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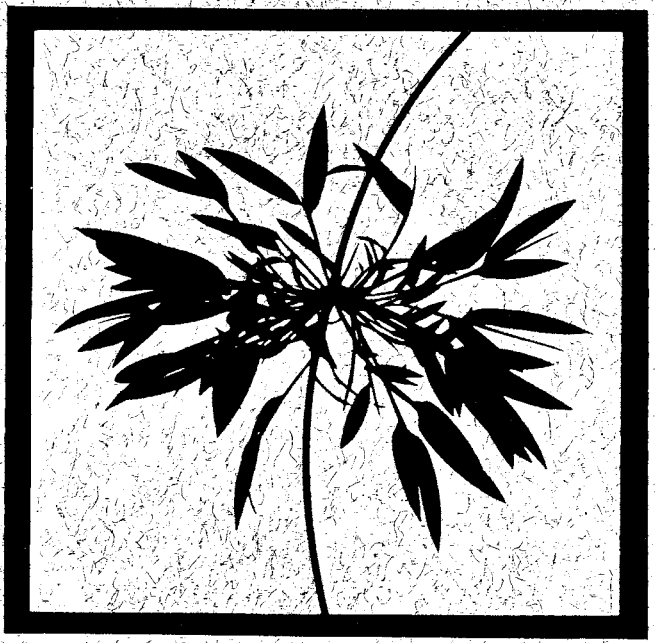

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OBJECTIVES

The objectives of the Society are:

1. To provide a source of information on the identification, propagation, utilization, culture, and appreciation of bamboos. To disseminate and store this information, the Society has established a journal, and is establishing a reference library, and a herbarium.

2. To promote the utilization of desirable species by developing stocks of plants for distribution to botanic gardens and eventually to the general public.

3. To preserve and increase the number of bamboo species in the United States. To implement this, the Society has established a bamboo quarantine greenhouse at Quail Botanic Gardens in order to import selected species from foreign sources.

4. To plant and maintain a bamboo garden which displays the characteristic beauty of mature plants and to provide plant material for research in the taxonomy, propagation, and culture of as many species as possible.

5. To support bamboo research in the field and to establish facilities necessary for approved research projects.

Richard Haubrich*: Handbook of Bamboos Cultivated in the United States Part II: The Giant Tropical Clumping Bamboos

Introduction

The giant tropical bamboos include the largest of all grasses, the tree grasses which grow upright to over 100 ft. tall with culms 8 in. in diameter. The group is represented in the United States by two genera, *Bambusa* Schreber and *Dendrocalamus* Nees, whose vegetative characteristics are very similar. I have included the descriptions of 13 different species plus 9 varieties all of which are common to the extent that they are established in at least two different locations in the U.S. I have left out several species of the genera *Bambusa*, *Dendrocalamus*, *Gigantochloa* Kurz ex Munro, *Melocanna* Trinius and *Oxytenanthera* Munro whose identity has not been confirmed or which are established in only one place.

Section 1 describes the vegetative characteristics which are common to the group of species along with their growth habit and methods of propagation. Section 2 is and explanation of Table 2 which summarizes the species characteristics, and Section 3 describes each species and gives locations where they are growing in the U.S. The details of the locations are in Section 4. The descriptions of species are based on those of several authors plus personal observation. I have listed after each species name in Section 3 the references used in my description of that species.

1. Characteristics of the Tropical Clumping Bamboos

The largest genus of giant tropicals is *Bambusa* which consists of about 70 species from Asia and Africa plus another 30 species from America which belong to the subgenus *Guadua* (Kunth) Nees. *Dendrocalamus* contains about 30 species from Asia.

1.1. Common Vegetative Characteristics

The members of this group of bamboos can be distinguished from others by three characteristics: the branches at each midculm node are numerous and of two sizes with the larger ones typically several times as thick as the smaller ones, the culm leaves are deciduous, and the culms are cylindrical in cross section lacking the groove that occurs above the branches on the internodes of bamboos such as *Phyllostachys*. There are exceptions to the rules in some species. The branches of *B. textilis*, for example, are more nearly equal in size than in the other species. The culm leaves are usually persistent at the lowest few nodes for most species and new culms that shoot in late summer or fall may carry the culm leaves until the following spring when the growing branches push them off. The culms are not always cylindrical; in a few species such as *B. guadua* the culm is flattened just above the point of branch

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attachment.

All members of the group have pachymorph rhizomes which are generally thick and short producing culms spaced close together in rather compact clumps. Sometimes the basal part of the rhizome, called the neck, is considerably elongated allowing the culms to space themselves up to several feet apart. The more open clump can occur in some of the *Bambusa* species such as *B. guadua* and *B. vulgaris*.

The foliage leaves of the group are not tessellated like those of *Phyllostachys* and most hardy bamboos; all the veins run parallel to the length of the leaf. Some species, however, have small pellucid dots between the veinlets of the leaves that give the appearence of transverse veins. They are visible with a 10 power magnifier when holding the leaf up to the light. The markings are not as distinct and much harder to see than the transverse veins of the hardy bamboos.

