synflorescence length (cm)	6.5-10	15-Oct	9-Apr
No. of spikelets per synflorescence	15-Jun	> 30	7-Feb
Spikelet length (cm)	ca. 3.5	ca. 2	4-Mar
Rachilla joint length (mm)	(4.5-) 5-6	3.5-4	3.5-5
Glume abaxial surface	scabrous	glabrous	glabrous
Lemma length (mm) including awns	10-14	10-13	14.5-21

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A Checklist of the Basal Grasses and Bamboos in Brazil (POACEAE)

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A checklist of the basal grasses (subfam. Anomochlooideae: 2 genera, 3 spp.; subfam. Pharoideae: 1 genus; 4 spp.) and the true bamboos (subfam. Bambusoideae: 34 genera and c. 232 spp.) native to Brazil is presented. A list of the 20 most commonly cultivated bamboo species is also presented, as well as a list of the 22 most widespread bamboo mimics.

Apresenta-se uma listagem das gramíneas basais (subfam. Anomochooideae: 2 gêneros, 3 spp.; subfam. Pharoideae: 1 gênero, 4 spp.) e dos bambus verdadeiros (subfam. Bambusoideae: 34 gêneros e c. 232 spp.) nativos no Brasil. Apresenta-se, também, uma lista com as 20 spp. de bambus mais comumente cultivadas no Brasil, como também a lista das 22 espécies de mímicos de bambus (plantas com aspecto bambusóide, porém não pertencem à subfam. Bambusoideae, ou nem às Poaceae).

Brazil is the largest country in South America, having an area of 8,500,000 square km. The country is gifted with a wide range of large scale biomes, such as Amazonia, Atlantic Forest and Cerrado. Each one of these individual biomes is, of course, highly ecologically diversified (Rizzini 1978).

According to a recent survey (Judziewicz et al. 1999), Brazil is the country with the highest diversity of bamboo species in the New World. This is hardly surprising when one considers the country´s immense territory and the diversity of habitats it displays. Nonetheless, it is generally held that field botanists are just "scraping the surface" as far as carrying on detailed botanical surveys in large biomes, such as Amazonia (Nelson 1994) and even the Cerrado (Oliveira and Marquis 2002). The bamboos and the basal grasses discussed in this paper are found throughout the country but they are more abundant in the Atlantic Forest and in Amazonia.

The concept of basal grasses is fairly recent. It emerged when, in addition to structural data sets (external morphology, anatomy, cytology, physiology, palynology, etc.), molecular data sets (both nuclear and chloroplast sequences and plastid DNA restriction sites) were added to the analyses. In all the analyses that have been made (e.g. Clark et al. 1995, Davis and Soreng 1993, Soreng 1995, Zhang 1996, GPWG 2001), four tribes (Anomochloeae, Streptochaeteae, Phareae, and Streptogyneae) that were traditionally classified in the subfamily Bambusoideae (Calderón and Soderstrom 1980, Soderstrom and Ellis 1987) turned out to be not at all related to the true bamboos, but, instead, constitute distinct evolutionary and taxonomic entities.

The Anomochloeae (genus *Anomochloa Brong.*) and the Streptochaeteae (genus Streptochaeta Nees) are now considered the most basal grass subfamily, the Anomochlooideae; Pharoideae, with a single genus in the New World, Pharus P. Browne, is the second most basal subfamily, whereas *Streptogyna* P.Beauv., formerly also an herbaceous bamboo genus (e.g., Soderstrom and Calderón, 1980; Soderstrom, 1981), appears to be most closely related to the Oryzoideae (rice lineage).

The true bamboos, subfamily Bambusoideae, is a monophyletic taxon. It encompasses two tribes (Bambuseae and Olyreae), that correspond to two informal groups commonly known as woody and herbaceous bamboos, respectively.

MATERIALS AND METHODS

The data presented here were gathered from the literature (cf. especially Filgueiras 1988, Burman and Filgueiras 1993, Judziewicz et al.1999, Judziewicz et al. 2000, Santos-Gonçalves 2000, Oliveira, 2001, Longhi-Wagner et al. 2001, Londoño and Clark 2002, Zuloaga and Judziewicz 1991) plus the authors´ herbarium and field work. Several species listed have not yet been formally described, but as their new names will be published in the near future, they were taken into consideration for statistical purposes. These are indicated in the tables by an asterisk (*).

The classification presented is that of Judziewicz et al. (2000). Authors abbreviations follow Brummitt and Powell (1992). Common names for the cultivated species follow Lorenzi (1995).

RESULTS

Table 1 summarizes the number of taxa of basal grasses in Brazil: two subfamilies, three genera and seven species. *Anomochloa marantoidea* Brong. is considered the most basal taxon for the entire grass family. It is found only in the Brazilian state of Bahia (Atlantic Forest), where it is known from only three small populations. Undoubtedly, it deserves special conservation efforts. The other genus in the subfamily, *Streptochaeta*, consists of two (possibly a third) species in Brazil, found especially as part of the understory of the Atlantic Forest. *Pharus*, a genus with four species and two varieties in Brazil, is composed of widespread, shade-loving elements.

The true bamboos (subfam. Bambusoideae) are shown in tables 3 and 4. The herbaceous bamboos (table 3) can be separated from the woody ones (table 4) by a suite of eight characters, most of them morphological. The contents of table 2 are helpful to distinguish herbaceous from woody bamboos but there are exceptions to characters 1 and 8. For example, in the genera *Eremitis Döll* and *Olyra* L. both in herbaceous group, some plants can reach more than 3 meters in height; in *Colanthelia* McClure, *Chusquea* Kunth and *Aulonemia* Goudot the culms may be quite thin, climbing or clambering and some species of *Chusquea* and *Guadua* Kunth may flower continuously. Also, not all woody species have been tested for direct sun exposure.

There are 16 genera of herbaceous bamboos in Brazil (table 3), four of them are endemic (*Diandrolyra* Stapf, *Eremitis, Reitzia* Swallen, *Sucrea* Soderstr.), and of c.75 species, 45 (60%) are endemic. The most speciose genera in this group are *Olyra* and *Pariana* Aubl., with 18 species each. Although, practically, all the species in this tribe have an obvious potential as ornamental plants, primarily when grown in shady habitats, *Raddia* Bertol., *Diandrolyra, Sucrea* and *Raddiella* Swallen deserve special attention. The only known annual bamboo species is found in the latter genus (*Raddiella minima* Judz. & Zuloaga), from the state of Mato Grosso (Cerrado biome, central Brazil; cf. Zuloaga and Judziewicz, 1991).

There are 18 woody genera of bamboos in Brazil, six of which are endemic (*Alvimia* Soderstr. & Londoño, *Apoclada* McClure, *Athroostachys* Benth., *Eremocaulon* Soderstr. & Londoño, *Filgueirasia* Guala, *Glaziophyton* Franch.), and ca.155 species, ca. 129 of which (ca. 83 %) are endemic. The most speciose genera in this group are *Merostachys* Spreng (53 spp.) and *Chusquea* (40 spp.), but five include only a single species (*Apoclada, Athroostachys, Elytrostachys* McClure, *Glaziophyton*, *Rhipidocladum* McClure). *Apoclada* and *Glaziophyton* are monotypic.

Altogether, there are 34 bamboo genera in Brazil and c. 232 species, a few not yet formally described. A total of ca.174 species (ca.75 %) are considered endemic. A comparison between the number of genera and species in Brazil and in the New World is shown in Table 6. Brazil has 89 % of all known genera and around 65 % of all species in the New World. The five most speciose genera are shown in table 7. Merostachys is the most speciose of all, contributing with ca. 22 % of all the species; *Chusquea* with 41 species is the second most speciose genus, followed by *Guadua* and *Pariana.*

However, these ca. 232 species are not evenly distributed throughout the country. When they are placed as to fit the three major biomes in the country (Table 8), it becomes evident that the Atlantic Forest is by far, the richest biome, followed by Amazonia and Cerrado. The high altitude campos (here included in the Atlantic Forest or in the Cerrado biomes, depending on the case) are the home of some extremely specialized species, such as the odd-looking *Glaziphyton mirabile* Franch. and *Aulonemia effusa* (Hack.) McClure. The former resembles a giant rush (cf. fig. 87 of Judziewicz et al., 1999) and grows in very rocky hilltops, subjected to both mist and fire, depending on the season of the year. The latter is the only known bamboo species to grow in dry, rocky places, in fairly high altitude (c.1000 m), subjected to seasonal fires and very poor edaphic soil conditions (campo rupestre; cf. Rizzini 1978 for habitat description).

Cultivated Species

A fairly large number of bamboo species are cultivated in Brazil. Although it is nearly impossible to keep an accurate record of all species that are currently grown in the country´s immense territory, Table 9 is a preliminary attempt to list the species most commonly seen under cultivation. The word “rare” in Table 9 means that the species was only observed in botanical gardens or research institutions, “common” means that the species was seen in botanical gardens, research institutions and private gardens, “widespread” means that the species is found almost anywhere, where the climate is suitable for its cultivation.

The bulk of the these species are cultivated as ornamentals, but some are used for erosion control, as source of raw material for housing, for the paper industry, and for general farm uses.They are also prime raw materials much sought after by artisans. A few NGOs (Non Profit Organizations) throughout the country are starting to use the cultivated bamboos (as raw material) as part of a program to help some poor, local communities to increase their income. In this context, the bamboos are viewed as an effective way to obtain the “social inclusion” of these poor communities. Only 20 species are presented in Table 9, but the list is growing rapidly as nurseries and private growers become interested in the trade.

Bamboo mimics

Table 10 shows a list of 22 species of the most common bamboo mimics in Brazil. These are an assemblage of non-bambusoid grasses plus some other broad-leaved plants that display a general bamboo gestalt. Because of that, they are often mistaken as true bamboos. Judziewicz et al. (1999) call them “impostors”, but since it is not their fault that they ended up with a bambusoid appearance, it is perhaps best refer to them simply as bamboo mimics.

Out of the 22 species listed, 14 are grasses and eight belong to four other families. Interestingly, six of them belong to the palm family (Arecaceae).

DISCUSSION

The data presented here show that Brazil has a high number of native bamboo species, higher in fact than any other country in the New World. This, however, does not mean that the list of the bamboos of Brazil is complete. On the contrary, a great deal still remains to be done. Some large areas in the Amazonia remain totally unexplored for bamboos. The great natural bamboo forests called *tabocais* in Brazil (IBGE, 1990) and *pacales* in Peru (Judziewicz et al., 1999) cover a large area in the Brazilian state of Acre and extends into Peru and Bolivia.

Tabocais is the plural form of *tabocal*, a word that means a great population of *taboca,* the common name used by some native Brazilian Indians to designate the bamboos in the genera *Guadua* and *Chusquea.* The whole bamboo population in those three neighboring countries is estimated to cover around 180,000 square kilometers. These *tabocais* have hardly been botanized and yet four genera have been recorded from there (*Elytrostachys, Guadua, Olyra, Merostachys*). *Guadua superba* Huber, locally known as *taboca-gigante* and probably the largest native bamboo in Brazil (up to 30m x 20cm), is said to cover 80% of the forest clearings on the Brazilian side (IBGE, 1990).

Likewise, some areas within the Atlantic Forest complex have not yet been botanized properly, either. In this context, the Parque Estadual do Rio Doce (an inland extension of the coastal forest with ca. 36,000 hectares) should be especially targeted. In a small fraction of this park explored by the junior author (Santos-Gonçalves 2000) two new species of large bamboos (*Merostachys*) and a new *Eremitis* were found as well as many new geographical records were established. In the coastal part of the Atlantic Forest, Oliveira (2001) also found several new species of herbaceous bambos (*Eremitis, Raddia*). Even the fairly well known Cerrado bamboos (Filgueiras, 1988; Burman and Filgueiras, 1993) can contain previously hidden taxonomic novelties when accurate analytical techniques are employed (Guala 2003).

The number of endemic, rare, and endangered species in Brazil is high. The case of *Anomochloa marantoidea* is emblematic: It represents the most basal taxon of the entire grass family, it is known only from three small populations, all located on private lands, and, alas, it has no legal protection. Clearly, something has to be done about it urgently. One possible solution would be to devise a quick, scientific way to predict the existence of potential habitats followed by field work to locate new populations.

Brazilian conservation laws provide for the existence of small or large private conservation units known as *Reserva Particular do Patrimônio Natural* (RPPN). This strategy is quite desirable because it is done in perpetuity (the future heirs of the land cannot change their mind about its conservation status), the owner is entitled to tax exemption, and, in addition, funds from different sources can be obtained to be used in management and educational programs. No direct use of the natural resources is permitted in a RPPN.

The *tabocais* of Acre deserve special attention from the Instituto Brasileiro do Meio Ambiente (IBAMA – the federal agency responsible for the conservation policy in Brazil). Because the *tabocais* cover large tracts of land, a representative part of them should be made into a Bamboo National Park, and the remaining could be made into *Floresta Nacional* or Reserva *Extrativista* (national forest or extractive forest), where sustainable activities could take place.

The last part of the last paragraph touched a key point in the contemporary philosophy on conservation strategies, which is the consideration of humans as integral part of the ecosystem. If conservation measures are to be successful, explicit considerations of human necessities have to be made. After all, humans are an inseparable part of the environment.

There is an increasing awareness of the Brazilian society regarding the immense potential use of bamboos. A small but active group of bamboo enthusiasts is emerging (cf. www.bambubrasileiro.com; www.institutodobambu.org.br) and growing rapidly. The recently created (2003) Instituto do Bambu (Bamboo Institute) in Maceio, northeastern Brazil is dedicated, amongst other things, to devise new and inexpensive ways to build homes for the poor using bamboos as a primary raw material. These initiatives are proof of the interest that Brazilian society is taking in bamboos. The suggestion presented herein for the creation of bamboo national and/or international forests may become one way to creatively address the issue of sustainability of native bamboo resources.

The authors cannot stress enough the urgent need for field work on bamboos in Brazil. There is a great potential for new and exciting discoveries. For that, trained personnel are necessary. To collect bamboos for scientific studies, a strict protocol has to be followed (Soderstrom and Young 1983), and the basic resources have to be made available. Field excursions provide a great opportunity to document the natural populations, through the collection of herbarium specimens and images (videos, photos, etc.). They are also the right time to collect plant material to establish live collections for experimental purposes.

A laudable initiative has just been established by IBAMA in Brasilia, which is, a bamboo program to encourage and support the many potential uses of this group of plants by Brazilian society (Almeida and Roitman, pers. comm.). Ideally this initiative would involve, among other things, an active collecting program connected with the establishement of regional live collections. Partnership with Universities and Research Institutes are being taken into consideration because they can provide scientific support and they can also help to enlist and train new bamboo specialists and collecting teams.