1.2. Growth and Hardiness

The tropical clumpers typically initiate culm growth in late summer or early fall. In Southern California the first shoots usually appear in late June and shooting continues until October. Sometimes shooting starts as early as April and occasionally plants shoot throughout winter. Most growth activity ends, however, with the onset of cool nights in November by which time the early emerging culms will have branches and leaves while the late shooters will remain branchless until spring.

All of the giant tropicals are subject to damage and death due to frost. There are two classes of species, those that are damaged by only a few degrees of frost and those which can tolerate temperatures down to 20 ° F. or lower. Three of the species are said to tolerate even lower temperatures and of these *B. textilis* has the reputation of being the most hardy. I have divided the species into 3 different hardiness groups. Column 23 of Table 2 gives a nominal temperature in degrees F. at which damage begins for each species. The temperatures are approximate since damage depends on many factors other than minimum temperature.

1.3. Propagation

Propagation of the tropical clumping bamboos is usually done by clump division. The rhizomes are cut into sections from a growing clump with each section containing one or more culms. Generally if the division contains at least one culm and a sufficiently large piece of rhizome, the success rate is over 90%.

A second method of propagation is by means of culm or branch cuttings which have two advantages over clum division - they avoid the job of cutting through the tough rhizome and more plants can be produced from the same material. Cuttings can consist of whole culms, sections of culms with one or more nodes, basal sections of branches, or sections of branches. The success rate for cuttings is variable and often lower than that for clump divisions; usually somewhere between 0 and 50 % of the cuttings will produce viable plants. The method requires more skill (or luck) than clump division and the results can depend on species, size, type and age of the cutting material, time of the year, growing conditions of the cuttings, and the

condition of the mother plant. An extensive review of all propagation methods for clumping bamboos is given by McClure (1966).

2. Species Characteristics

The species of giant clumping bamboos are easier to distinguish one from another than are the species of *Phyllostachys*. As in other bamboos the culm leaf is a valuable clue to identification, but often the species of a giant tropical can be determined simply from the overall appearence of the plant. Table 2 summarizes those characteristics that are of value in identifying the species. As always one should look at fresh material from a healthy plant.

2.1. The Culms

Columns 1 and 2 of Table 2 give the maximum height in feet and the maximum diameter in inches of the culms of a plant grown under ideal conditions. Since all are tropical or subtropical species, cool climates generally result in a smaller maximum size. For example, *B. oldhamii* reaches its full height of 55 ft. in San Diego, California, but grows no taller than about 30 ft. in the San Francisco area of Northern California.

Some species grow in a very tight clump with culms almost touching one another while others grow in open clumps with the culms spaced up to 2 or 3 ft. apart. Column 3 is a 0, 1, or 2 for culms which are usually tight together, moderately tight together, or open.

Column 4 is 0, 1, or 2 for culms that are erect, moderately curved or arched, and very curved or arched. Column 5 is 0, 1, or 2 for culms that are straight, slightly zigzag, or zigzag. The relative internode length is given in column 6 as a 0, 1, or 2 for relatively short, medium or long internodes.

Most young culms are green. After a year or two the color may change to yellow-green or yellow especially when there is exposure to the sun. Column 7 indicates the color of young culms by a 0 for green, 1 for yellow with green stripes and 2 for green with occasional white stripes.

Column 8 of Table 2 is 0, 1, or 2 for culm internodes which are hairless, with minute hairs, or with dense long hairs. The smaller hairs are difficult to see without magnification. They can, however, be felt as a roughness of the culm surface that is usually more pronounced on the upper part of the internodes. Culms more than 1 year old may loose all of their hairs.

Column 9 is 0, 1, or 2 for culms that are covered with little, some, or much white powder at sheath fall. Column 10 is 0, 1, or 2 for culm nodes that are not prominent, rather prominent, or very prominent.

2.2. The Culm Leaves

Examine culm leaves that are fresh and from the middle of the culm.

Most of the giant tropicals have some hairs on the back of the culm leaf sheath. Column 11 is 0, 1, or 2 for little or no hair, moderately hairy, and very hairy. Column 12 is 0, 1, or 2 for culm leaves that are usually without auricles; with small auricles or sometimes with auricles and somtimes without them; or usually with large auricles.

Columns 13 to 16 of Table 2 give the characteristics of the culm leaf ligule. Column 13 is 0, 1, or 2 for a short, medium, or tall ligule. Column 14 is 0, 1, or 2 for a ligule whose upper margin is straight or concave, slightly convex, or very convex. Column 15 is 0, 1, or 2 for a ligule whose upper margin is almost hairless, hairy, or with large hairs, Column 16 is 0, 1, or 2 for a ligule whose upper margin is smooth, somewhat jagged or toothed, or very jagged or toothed.

Column 17 of Table 2 is 0, 1, or 2 for a culm leaf blade that is small, medium, or large compared to its sheath. Column 18 is 0, 1, or 2 for a culm leaf blade that is pressed to the culm, slightly bent back, or bent way back and down.

2.3. The Foliage Leaves

Columns 19 to 22 of Table 2 describe the foliage leaves. One should look at the leaves that grow from twigs and not at leaves which are at the ends of culms or large branches.