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Table 1. Summary of the basal grasses in Brazil (!=endemic)

Subfamily	Genus	Species
Anomochlooideae	*Anomochloa* Brong.! *Streptochaeta* Nees	*A. marantoidea* Brong.! *S. angustifolia* Soderstr.! *S. spicata* Nees
Pharoideae	*Pharus* P. Browne	*P. lappulaceus* Aubl. *P. latifolius* L. *P. parvifolius* Nash subsp. *elongatus* Judz. *P. parvifolius* Nash subsp. *parvifolius* *P. virescens* Döll
TOTAL 2	3	7

Table 2. Principal distinguishing characters of herbaceous versus woody bamboos

Caracter	Herbaceous	Woody
1. Height	Usually < 2m high	1-35m high
2. Branching	Simple	Complex
3. Culm consistency	Herbaceous (not lignified; easily breakable between 2 fingers)	Woody (Lignified; not breakable between 2 fingers)
4. Culm leaves	Absent	Present
5. Outer ligule	Absent	Present
6. Flowers	Unisexual	Bisexual
7. Flowering	Continuous (polycarpic)	Seasonal (monocarpic)
8. Direct sun exposure	Not tolerant	Tolerant

Table 3. Herbaceous bamboo genera and species in Brazil (! = endemic genus; * = not formally described)

Genus	Species	Obs.
Agnesia Zuloaga & Judz.	*A. lancifolia* (Mez) Zuloaga & Judz.	–
Arberella Soderstr.	*A. bahiensis* Soderstr. & Zuloaga	Endemic
	A. flaccida (Döll) Soderstr. & C.E.Calderón	Endemic
Cryptochloa Swallen	*C. capillata* (Trin.) Soderstr.	–
Diandrolyra Stapf!	*D. bicolor* Stapf	Endemic
	D. tatianae Soderstr. & Zuloaga	Endemic
	D. sp. nov. (Oliveira 2001)	Endemic
Eremitis Döll!	*E. parviflora* (Trin.) C.E.Calderón	Endemic
	*E. sp. nov. 1** (Hollowell, 1989, 1977; Oliveira 2001)	Endemic
	*E. sp. nov. 2** (Oliveira, 2001)	Endemic
	*E. sp. nov. 3** (Santos-Gonçalves 2000)	Endemic
Froesiochloa G.A.Black	*F. boutelouoides* G. A Black	–
Lithachne P. Beauv.	*L. horizontalis* Chase	Endemic
	L. pauciflora (Sw.) P. Beauv.	–
Olyra L.	*O. amapana* Soderstr. & Zuloaga	Endemic
	O. caudata Trin.	Endemic
	O. davidseana Judz. & Zuloaga	–
	O. ecaudata Döll	Endemic
	O. fasciculata Trin.	–
	O. filiformis Trin.	Endemic
	O. glaberrima Raddi	–
	O. humilis Nees	–
	O. juruana Mez	Endemic
	O. latifolia L.	–
	O. latispicula Soderstr. & Zuloaga	Endemic
Olyra L.	*O. longifolia* Kunth	–
	O. loretensis Mez	–
	O. obliquifolia Steud.	–
	O. retrorsa Soderstr. & Zuloaga	Endemic
	O. tamanquareana Soderstr. & Zuloaga	Endemic
	O. taquara Swallen	Endemic
	O. wurdackii Swallen	–
Pariana Aubl.	*P. campestris* Aubl.	–
	P. concinna Tutin	Endemic
	P. distans Swallen	Endemic
	P. gracilis Döll	Endemic
	P. lanceolata Trin.	Endemic
	P. ligulata Swallen	Endemic
Pariana Aubl.	*P. maynensis* Huber	–
	P. modesta Swallen	Endemic
	P. nervata Swallen	Endemic
	P. ovalifolia Swallen	Endemic
	P. radiciflora Döll	–
	P. simulans Tutin	–
	P. sociata Swallen	Endemic
	P. stenolemma Tutin	–
	P. tenuis Tutin	–
	P. trichosticha Tutin	–
	P. ulei Pilg.	Endemic
	*P. sp. nov. 1** (Hollowell, 1989)	Endemic
	*P. sp. nov. 2** (Hollowell, 1989)	Endemic
Parodiolyra Soderstr. & Zuloaga	*P. lateralis* (J. Presl ex Nees) Soderstr. & Zuloaga	–
	P. luetzelburgii (Pilg.) Soderstr. & Zuloaga	–
	P. micrantha (Kunth)	–
	P. ramosissima (Trin.) Soderstr. & Zuloaga	Endemic
Piresia Swallen	*P. goeldii* Swallen	–
	P. leptophylla Soderstr.	–
	P. macrophylla Soderstr.	–
	P. sympodica (Döll) Swallen	–

Raddia Bertol.	*R. angustifolia* Soderstr. & Zuloaga	Endemic
	R. brasiliensis Bertol.	Endemic
	R. distichophylla (Nees) Chase	Endemic
	R. guianensis (Brogn.)Hitchc.	–
	R. portoi Kuhlm.	Endemic
Raddiella Swallen	*R. sp. nov. 1** (Oliveira, 2001)	Endemic
	*R. sp. nov. 2** (Oliveira, 2001)	Endemic
	R. esenbeckii (Steud.) C.E.Calderón & Soderstr.	–
	R. kaieteurana Soderstr.	–
	R. lunata Zuloaga & Judz.	Endemic
	R. malmeana (Ekm.) Swallen	Endemic
	R. minima Judz. & Zuloaga	Endemic
Rehia Fijten	*R. nervata* (Swallen) Fijten	–
Reitzia Swallen!	*R. smithii* Swallen	Endemic
Sucrea Soderstr.!	*S. maculata* Soderstr.	Endemic
	S. monophylla Soderstr.	Endemic
	S. sampaiana (Hitchc.) Soderstr.	Endemic

Table 4. Woody bamboo genera and species in Brazil (!=endemic genus; * = not formally described)

Genus	**Species**	**Obs.**
Actinocladum Soderstr.	*A. verticillatum* (Nees) Soderstr.	Bolivia, Brazil
Alvimia Soderstr. & Londoño!	*A. auriculata* Soderstr. & Londoño	Endemic
	A. gracilis Soderstr. & Londoño	Endemic
	A. lancifolia Soderstr. & Londoño	Endemic
Apoclada McClure!	*A. simplex* McClure & L.B. Sm.	Endemic
Arthrostylidium Rupr.	*A. fimbrinodum* Judz. & L.G.Clark	Endemic
	A.grandifolium Judz. & L.G.Clark	Endemic
	A. simpliciusculum (Pilg.)McClure	–
Athroostachys Benth. !	*A. capitata* (Hook. f.) Benth.	Endemic
Atractantha McClure	*A. amazonica* Judz. & L. G. Clark	–
	A. aureolanata Judz.	Endemic
	A. cardinalis Judz.	Endemic
	A. falcata McClure	Endemic
	A. radiata McClure	Endemic
Aulonemia Goudot	*A. amplissima* (Nees)McClure	Endemic
	A. aristulata (Döll) McClure	Endemic
	A. effusa (Hack.)McClure	Endemic
	A. fimbriatifolia L.G. Clark	Endemic
	A. glaziovii (Hack.) McClure	Endemic
	A. goyazensis (Hack.) McClure	Endemic
	A. radiata (Rupr.) McClure	Endemic
	A. ramosissima (Hack.) McClure	Endemic
	A. setigera (Hack.) McClure	Endemic
	A. ulei (Hack.) McClure	Endemic
Chusquea Kunth	*C. acuminata* Döll	Endemic
	C. anelythra Nees	Endemic
	C. anelythroides Döll	Endemic
	C. attenuata (Döll) L.G. Clark	Endemic
	C. baculifera Silveira	Endemic
	C. bahiana L.G. Clark	Endemic
	C. bambusoides (Raddi) Hack. var. bambusoides	Endemic
	C. bambusoides var. minor McClure & L.B. Sm.	Endemic
	C. bradei L.G. Clark	Endemic
	C. caparaoensis L.G. Clark	Endemic
	C. capitata Nees	Endemic
	C. capituliflora Trin. var. Capituliflora	Endemic
	C. capituliflora Trin. var. *pubescens* McClure & L.B. Sm.	Endemic
	C. erecta L.G. Clark	Endemic
	C. fasciculata Döll	Endemic
	C. gracilis McClure & L.B. Sm.	Endemic
	C. heterophylla Nees	Endemic
	C. ibiramae McClure & L.B. Sm.	Endemic

Table 4 (cont'd)

	C. juergensii Hack.	–
	C. leptophylla Nees	Endemic
	C. linearis N.E. Br.	Endemic
	C. longispiculata L.G. Clark	Endemic
	C. meyeriana Döll	Endemic
	C. microphylla (Döll) L.G. Clark	Endemic
	C. mimosa subsp. *australis* L.G. Clark	Endemic
	C. mimosa McClure & L.B. Sm. subsp. mimosa	Endemic
	C. nudiramea L.G. Clark	Endemic
	C. nutans L.G. Clark	Endemic
	C. oligophylla Rupr.	Endemic
	C. oxylepis (Hack.) Ekman	Endemic
	C. pinifolia (Nees) Nees	Endemic
	C. pulchella L.G. Clark	Endemic
	C. ramosissima Lindm.	–
	C. riosaltensis L.G. Clark	Endemic
	C. sclerophylla Döll	Endemic
	C. sellowii Rupr. *C. tenella* Nees	Endemic
	C. tenella Nees	–
	C. tenuiglumis Döll	Endemic
	C. tenuis E.G. Camus	Endemic
	C. urelythra Hack.	Endemic
	C. wilkeskii Munro	Endemic
	C. windischii L.G. Clark	Endemic
	*C. sp. nov. 1** (Clark, pers. comm.)	Endemic
Colanthelia McClure & E.W Sm.	*C. burchellii* (Munro) McClure	Endemic
	C. cingulata (McClure & L.B. Sm.) McClure	–
	C. distans (Trin.) McClure	Endemic
	C. intermedia (McClure & L.B. Sm.) McClure	Endemic
	C. lanciflora (McClure & L.B. Sm.) McClure	Endemic
	C. macrostachya (Nees) McClure	Endemic
	C. rhizantha (Hack.) McClure	Endemic
	*C. sp. nov. 1** (nobis)	Endemic
	*C. sp. nov. 2** (nobis)	Endemic
Elytrostachys McClure	*E. sp. nov* . * (Judziewicz et al. 1999)	–
Eremocaulon Soderstr. & Londoño !	*E. amazonicum* Londoño	Endemic
	*E. asymmetri*cum (Soderstr. & Londoño) Londoño	Endemic
	E. aureofimbriatum Soderstr. & Londoño	Endemic
	E. capitatum (Trin.) Londoño	Endemic
	*E. setos*um Londoño & L.G. Clark	Endemic
Filgueirasia Guala!	*F. arenicola* (McClure) Guala	Endemic
	F. cannavieira (Silveira) Guala	Endemic
Glaziophyton Franch.!	*G. mirabile* Franch.	Endemic
Guadua Kunth	*G. calderoniana* Londoño & Judz.	Endemic
	G. ciliata Londoño & Davidse	–
	G. glomerata Munro	–
	G. latifolia (Humb. & Bonpl.) Kunth	–
	G. macrostachya Rupr.	–
	G. maculosa (Hack.) E.G. Camus	Endemic
Guadua Kunth	*G. paniculata* Munro	–
	G. paraguayana Döll	–
	G. refracta Munro	Endemic
	G. sarcocarpa Londoño & Peterson subsp. *sarcocarpa*	–
	G. sarcocarpa subsp. *purpuracea* Londoño & Peterson	–
	G. superba Huber	–
	G. tagoara (Nees) Kunth	–
	G. trinii (Nees) Nees ex Rupr.	–
	G. virgata (Trin.) Rupr.	Endemic
	*G. sp. nov. 1** (Londoño, pers. comm.)	?
	*G. sp. nov. 2** (Londoño, pers. comm.)	?
Merostachys Spreng	*M. abadiana* Send.	Endemic
	M. annulifera Send.	Endemic
	M. argentea Send.	Endemic

Table 4 (cont'd)

	M. argyronema Lindm.	Endemic
	M. bifurcata Send.	Endemic
	M. bradei Pilg.	Endemic
	M. brevigluma Send.	Endemic
	M. burmanii Send.	Endemic
	M. calderoniana Send.	Endemic
	M. caucaiana Send.	Endemic
	M. ciliata McClure & L.B. Sm.	Endemic
	M. clausenii Munro var. *clausenii*	–
	M. clausenii var. *mollior* Döll	Endemic
	M. exserta E.G. Camus	Endemic
	M. filgueirasii Send.	Endemic
	M. fimbriata Send.	Endemic
	M. fisheriana Döll	Endemic
	M. fistulosa Döll	Endemic
	M. glauca Send.	Endemic
	M. kleinii Send.	Endemic
	M. lanata Send.	Endemic
	M. latifolia R. Pohl	–
	M. leptophylla Send.	Endemic
	M. magellanica Send.	Endemic
	M. magnispicula Send.	Endemic
	M. medullosa Send.	Endemic
	M. multiramea Hack.	Endemic
	M. neesii Rupr.	Endemic
Merostachys Spreng	*M. petiolata* Döll	Endemic
	M. pilifera Send.	Endemic
	M. pluriflora E.G. Camus	Endemic
	M. polyantha McClure	Endemic
	M. procerrima Send.	Endemic
	M. ramosissima Send.	Endemic
	M. riedelianana Döll	Endemic
Merostachys Spreng (cont'd)	*M. rondoniensis* Send.	Endemic
	M. scandens Send.	Endemic
	M. sellovii Munro	Endemic
	M. skvortzovii Send.	Endemic
	M. sparsiflora Rupr.	Endemic
	M. speciosa Spreng.	Endemic
	M. ternata Nees	Endemic
	M. vestita McClure & L.B.Sm.	Endemic
	*M. sp. nov. 1** (Sendulsky, pers.comm.)	Endemic
	*M. sp. nov. 2** (idem)	Endemic
	*M. sp. nov. 3** (idem)	Endemic
	*M. sp. nov. 4** (idem)	Endemic
	*M. sp. nov. 5** (idem)	Endemic
	*M. sp. nov. 6** (idem)	Endemic
	*M. sp. nov. 7** (idem)	Endemic
	*M. sp. nov. 8** (nobis)	Endemic
	*M. sp. nov. 9** (nobis)	Endemic
Myriocladus Swallen	*M. neblinensis* Swallen	–
	M. paludicolus Swallen	–
	M. virgatus Swallen	–
Neurolepis Meiss.	*N. diversiglumis* Soderstr.	–
Rhipidocladum McClure	*R. parviflorum* (Trin.) McClure	–

Table 5. Comparison of the number of bamboo genera and species in Brazil and in the New World