Column 19 is 0, 1, or 2 for foliage leaves that typically are without auricles, with small auricles or sometimes with and sometimes without auricles, or usually with auricles.

Columns 20 and 21 give a typical length and width of the foliage leaf blade in inches. Column 22 is 0, 1, or 2 for foliage leaf blades that have little or no hair, some hair, or much hair. The hair usually occurs mostly on the underside of the blade.

3. The Species

***Bambusa arundinacea* (Retz.) Willd.**
Giant Thorny Bamboo

Gamble 1896; Lin 1978; McClure 1955; Young and Haun 1961.

Giant Thorny bamboo is a giant tropical from India where it reaches heights up to 100 ft. with culms to 7 in. in diameter. It was first introduced early this century into Southern Florida where culms have attained 95 ft. in height by 5 1/2 in. in diameter. The long thorny lower branches form an almost impenetrable barrier which is so effective that in ancient times it was planted around cities as a living wall. In India the wood is important as construction material. The shoots can be eaten if they are cooked for 20 minutes; the water should be changed after the first 10 minutes.

Giant Thorny bamboo is distinguished from the other species treated here by its thorny branches and by its small narrow foliage leaves. The thorns may not appear on very small plants (one or two ft. tall) but they do appear on culms over 6 feet tall.

In Miami, Florida, Giant Thorny flowered and died a few years ago. Seedlings were produced and I saw several in February, 1980 that had grown to about 10 ft. tall. The species has recently been established on the West Coast with a small plant that was put into the ground at Quail in January, 1981.

Clumps densely compact, culms to 100 ft. high and 7 in. in diameter, erect or more commonly broadly arched above; the internodes relatively short, hairless, densely covered with white powder when young; the lower nodes prominent, fringed at first with stiff, brown hairs.

Culm leaf sheaths orange-yellow when young with a zone of brown hairs along the base, otherwise hairless on the back; auricles and oral setae not developed; ligules tall, the apex straight, the margin fringed with long hairs; blades broadly triangular, pressed to the culm below but bent back at the upper nodes, persistent, with dense, flatly pressed, dark brown, deciduous hairs on the inside, hairless on the outside.

Branches thorny, solitary and very long in the lower part of the culm, then in 2's and 3's, and shorter above.

Foliage leaf sheaths hairless or sparsely covered with long stiff hairs; auricles and oral setae irregularly developed, the later soon falling off; blades linear lance-shaped, from 2 to 8 in. long by 1/2 to 1 in. broad, hairless or with a few long hairs near the base on the upper surface, hairless or minutely hairy on the lower surface.

***Bambusa beecheyana* Munro**
[*Sinocalamus beecheyanus* (Munro) McClure]
Beechey bamboo

Lin 1978; Young and Haun 1961.

Beechey bamboo is a large subtropical bamboo native to southeastern China where it is an important source of commercial bamboo shoots. It is a fast growing plant that can reach a height of 40 feet with culms 4 in. in diameter in about 5 years after planting. It produces relatively few, large culms each year.

Beechey bamboo can be distinguished from other giant tropicals by its strongly tapering, broadly arching culms which have prominent nodes and relatively short internodes and by its relatively broad foliage leaf blades.

Several fine mature clumps of *B. beecheyana* can be found at the Huntington. A two year old plant is growing at Quail.

Clumps rather compact; the culms reaching a height of 50 ft. and a diameter of 5 in., strongly tapered, erect or more commonly broadly arched above, sometimes zigzag; internodes relatively short, bright green, at first covered with a white, waxy, powdery coating, hairless; nodes prominent.

Culm leaf sheaths finely hairy at the base, hairless on the back or at first with brown, appressed hairs which drop off as the sheath dries, much wider at the base than at the apex; auricles and oral setae not developed; ligules prominently tall with a jagged, straight, upper margin; blades small, triangular, persistent, a little narrower at the base than the top of the sheath.

Branches usually 3 per node the first year, multiple with numerous twigs thereafter.

Foliage leaf sheaths hairless; auricles and oral setae generally lacking; blades up to 7 in. long by 1 1/2 in. broad.

***Bambusa dolichoclada* Hayata Cv. Stripe Lin**
[*Leleba dolichoclada* (Hayata) Odashima]

Lin 1878; Suzuki 1979; Walker 1976.

Although this native of Taiwan was introduced by the U.S.D.A. about 40 years ago, I can find no record that it survived. The species was reintroduced with a propagule of the Cv. Stripe in March, 1979 by the Huntington. After 2 years in quarantine the propagule still survives and a second small plant taken from the first is now being grown in a pot for planting at Quail. The green stripes on pale yellow culms make the plant a most attractive ornamental.

Clumping bamboo with culms up to 65 ft. high and 4 in. in diameter; internodes 8 to 24 in. long, powdery when young, yellowish-green gradually turning pale yellow with persistent, dark green stripes running longitudinally along the internodes; nodes prominent with many branches.