Taxa	Brazil	New World
Genera	34.0 (89.0%)	38
Species	232.0 (65.0%)	ca. 356.0

Table 6. Endemic bamboo genera in Brazil and their respective number of species

Genus		# Spp. (incl. undescribed spp.)
Alvimia		3
Apoclada		1
Athroostachys		1
Diandrolyra		3
Eremocaulon		5
Filgueirasia		2
Glaziophyton		1
Reitzia		1
Sucrea		3
Total	9	19

Table 7. The five most speciose bamboo genera in Brazil

Genus	# Species	% contribution to the total # spp. in Brazil
Merostachys	53	23
Chusquea	40	17
Olyra	18	7.8
Pariana	18	7.8
Guadua	16	7
Total	145	62.6

Table 8. Bamboo species distribution in the main biomes of Brazil: Atlantic Forest, Amazonia, and Cerrado

Biome	# spp.	%
Atlantic Forest	151.0	65.0
Amazonia	60.0	26.0
Cerrado	21.0	9.0
Total	232.0	100.0

Table 9. List of the most common bamboo species cultivated in Brazil

Binomial	Common names (s)	Obs.
Bambusa blumeana Schult. & Schult. f.	–	Rare
B. dissemulator McClure	–	Rare
B. multiplex (Lour.) Raeusch. ex Schult. & Schult. f.	Bambu-multiplex, bambu-folha-de-samambaia	Common
B. tulda Roxb.	–	Rare
B. tuldoides Munro	–	Rare
B. ventricosa McClure	Bambu barrigudo	Rare
B. vulgaris Schrad. ex J.C. Wendl.	Bambu, bambu comum	Widespread
Dendrocalamopsis beecheyana (Munro) Keng f.	–	Rare
Dendrocalamus asper (Schult. & Schult. f.) Backer ex K. Heyne	Bambu balde, bambu gigante	Common
D. latiflorus Munro	–	Rare
D. strictus	Bambu balde, bambu gigante	Rare
Gigantochloa apus (Schult. & Schult. f.) Kurz	–	Rare
Guadua angustifolia Kunth	Guadua	Rare
Phyllostachys aurea Rivière & C. Rivière	Bambu amarelo, bambu de jardim, bambu-vara-de-pescar, bambu dourado; cana-da-India	Widespread
P. bambusoides Siebold & Zucc.	Bambu japonês	Common
P. sp.	–	Rare
P. nigra (Lodd. ex Lindl.) Mundro	Bambu preto; bambu negro	Rare
Pseudosasa japonica (Siebold & Zucc. ex Steud.) Makino	Bambu metaque	Common
Sasa fortunei (Van Houtte) Fiori	Bambu-miniatura	Common
Sinoarundinaria falcata (Nees) C.S.Chao & Renv.	Bambu-de-jardim	Widespread

Table 10. Most common bamboo mimics in Brazil

Binomial	Family	Common name (s)	Obs.
Arundo donax L.	Poaceae:Arundinoideae	Cana-do-reino	Introduced from Europe
Chamaedora erupens Moore	Arecaceae	Camedórea-bambu; bambu-areca	Introduced from Mexico and Honduras
C. fragrans Mart.	Arecaceae	Camedórea-do-peru	Introduced from Peru
C. microspadix Burr.	Arecaceae	Camedórea elegante	Introduced from Mexico and Guatemala
C. stolonifera Wendl.	Arecaceae	Camedórea-rasteira	Introduced from Mexico and Guatemala
Cortaderia selloana Asch. & Graebn.	Poaceae	Capim dos pampas, penacho branco	Native
Costus	Costaceae	--	Native
Gynerium sagittatum (Aubl.) P. Beauv.	Poaceae: Panicoideae	Canavieira; canabrava	Native
Ichnanthus bambusiflorus (Trin.) Döll	Poaceae: Paniceae	--	Native
I. breviscrobs Döll	Poaceae: Paniceae	--	Native
I. panicoides P. Beauv.	Poaceae: Paniceae	--	Native\
Ischnosiphon sp.	Marantaceae	--	Native
Lasiacis divaricata (L.) Hitchc.	Poaceae: Paniceae	Taquari	Native
L. ligulata Hitchc. & Chase.	Poaceae: Paniceae	Taquari	Native
L. sorghoidea (Desv.) Hitchc. & Chase.	Poaceae: Paniceae	Taquari	Native
Miscanthus sinensis Anders.	Poaceae: Andropogoneae	Capim zebra	Introduced
Orthoclada laxa (Rich.) P. Beauv.	Poaceae: Centothecoideae	--	Native
Panicum tricholaenoides Steud.	Poaceae: Paniceae	--	Native
Pinanga kuhlii Blume	Arecaceae	Pinanga	Introduced from Java and Sumatra
Pogonatherum crinitum (Thumb.) Kunth	Poaceae: Andropogoneae	Bambu japonês	Introduced
Rhapis excelsa Henry ex Rehd.	Arecaceae	Palmeira-ráfis	Introduced from China
Thysanolaena maxima O. Ktze.	Poaceae:	Capim-bambu	Introduced from Indonesia

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Phenology and Culm Growth of *Bambusa cacharensis* R.Majumdar in Barak Valley, Assam, North-East India

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Phenology and growth of the culms of 'Betua' *(Bambusa cacharensis)*, a priority village bamboo was studied in the Cachar district of the Barak Valley, Assam, North-East India. The culms emerge from June to September with a peak during July and August. Growth continues for a period of 135 days showing peak growth from the sixth to the tenth week. The growth curve for culms is S-shaped. The leafing pattern is the periodic growth leaf-exchange type for one and two year old culms and the periodic growth evergreen type in current year culms. The sheath is persistent and retained for about 90 days. The success of this village bamboo species is discussed in light of the ecological significance of its growth pattern.

Bamboo is an important non-timber forest product (NTFP) of subsistence agriculture and meets several commercial, social, environmental and economical needs. (Ramakrishnan 1992, Rao 1998, Belcher 1996, Blowfield et al. 1996, Sundriyal, *et al.* 2002). India is the second largest producer of bamboo in the world next to China and also has the rich diversity of bamboos with almost 130 species spread over 18 genera (NMBA 2004). Of the 78 species of bamboos distributed in the North Eastern region of India (Biswas 1988, Hore 1998), *Bambusa cacharensis* (locally *betua*) forms an important village bamboo prioritised by the rural people of Barak Valley in Southern Assam (Nandy 1998; Nath 2001). The species is endemic to Assam (Majumdar 1983, Barooah and Barthakur 2003) and distributed abundantly within the Brahmaputra and the Barak Valley of North East India between 24° 00'- 26° 40'N latitude and 91° 40'-94° 24' E longitude, with an altitudinal range of 30 m to 250 m above mean sea level (Singha *et al.* 2003). Studies on phenology and growth pattern of bamboos are relatively scarce, although see: Ueda (1960), Rao *et al.* (1990), Schlegel (1991), Shanmughavel *et al.* (1996) and Banik (2000). Such studies are important in developing scientific management systems for optimum yield. The present work assesses the phenology and culm growth of *Bambusa cacharensis,* an important village bamboo resource of Barak Valley, Assam in North East India.

MATERIALS AND METHODS

Study area and climate

The study was conducted in the village of Dargakona (latitude 24° 41" and longitude 92° 45") of Cachar district in South Assam, North East India. The site has a warm humid climate with annual rainfall of 2660 mm, most of which is received during the southwest monsoon season (May to September). The mean maximum temperature ranges from 25.4 C (January) to 32.6 C (August) and the mean minimum temperature varies from 11 C to 25 C (August). The dry season usually occurs from December to February. The rural people have prioritized *B. cacharensis* in their home gardens and bamboo groves because of its desirable growth architecture (few branches and a straight culm) and multiple uses (Nath 2001).

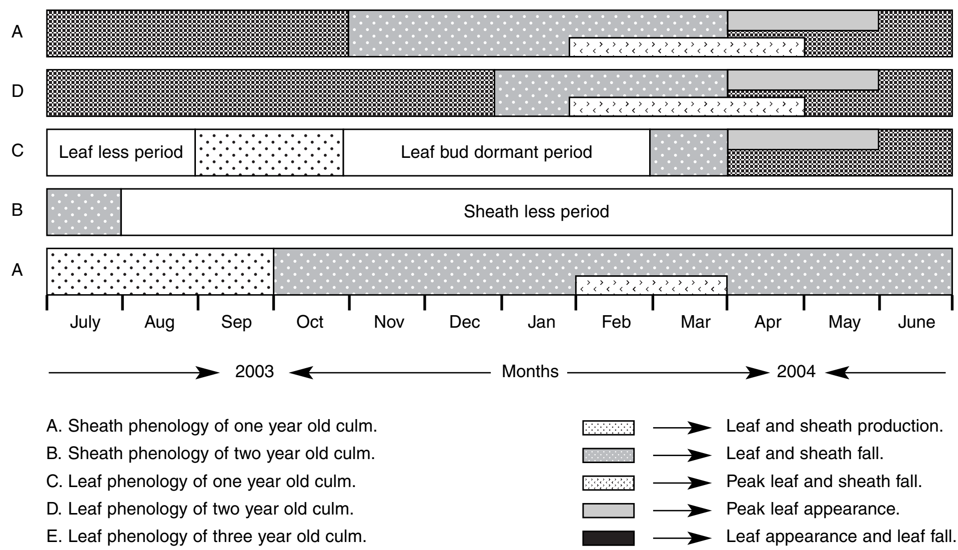


Figure 1: Graphical representation of sheath and leaf phenology of one, two and three year old culms of *Bambusa cacharensis.*

Phenology of the culm

Phenological observations were made on first, second and third year culms during the period July 2003 to June 2004. Characteristics of sheath, branching and leafing activity on selected culms were made at monthly intervals. The data on phenological observations were compiled in fig. 1.

Culm growth

Culm growth was observed during July 2003 to November 2003. Because bamboo is a quick growing plant and its height is stabilized over a comparatively short span of time, longitudinal study was preferred over random samples at different times (Hills 1974). Twenty five newly sprouted culms were selected randomly and identified with numbered aluminium foil. The culm growth was observed for 135 days starting in July. Initially the heights of the selected culms were measured daily for first 90 days. Thereafter the height of each culm was measured on every third day for 30 days and for the last two weeks (the growth being slower) they were measured on every fifth day. It was observed that maximum height is attained within four and a half months. Since all the 25 culms began their life almost together, their average height was considered to study the behavior of growth. The growth data were then plotted on the graph (fig.2 (a)). Although the maximum height is attained within a short period of four and a half months, growth does not occur at the same rate throughout this period. Therefore we studied how growth rate changes over different months, identied the peak growth period and so on. To study the growth rate in height, the average rate of change in height between any two-time epochs, say t1 and t2, is measured as

$$\frac{y_2 - y_1}{t_2 - t_1}$$

where y1 and y2 are heights at time t1 and t2. This may be used as an estimate of the instantaneous rate of change at the mid-point of the time interval. These rates of change are plotted against time (fig. 2(b)).

RESULTS AND DISCUSSION

Culm phenology

New culms emerged from June to August (rainy season) with a peak in July. The young culm sheaths were light green, during this period. The color of the sheaths changed to light brown and brown at maturity. The sheaths fell in October (i.e. after 3 months) indicating the semi-deciduous nature of the culm sheath. The few sheaths retained in second year culms, fell off by July. Sheath fall starts from the top of the culm and proceeds downwards and this pattern is related to the appearance of branches and leaves on the culm. The ecological significance of culm sheath retention in different bamboo species needs further investigations.

The leaves started appearing in September (i.e. 2 months after culm emergence) and were confined to the upper one-third portion of the culm. No leafing activity was observed from November to March. Leafing activity was renewed after the dormant period and continued till June when leaves covered the lower two third portion of the culm as well. Thus a one year old culm of *B. cacharensis* is fully leafed out at 10 months, compared to a culm of *Melocanna baccifera* which remains almost leafless for at least the first 8-10 months of it's appearance (Nandy *et al.* 2004).

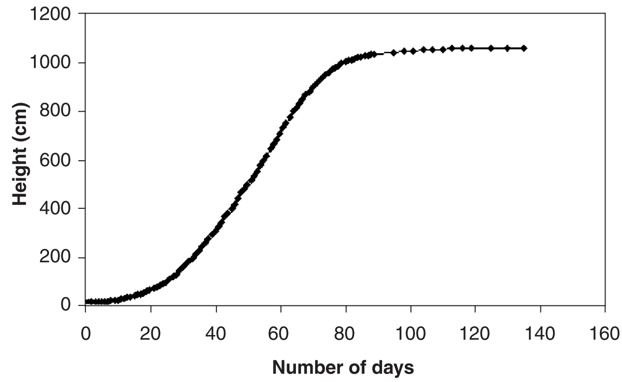
The leaves, which appear during the months of April and May start falling after 8-9 months with a peak fall during February to April (drier months). The leafing pattern in second and third year culms showed the *periodic growth leaf exchange type* (Longman and Jenik 1987), as peak leaf fall is associated with new leaf appearance. According to local bamboo growers, during the longer drier months, because of delayed rainfall, the culms may even remain leafless for a brief period (the *periodic growth deciduous type*). First year culms however, showed periodic growth evergreen type as there is no peak leaf fall during the first year of culm emergence – although leafing activity takes place twice (September and April). This pattern of differential leafing activity in culms of different ages is likely an adaptive strategy towards the success of this species under the prevailing environmental conditions. The relation between leaf fall and flushing is thus related to weather conditions. The comparatively drier period prevailing during the months of February, March and April with very little moisture in the soil may be the cause of shedding of leaves at this time to avoid transpiration loss as is the case with pines (Das and Ramakrishnan 1992).

Culm growth

The height growth curve of the culms (fig. 2(a)) has a smooth S shape. The shape of the growth curve is described by the rate of change of growth at different times. From the growth rate curve of culm height (fig. 2(b)) one may observe that during the first 15 days, growth is very slow, only 1.0 cm to 3.0 cm in height per day. However, over the next 40 days (i.e. up to last week of August) the growth rate increases very fast, from 3.0 to 28.0 cm per day. During the next 30 days till last week of September growth rate starts falling. Within 30 days the growth rate reduces to 3.0 cm per day. It is further observed that during the first week of August till September 11, the growth rate varies between 15.0 cm to 28.0 cm. This period may be termed as peak growth period. Nearly 66% of the total height growth is attained |during these 40 days, which is only 30% of the total growth period. Such a peak elongation period was also reported in other bamboo species by Rao et al. (1990). During the last phase of growth which continues for almost 50 days, growth rate is extremely slow, varying from 0 to 3.0 cm, finally showing zero growth by middle of November.