Culm leaf sheaths spotless, pale to light green with a few yellowish cream stripes, hairy above outside; auricles prominent and wide, extending from the blade along the top of the sheath, fringed with brown oral setae; ligules short with a smooth upper margin fringed with long brown bristles; blades triangular on lower culm nodes, hairless or with a few hairs outside, with brown hairs inside.

Foliage leaf sheaths with minute hairs above, outside; auricles generally developed with tufts of brown oral setae; ligules rounded, fringed with bristles; blades 4 to 10 in. long by 1/2 to 1 1/4 in. broad, hairy beneath, veins parallel.

***Bambusa glaucescens* (Willd.) Sieb. ex Holtt.**
[*B. multiplex* (Lour.) Raeusch. ex Schult., *B. nana* Roxb., *B. argentea* Hort.]
Hedge bamboo, Oriental Hedge bamboo

Lin 1978; McClure 1955; Walker 1976; Young and Haun 1961.

This subtropical Chinese bamboo with its densely crowded clumps and numerous branches is ideal for use as a hedge. It is the most variable of the

cultivated bamboos with at least 9 distinct forms that vary in their maximum height from less than 3 ft. up to almost 50 ft. for Cv. Silverstripe. The culms are slender for their height so that the taller ones typically arch over strongly.

The new shoots being bitter are not generally eaten, and the thin walled culms are not as useful as other bamboos. The variety of forms, however, provides a broad choice of culm height and leaf size for screens, hedges or single clump ornamentals. There are several good examples of the typical form of Hedge bamboo growing at the Huntington and at LASCA. Hedge bamboo is distinguished from the other species by the large number of small branchlets that grow from a culm node, by the minute hairs on young culm internodes that make them rough to the touch and by culms with rather long internodes that are not over 1 1/2 in. in diameter.

Clumps densely compact, the culms ascending, rarely erect, straight or broadly arched, up to 35 ft. high and 1 1/2 in. in diameter, commonly smaller, the internodes relatively long, up to 24 in., thin walled, the surface rough due to small sharp hairs.

Culm leaf sheaths somewhat tardily deciduous, hairless; auricles and oral setae not at all or only slightly developed; ligules short; blades pressed to the culm, soon falling off, usually with sharp hairs on both surfaces, then almost hairless.

Branches very numerous, up to 35 at a node, relatively slender.

Foliage leaf sheaths hairless; auricles and oral setae absent or weakly developed; blades of variable size, sometimes to 7 in. by 3/4 in., hairless on the upper surface, conspicuously powdery and hairy on the lower surface.

***B. glaucescens* Cv. Alphonse Karr Young**
[*B. multiplex* (Lour.) Raeusch. Cv. Alphonse Karr Young, *B. Alphonse-Karii* Mitf. ex Satow, *B. nana* Var. *Alphonse-Karrii* (Mitf. ex Satow) Mak. ex Shiras]
Alphonse Karr bamboo

Lin 1978; McClure 1955; Young and Haun 1961.

Alphonse Karr bamboo differs from the typical form by the color of its culms and branches and their sheaths which are yellow, striped with green. New shoots are often pink or red in color.

Alphonse Karr is a commonly planted bamboo. Several large, mature stands are growing at the Huntington and also at the San Diego Zoo. Three small clumps have been planted at Quail.

***B. glaucescens* Cv. Fernleaf Young**
[*B. multiplex* (Lour.) Raeusch. Cv. Fernleaf Young]
Fernleaf Hedge Bamboo

Young and Haun 1961.

Fernleaf bamboo differs from the typical form by its smaller size - the culms are 10 to 20 ft. high. The leaves are small, 5/8 to 1 1/2 in. long by 1/8 to 7/16 in. broad, and closely two ranked with 10 to 20 on a twig. In dry infertile soil the culms will not exceed 11 ft., but in better, moist soil the culms grow large and the leaves often become larger losing their fernlike appearance.

***B. glaucescens* Horticultural Form Golden Goddess**

Golden Goddess bamboo is a dwarf form that grows in dense clumps up to about 10 ft. high with leaves up to 6 by 1/2 in.

***B. glaucescens* Var. *riviereorum* Maire**
[*B. multiplex* Var. *riviereorum* Maire]
Chinese Goddess bamboo

Young and Haun 1961.

Chinese Goddess is a dwarf bamboo which grows to about 6 ft. tall with small leaves that are very much like those of Cv. Fernleaf from which it differs by having solid culms. Unlike Fernleaf bamboo the characterisics of Chinese Goddess remain stable when the soil or moisture conditions change.

***B. glaucescens* Cv. Silverstripe**
[*B. nana* Var. *variegagta* Camus]
Silverstripe Hedge bamboo

Young and Haun 1961.

Silverstripe is the largest form of *B. glaucescens* growing to 45 ft. high under the most favorable conditions; ordinarily, however, it grows no taller than 35 or 40 ft. It differs from the typical form in that some of the foliage leaves are striped with white, some of the culm internodes have narrow white, vertical stripes, and the culm leaf sheaths are striped with brown and green when fresh.

There are mature clumps of Silverstripe growing at the Huntington and a 2 year old clump growing at Quail.

***B. glaucescens* Cv. Silverstripe Fernleaf Young**

Young and Haun 1961.

The cultivar is similar to Fernleaf except that it has white striped leaves.

***B. glaucescens* Cv. Stripestem Fernleaf Young**
[*B. nana* Roxb. F. *viridi-striata* Makino, *B. floribunda* (Buse) Zoll. F. *viridi-striata* Nakai]

Young and Haun 1961.

This cultivar is similar to Cv. Fernleaf except that the culms are at first light reddish to yellowish with irregular green stripes on the internodes.

***B. glaucescens* Horticultural Form Tiny Fern**

This is not a formally described cultivar but it appears to be a distinct dwarf form of Var. *riviereorum* which grows no taller than 2 or 3 ft. The leaves are very small, often less than 1 in.

***Bambusa guadua* Humboldt & Bonpland**
[*Guadua angustifolia* Kunth]
Guadua, Caña Brava

B. guadua is the most outstanding of the American bamboos because of its size and the usefulness of its culms. The wood is mechanically strong, durable, and easy to work. Entire houses can be made from it. Most common in Columbia and Ecuador it occurs from Panama south to northern Argentina. Because it grows best in well watered, fertile, soil, most of the native stands have been cleared for farming. In its typical form a shield of long very thorny branches grows around the base of the culms. One strain has almost none of the thorny branches.

A small clump of thorny *B. guadua* is growing at Miami, Florida. It has fewer than 10 culms, the largest being about 40 ft. high. I saw a fine large stand at CATIE, Turialba, Costa Rica whose culms were at least 80 ft. high and 6 1/2 in. in diameter. There were only a few thorny branches around the base. Small plants from Costa Rica are now in quarantine at the Huntington to be released in June, 1982.

B. guadua can be distinguished from the other giant tropicals by the thorny branches and the rather broad foliage leaf blades. Large culms can be recognized even at a distance by the whitish band of hairs that grow around each node.

Clumps open, culms commonly to 60 ft. somtimes approaching 100 ft. in height, commonly to 6 in. occasionally to 8 in. in diameter, erect, broadly arched above; internodes usually grooved above the point of branch attachment, the lower internodes very short and hairless or sparsely covered with sharp, flatly pressed hairs,

the upper internodes more densely covered with such hairs; nodes with a rather prominent sheath scar, especially at the base of the culm, the lower nodes marked by a dense band of flat lying cream or buff colored hairs extending about 1/2 in. above and below the sheath scar, these gradually falling off.

Culm leaf sheaths deciduous above, more or less persistent at the lower nodes, with dense, short, wooly hairs on the back; auricles and oral setae usually lacking in the lower sheaths; ligules variable, usually convex, sometimes straight or humped, about as wide as the apex of the sheath, jagged or toothed and fringed with hairs on the margin; blades roughly triangular, about as broad as the base of the sheath, persistent, pressed to the culm, hairy on the inside surface, hairless on the outer surface.

Branches solitary and very thorny at the basal nodes in large culms, lacking above the basal nodes for the lower half or two thirds of the height.

Foliage leaf sheaths hairless throughout or weakly fringed with hairs on the margins; auricles usually not much developed beyond a callus at the base of the oral setae; oral setae weakly or strongly developed; ligules very short, scarcely protruding; petiole up to 3/8 in. long, slender, hairless or nearly so; blades variable, up to 7 by 2 in. on young growth, up to 8 by 1 in. on old wood, commonly hairless on the lower surface and with coarse white bristles on the upper surface.

***Bambusa oldhamii* Munro**
[*Sinocalamus oldhamii* (Munro) McClure, *Leleba oldhamii* (Munro) Nakai]
Oldham bamboo, Giant Timber bamboo, Morokudake

Lin 1978; McClure 1955; Walker 1976.

Oldham bamboo is a native of Southern China and Formosa that was introduced into the United States by West Coast horticulturists. It is the most widely grown giant in Southern California making an outstanding, handsome ornamental because of its size. There are several fine, large stands growing at the San Diego Zoo. There are also many clumps growing at the Huntington, LASCA, and at Quail. Oldham bamboo is distinguished from the other species considered here by its erect culms with relatively short branches and by its relatively broad leaves.

Clump compact, the culms very erect almost to their tips, reaching a height of 55 ft. and a diameter of 4 in., sometimes sinuous; internodes of moderate length, dark green, hairless, with some white powder at sheath fall, the wood about 1/2 in. thick, the nodes only slightly prominent.

Culm leaf sheaths at first strewn with brown flat lying hairs which drop off as the sheath dries; the auricles and oral setae rather small or lacking; ligules short; blades broadly triangular with concave sides, pressed to the culm, lightly hairy on the inner surface, hairless on the outer surface.

Branches relatively short, the central one at each node often tardily developed.

Foliage leaf auricles and oral setae usually lacking; blades oblong lance-shaped, up to 9 by 1 1/2 in., hairless on the upper surface, small hairs at first, becoming hairless with age on the lower surface.

***Bambusa textilis* McClure**

McClure 1955; Young and Haun 1961.