As compared to culms of *Melocanna baccifera* (Nandy et al. 2004), which grows for more than eight months, *Bambusa cacharensis* has a much shorter span of growth of less than five months. Information on the duration of culm extension growth is scarce. Limited information available indicates thick-walled bamboos such as *B. bambos* having 135 days of extension growth, which is similar as in *B. cacharensis.* The shorter extension period could be a strategy to allocate more resources towards culm thickness in thick walled culms as *B. cacharensis* and other similar species. Shanmughavel and Francis (1996) have reported an average height growth of 30 cm per day in *B. bambos.* In the present study average height growth during the peak growth period varies from 15 cm to 28 cm per day. In *Bambusa tulda* maximum growth of 70 cm per day was reported (Dransfield and Widjaja 2001). The growth strategy exhibited by *B. cacharensis* with rapid extension growth and periodic growth leaf exchange type of leafing pattern along with it's multiple uses makes this species a preferred village bamboo of Barak Valley in North- East India.

(a)



(b)

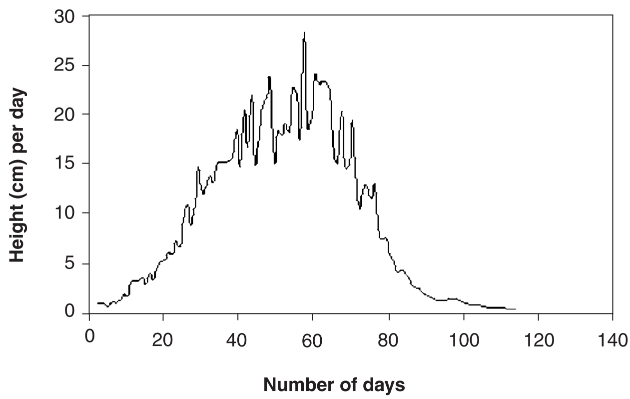


Figure 2. Growth curves for *Bambusa cacharensis*

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Validation of *Chusquea decolorata* Munro (Poaceae: Bambusoideae: Bambuseae)

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ABSTRACT

The herbarium name *Chusquea decolorata* Munro is here validated by providing a Latin description and formal designation of a type specimen. Placement of this species in *Chusquea* Sect. *Verticillatae* is confirmed and the species is compared and contrasted with the other South American species of Sect. *Verticillatae* and *C. cumingii,* a superficially similar Chilean species with which *C. decolorata* has been compared previously. Available specimens and the provenance of the species are discussed.

Colonel William Munro is well known in the bamboo world for his 1868 treatise on the bamboos. He named many new species of woody bamboo, provided detailed descriptions, and proposed one of the earliest comprehensive classification systems for bamboos. Even so, Col. Munro was unable to finish all of the work he wanted to do on bamboos, as demonstrated by the existence of his notes on herbarium specimens indicating provisional names for species that were never published. One example of this is the name *Chusquea decolorata* Munro that can be seen on two specimens (one at Kew and one at Paris) collected (apparently) by J. A. Pavon y Jiménez during the Ruiz and Pavon botanical expedition that took place from 1778 to 1788 in what are now Peru and Chile. This species was not mentioned in Munro's 1868 bamboo monograph and was evidently never published elsewhere by him.

Lorenzo Parodi, the renowned Argentinian grass specialist of the 20th century, saw the annotated specimen at the herbarium in Paris and realized that the name had never been published. He attempted to validate this name in a publication on the species of *Chusquea* in Chile (Parodi 1945). Parodi compared *C. decolorata* to *C. cumingii* Nees, a Chilean species with similarly small leaves, but did not provide a Latin diagnosis for *C. decolorata* as required by the International Code of Botanical Nomenclature (Greuter et al. 2000: Art. 36.1) for all names published after 1 January 1935. The lack of a Latin diagnosis for *C. decolorata* means that this species name was not properly validated by Parodi and I thank Dr. Rob Soreng of the U.S. National Herbarium, Smithsonian Institution, for pointing this out to me. In this paper I hereby validate the name for this species and provide some additional information on its probable distribution and affinities within *Chusquea*.

MATERIALS AND METHODS

During my visits to European herbaria in 1995 and 2003, I was able to view the specimens of this species in both Kew and Paris, but I also found six additional sheets of this collection in the herbarium at Geneva. There are two sheets at Kew and one at Paris, giving a total of nine duplicates from what I will argue is a single gathering, even though the sheets are inconsistently annotated.

Of the two Kew sheets, one consists of two flowering subsidiary branches and is annotated by Munro with a handwritten page of notes attached. Written in the lower left hand corner is "Bambusa de la Concepción de Chile". The second sheet consists of a flowering stem with several nodes and internodes. It is clearly identified as "Peruvia. Herb. Pavon" but there are no annotations by Munro or Parodi.

The specimen in Paris, consisting of two separate stem segments each bearing a node with flowering branches, clearly shows Munro's annotation label, with the name *C. decolorata*. The label further indicates that the species belongs to [*Chusquea*] Sect. *Dendragrostis* Nees (now considered a synonym of *Chusquea*, Clark 1997), and that it is close to *C. pallida* Munro (a Venezuelan and Colombian species belonging to *Chusquea* sect. *Verticillatae*). However, there is no indication of who collected this specimen-there is a small, handwritten label that says "*Bambusa* sp. na. de Chile". A third, printed label on the same sheet says "Provenant de l'herbier de Pavon (1868. No. 36)".

The six sheets of *C. decolorata* from the Geneva herbarium (see figures 1 & 2) match those from Kew and Paris, but there are additional variations in the labeling. Four of the six are clearly marked with pink tags as being from "Peruvia Herb. Pavon." Another sheet bears a handwritten label "*Bambusa* n. sp., Perou, M. Pavon" and the last sheet has a handwritten label in French that indicates that this species was collected in the forests of Chile and Peru. The common name of "quila" for *C. decolorata* is also given in this label. A packet and a piece of paper pinned to this latter sheet both have "Peruvia" hand-printed on them. For the most part these specimens consist of longer segments of stems, or more likely branches, with several nodes.

Despite the variety of labels, it is very unlikely that these nine sheets in three herbaria represent more than one gathering. Duplicates were probably distributed at different times, accounting for the differences in labels and perhaps even the confusion about the provenance of the species. The material on all of these sheets is at about the same stage of flowering, so the most likely explanation is that they were collected at the same time in the same location.

TAXONOMIC TREATMENT

Chusquea decolorata Munro ex L.G. Clark, sp. nov. TYPE: PERU. M. Pavon [holotype: G 8140/12; isotypes: G (5 sheets), K (2 sheets), P (1 sheet)].

Ramificatio extravaginalis; rami subsidiarii cujusquisque nodi (9) 13-22, 3-4 cm longi synflorescentiis exclusis, patentes. Folia ramorum vaginis glabris; laminis 3-5 (-7.4) cm longis, 0.3-0.5 cm latis, longitudibus versus latitudibus = 10-15, abaxialiter pilis ad basim in latere costae ceterum glabris; ligulis interioris ca. 0.5 mm longis, truncatis vel irregularibus. Synflorescentiae 2.5-3 cm longae, paniculatae, contractae. Spiculae 8.5-9 mm longae, dorsaliter compressae; glumae I et II minutae, ca. 0.1 mm longae; glumae III et IV breviter subulatae; gluma III 3-3.5 mm longa, abaxialiter pubescens; gluma IV 3.5-4 mm longa, abaxialiter pubescens in dimidio superiore; lemma 8-8.5 mm longum, acutum vel apiculatum, abaxialiter pubescens supra basin; palea ca. 8 mm longa, bimucronulata, abaxialiter pubescens in dimidio superiore. Lodiculae 3, ciliatae ad apicem; par anticum 1-1.4 mm longum, lodicula postica ca. 1 mm longa.