B. textilis is an exceptionally attractive medium sized bamboo. It forms a compact clump of straight, thin walled but tough culms with relatively long internodes. In addition the lower nodes are free of branches and not very prominent. In China the culms are split and used for weaving baskets, mats and rope.

B. textilis is one of the most cold hardy of the tropical clumping bamboos. It is reported to survive temperatures down to 13 ° F. with only slight leaf damage. It can be distinguished from the other members of the genus by its thin-walled culms which are rough to the touch when young and by its principal branches which are almost equal in size at a node.

Clumps compact, culms erect, straight, up to 40 ft. tall by 2 in. in diameter; internodes to 16 in. long, relatively thin walled, strewn with small sharp hairs; nodes not prominent.

Culm leaf sheaths hairless or nearly so in mature plants, hairy at first in young ones, narrowly subtriangular; auricles and oral setae slightly or moderately developed; ligules short; blades narrowly triangular or ovate lance-shaped, the base nearly as wide as the apex of the sheath, pressed to the culm, often falling off, sometimes with sharp hairs on the inner surface and near the base on the outer surface, outherwise hairless on the outer surface.

Branches beginning to develop only some months after the culm reaches its full height, numerous, slender, the largest less dominant than in most species of the genus; branches and buds lacking on the lower half of mature culms.

Foliage leaf sheaths slender, almost hairless; auricles and oral setae usually well developed, soon falling off; blades narrowly ovate lance-shaped, 6 to 8 in. long by 1/2 to 1 in. broad, hairless on the upper surface, lightly powdery and hairy on the lower surface.

***Bambusa tulda* Roxb.**

Backer and Van den Brink 1968; Gamble 1896; McClure 1955; Young and Haun 1961.

B. tulda is a giant tropical bamboo which reaches heights of over 70 ft. in its native India. The largest culms which are thick walled with fairly dense wood have been used for split fishing rods in Florida.

B. tulda somewhat resembles *B. tuldoides* but differs from it by having culms which are larger and straighter. *B. tulda* can be distinguished by the dense black hairs on the back of its culm leaf sheath. *B. tuldoides* has only a few brown hairs on the back of some of its sheaths. *B. tulda* is much less hardy than *B. tuldoides* being damaged by temperatures below about 27 ° F.

Clump rather compact, the culms reaching a height of 70 ft. and a diameter of 4 in., straight, broadly arched at the tip; the internodes elongate, thick-walled, sometimes nearly solid, entirely hairless; the lower nodes prominent.

Culm leaf sheaths broadly triangular, clothed with black, deciduous sharply pointed hairs; the auricles well developed, often unequal, fringed with oral setae; ligules moderately tall, shortly toothed and margined with short hairs; blades partially falling off, subovate, abruptly pointed above, concave below to conform to the strongly convex apex of the sheath, shorter than the sheath.

Branches several, strongly unequal, arise from all nodes down to the base.

Foliage leaf sheaths usually hairless; the auricle and oral setae often well developed, soon falling off; blades oblong or linear lance-shaped, 3 to 10 in. by 1/2 to 1 1/8 in., hairless on the upper surface, white-powdery with soft, white hairs on the lower surface.

***Bambusa tuldoides* Munro**
[*B. pallescens* (Dull) Hack.]
Puntingpole bamboo

McClure 1955; Young and Haun 1961.

Puntingpole bamboo is a subtropical giant bamboo native to southern China where it is important for its uses in construction, basketry, and punting poles. Under favorable conditions it is a fast grower producing large numbers of long, straight, thick-walled culms that are useful for many purposes.

There are several mature stands of the species growing at the Huntington. Some of these have produced flowers over the past 3 years usually on only one or a few culms in a clump. Among the masses of flowers only a few seeds have been found and none of these has germinated. A clump of *B. tuldoides* is growing at Quail. Planted in June, 1979 it has grown about 20 culms that are between 15 and 20 ft. tall (as of May 1981).

Clumps compact, culms stiffly erect (except in very young plants), reaching 55 ft. high by 2 1/4 in. in diameter; internodes of moderate length, hairless, covered with some white powder at first.

Culm leaf sheaths narrowly triangular, hairless except for a few brown hairs on the back of some sheaths which soon falls off, commonly bearing two fine, white vertical stripes on one side of the sheath, the auricles well developed, often unequal, fringed with oral setae; blades pressed to the culm, partially falling off, narrowly ovate lance-shaped, roughly hairy on the inner surface, hairless on the outer surface.

Branches developed at all but the lower one or two nodes of the culm.

Foliage leaf sheaths hairless; the auricles and oral setae irregularly developed, soon falling off; blades narrowly lance-shaped, up to 10 by 1 in., smaller on older culms, hairless on the upper surface, lightly powdery and hairy on the lower surface.

***Bambusa ventricosa* McClure**
Buddha's Belly bamboo, Buddha bamboo

Lin 1978; McClure 1955; Young and Haun 1961.

Buddha's Belly bamboo is a subtropical from Southern China where it is grown as a potted ornamental for its peculiar swollen internodes that develop under unfavorable growing conditions. The swollen internodes occur in plants that are stressed by being pot-bound, underwatered, and undernourished. The plants then grow no more than about 6 to 8 ft. high. Under favorable conditions planted in the ground *B. ventricosa* can become a giant bamboo with no distorted internodes.