Internodes 1.5-3 mm in diameter, 16-18.5 cm long, glabrous, probably from the culm apex or branches. *Culm leaves* not seen complete; sheaths persistent, apparently abaxially glabrous; girdle to ca. 1 mm long, glabrous. *Branching* extravaginal; central bud dome-shaped, prophyll pubescent; leafy subsidiary branches (9-) 13-22 per node, constellate, in more or less one row, 3-4 cm long excluding the inflorescence, spreading. *Foliage leaves* with sheaths striate, the nerves raised, glabrous, internerves appearing papillose, at least the overlapping margin ciliate, the summit bearing a tuft of cilia 1.5-2 mm long on each side; blades 3-5 (-7.4) cm long, 0.3-0.5 cm wide, L:W = 10-15, not tessellate, more or less stiff, ascending, glabrous except for a small patch of hairs on one side of the midrib abaxially at the base, the midrib adaxially barely or not distinguishable, abaxially slightly raised and distinguishable for the full length, centric to slightly excentric, the base rounded-attenuate, the apex tapering, acute to shortly subulate, the margins cartilaginous, more or less well developed but sparsely denticulate; pseudopetioles 0.5-1 mm long, more or less well defined, glabrous; outer ligule ca. 0.5 mm long, irregular, glabrous; inner ligule ca. 0.5 mm long, truncate

Figure. 1. Holotype of *Chusquea decolorata* in the Geneva herbarium.

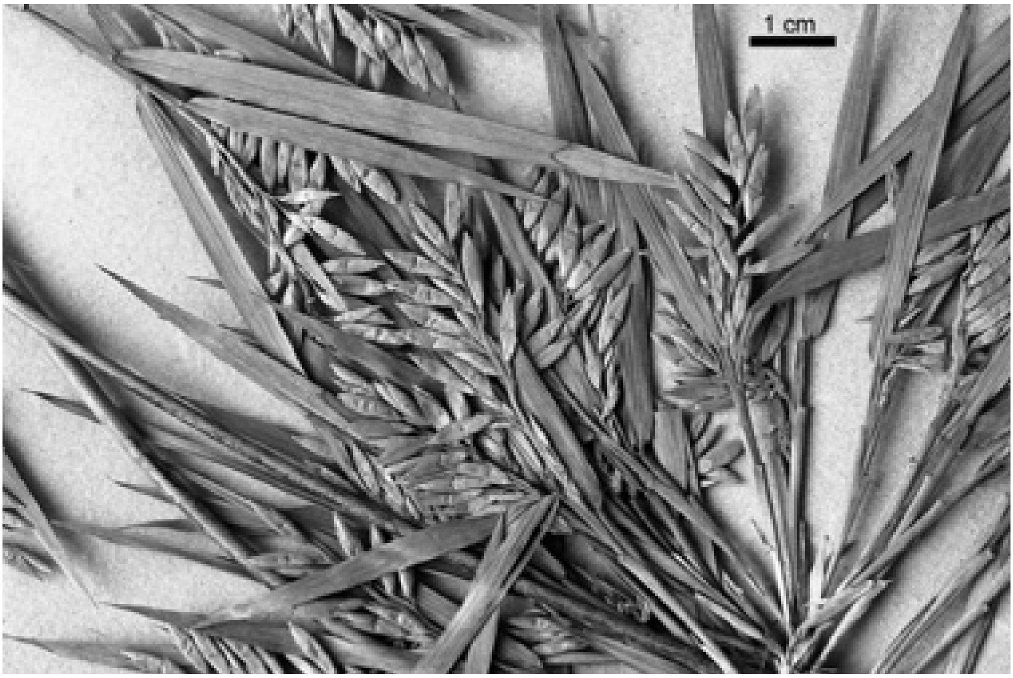

Figure. 2. Close-up of one of the Geneva isotypes of *Chusquea decolorata* showing synflorescences and spikelets.

to irregular. *Synflorescences* 2.5-3 cm long, 1-1.5 cm wide, paniculate but branching reduced, rachis angular, pubescent, the edges ciliate; branches and pedicels pubescent, the lowermost branch to 0.5 cm long, the pedicels 1-2.5 mm long. *Spikelets* 8.5-9 mm long, dorsally compressed; glumes I and II minute, ca. 0.1 mm long, almost forming a cupule, glabrous; glumes III and IV short subulate, rounded-triangular, shallowly navicular, 5-7-nerved; glume III 3-3.5 mm long, 1/3-2/5 the spikelet length, abaxially pubescent; glume IV 3.5-4 mm long, 2/5-1/2 the spikelet length, abaxially pubescent on the upper half; lemma 8-8.5 mm long, acute to apiculate, abaxially pubescent on the upper 3/4, rounded-triangular, navicular, 9 (-11)-nerved; palea ca. 8 mm long, bimucronulate, navicular, abaxially pubescent on the upper half, 6-nerved, 2-keeled, sulcate only toward the apex. *Lodicules* 3, apically long ciliate, weakly vasculated; anterior pair 1-1.4 mm long, asymmetrical; posterior one ca. 1 mm long, symmetrical, narrow. *Stamens* 3; anthers ca. 5 mm long. *Ovary* not seen. *Fruit* not seen.

The combination in *C. decolorata* of the basal, abaxial tuft of hairs on the foliage leaf blades and dorsally compressed spikelets with glumes I and II almost completely reduced caused me to assign it to *Chusquea* Sect. *Verticillatae* (Judziewicz et al. 1999). Spikelets with glumes III and IV and the lemma abaxially pubescent distinguish *C. decolorata* from the other members of this section. Other South American species currently assigned to Sect. *Verticillatae* include *C. albilanata* L. G. Clark, *C. delicatula* A. Hitchc., *C. pallida, C. simpliciflora* Munro, C. *uniflora* Steud., and *C. tuberculosa* Swallen. There is in addition an as yet undescribed species of this section from southwestern Ecuador. *Chusquea delicatula* is incompletely known, and I have no confirmed flowering material available so its position in this section is provisional, but its foliage leaf blades are 0.2-0.4 cm wide and only up to about 2 cm long, smaller than those of *C. decolorata*. The other South American Sect. *Verticillatae* species have glabrous spikelets and larger, more open and pyramidal synflorescences except for *C. simpliciflora,* which has racemose synflorescences of 3-4 spikelets. Although branching in the synflorescences of *C. decolorata* is reduced, there are approximately 14-16 spikelets per synflorescence.

Among the Chilean species of *Chusquea*, *C. decolorata* most resembles *C. cumingii.* Closer inspection reveals that the latter species lacks the basal, abaxial tuft of hairs on the foliage leaf blades and also that it has more or less laterally compressed spikelets with glumes I and II well developed. *Chusquea cumingii* belongs to *Chusquea* Sect. *Chusquea*, so the similarity between these two species is superficial.

Parodi (1945) noted that although a label on the specimen he saw in Paris was marked “De Chile”, the species might not be Chilean although he was unaware of any other material matching the characteristics of the species from anywhere else in South America. I have collected in Chile and examined material in SGO, CONC, and VALD, the Chilean herbaria with major holdings of *Chusquea*, and have seen nothing that matches this species. I also have not seen material from anywhere else in South or Central America that matches this collection. Considering that the Ruiz and Pavon expedition visited what is now both Peru and Chile, it seems most likely that *C. decolorata* is a Peruvian species, but this remains to be verified through additional fieldwork. The superficial similarity between *C. decolorata* and *C. cumingii,* which is definitely Chilean, may also have contributed to the confusion surrounding the source of this collection.

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