There are several clumps of *B. ventricosa* growing at LASCA and at the Huntington. Most of the culms do not show the swollen internodes.

Clumps compact, culms erect or ascending, straight or sometimes zigzag, especially smaller culms, reaching up to 55 ft. in height and 2 1/4 in. in diameter, internodes hairless, dark green. Under unfavorable conditions the internodes of the culms and the principal branches are shortened and basally inflated to a somewhat asymmetrical flask-like shape, with a corresponding reduction in culm height.

Culm leaf sheaths narrowly triangular, hairless; auricles and oral setae irregularly developed; blades nearly as wide at the base as the sheath, pressed to the culm, partially falling off.

Branches developed at all nodes, the smaller ones very numerous, the central one at each node usually very long (sometimes only a single branch at a node on dwarfed culms).

Foliage leaf sheaths hairless; auricles and oral setae not or only moderately developed, soon falling off; blades narrowly oblong lance-shaped, up to 8 by 1 1/2 in. (smaller on dwarfed culms), hairless on the upper surface, softly hairy on the lower surface.

***Bambusa vulgaris* Schrad. ex Wendland**
[*Leleba vulgaris* (Schrad.) Nakai]
Common bamboo

Backer and Van den Brink 1968; McClure 1955,1966; Walker 1968; Young and Haun 1961.

B. vulgaris is the most widely grown tropical bamboo in the world. Its origins have become lost, for it has been cultivated in both Asia and Tropical America for

many hundreds of years. It grows up to 80 ft. high with culms 5 in. in diameter in some parts of the world, but more commonly it is 20 to 50 ft. tall. The rather soft wood of the culms has been used for furniture and is suitable for making paper. The shoots are edible.

Although *B. vulgaris* is the most widley distributed bamboo in cultivation, it has been observed to flower only infrequently. Each flowering has involved at most only a few plants which have died after flowering. There is no record that seed has ever been produced (McClure 1966, p. 82).

B. vulgaris is one of the least hardy bamboos in cultivation. Only a few degrees of frost cause visible leaf damage and brief temperatures below 25 ° F. kill it to the ground.

The typical form with green culms appears to be less common in California than the form Vittata. A small plant of the green form has just recently been established at Quail.

Clumps open, the culms green, usually more or less spreading, broadly arched above, somewhat zigzag, up to 50 ft. high with a diameter of 4 in., internodes hairless; nodes prominent.

Culm leaf sheaths densely clothed with brown, flat lying, deciduous hairs; auricles well developed, equal, sparsely fringed with oral setae; blades pressed to the culm, usually persistent, much narrower then the apex of the sheath.

Branches at all but a few of the lower culm nodes on young clumps, suppressed in the lower part of the culm in mature and crowded clumps.

Foliage leaf sheaths hairless or with a few stiff hairs, auricles and oral setae irregularly developed, soon falling off; blades linear lance-shaped, to 10 by 1 1/2 in., hairless or nearly so on both surfaces.

***Bambusa vulgaris* Cv. Vittata McClure**

This cultivar differs from the typical form in that the culms are golden-yellow with bright green vertical stripes. It is the variety seen growing throughout Central America. There are clumps growing at the Huntington, at LASCA and at Quail. The clump at LASCA was killed to the ground by frost a few years ago.

***Dendrocalamus asper* (Schult.) Backer ex Heyne**
[*Bambusa aspera* Schult., *Gigantochloa aspera* (Schult.) Kurz]

Backer and Van den Brink 1968; McClure 1955; Young and Haun 1961.

D. asper is a subtropical bamboo native to Burma and Java where it is reported to grow 100 ft. high with culms up to 8 in. in diameter. The large, strong, durable culms have been used for the principle parts of housing in Java. The plants are also grown for their edible shoots.

Several clumps of *D. asper* are growing in Miami, Florida. When I saw these in February of 1980, none were more than 40 ft. high. A clump of the species is also growing at the Huntington. Planted 8 years ago it was only about 20 ft. high until recently it grew a new culm which is much taller. In June 1979 a single culm and attached rhizome was cut from the Huntington plant and potted until April, 1980 when it was put into the ground at Quail. This plant started to shoot in April and by October, 1980 had produced 4 culms; the tallest is about 20 ft. tall and 2 in. in diameter.

D. asper is distinguished from the other giant tropicals by the very large leaves on small culms and by the hairs which are especially dense and long on large culms.

Clumps compact; the culms reaching 100 ft. high by 8 in. in diameter, erect or arched near the top; the lower internodes relatively short, those in the middle up to 22 in. long, all densely clothed at first with gray-brown, long sharp hairs; nodes in the lower part of the culm ringed with a wide band of root primordia.

Culm leaf sheaths thick, broad, oblong, broadly convex at the top, with flat lying hairs on the back; auricles small, rounded, with a few delicate setae on their margins, fragile, soon lost; ligules about 3/8 in. high, coarsely toothed and margined with hairs; blades much narrower at the base than the top of the sheath, bent back, almost as long as the sheath in the middle of the culm.

Foliage leaf sheaths usually without auricles and oral setae; blades 6 in. by 1 in., much larger on small culms (up to 14 by 2 in.), rough due to sparse hairs on the upper surface, paler and hairy on the lower surface.

***Dendrocalamus strictus* (Roxb.) Nees**
[*Bambusa stricta* Roxb.]
Male bamboo, Calcutta bamboo

Backer and Van den Brink 1968; Gamble 1896; McClure 1955,1966; Young and Haun 1961.

This tropical bamboo is the most common and the most used bamboo in India. The hard dense wood is used chiefly for paper pulp. There is a great deal of variability in different clones; seedling populations may vary in ultimate culm height and thickness, branching habit and size of leaves. The largest types have culms up to 60 ft. in height and 5 in. in diameter while other dwarf types are much smaller. *D. strictus* is more drought resistent than other bamboos.

There are two small clumps of *D. strictus* growing at Miami, Florida. The culms are not over 30 ft. tall and the plants look rather scraggly. On the West Coast there is a small clump of *D. strictus* at LASCA that has mostly died. Over the last few years it has grown only a few small leafy branches from the base of the old dead culms. Three small divisions were cut from this plant in July, 1979; one survives in a pot. There are also several seedlings in the San Diego area which were planted in about 1976; the largest is about 4 ft. high.

D. strictus can be distinguished from the other giant tropicals by its foliage leaf blades which are usually densely hairy on both surfaces.

Clumps densely compact, culms erect or broadly arched, up to 60 ft. high and 5 in. in diameter; internodes relatively short, often solid or very thick walled, hairless, with white powder when young.

Culm leaf sheaths variable, usually broad with a gently narrowed apex, hairless or with dark, flat lying, deciduous hairs on the back; auricles and oral setae usually not developed; ligule straight or arcuate, toothed and fringed with minute hairs on the margin; blades pressed to the culm, usually persistent, as wide at the base as the top of the sheath.

Branches stiff, wirey, the primary branch generally much larger than the others, arising even from the lower part of culms, or in some strains lacking in the lower 1/2 to 2/3 of the culm.

Foliage leaf auricles usually not well developed, oral setae small, deciduous, often lacking entirely; blades up to 10 by 1 1/4 in, usually with long soft hairs on both surfaces.

4. Locations of Growing Bamboo Mentioned in the Text

The Huntington: The Huntington Library and Botanic Gardens, 1151 Oxford Rd., San Marino, CA 91108.

LASCA: The Los Angeles State and County Arboretum, 301 North Baldwin Ave., Arcadia, CA 91006.

Mayaguez, Puerto Rico: U. S. Department of Agriculture, Mayaguez Institute of Tropical Agriculture, Box 70, Mayaguez, Puerto Rico 00708.

Miami, Florida: U. S. Department of Agriculture, Subtropical Horticulture Research Station, 13601 Old Cutler Rd., Miami, FL 33158.

Quail: Quail Botanic Gardens, 230 Quail Dr., Encinitas, CA 95070.

San Diego Zoo: The San Diego Zoo, Balboa Park, San Diego, CA.

Table 2 Giant Tropical Bamboos

Table 2 (continued)

Species	Culm																								
	Total Culm					Internodes				Node	Culm Leaf								Foliage Leaf				Hardy	
											Sheath		Ligule				Blade		Sheath	Blade				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23		
	ht	diam	open	curve	zig-zag	lgth	color	hair	pow-der	prom-inent	hair	aur-icle	ht	convex	hair	margin jagged	size	bent back	aur-icle	lgth	wdth	hair	degrees F.		
Bambusa																									
arundinacea	100	7	0	2	0	0	0	0	2	2	1	0	1	0	2	0	1	0	1	6	$\frac{3}{4}$	0	27		
beecheyana	50	5	1	2	2	0	0	0	2	2	1	0	1	0	0	2	0	0	0	7	$1\frac{1}{2}$	0	20		
dolichoclada 'Stripe'	65	4	1	1	0	1	1	0	1	2	1	2	0	1	2	0	1	0	2	7	$\frac{3}{4}$	1	27		
glaucescens	35	$1\frac{1}{2}$	0	2	0	2	0	1	0	1	0	0	0	1	0	0	2	0	0	5	$\frac{1}{2}$	1	15		
Alphonse Karr	35	$1\frac{1}{2}$					1													5	$\frac{1}{2}$				
Fernleaf	20	$\frac{1}{2}$					0													1	$\frac{1}{4}$				
Golden Goddess	10	$\frac{1}{2}$					0													4	$\frac{1}{2}$				
riviereorum	6	$\frac{3}{8}$					0													1	$\frac{1}{4}$				
Silverstripe	45	$1\frac{1}{2}$					2													5	$\frac{1}{2}$				
Silverstripe Fernleaf	20	$\frac{1}{2}$					0													1	$\frac{1}{4}$				
Stripestem Fernleaf	20	$\frac{1}{2}$					1													1	$\frac{1}{4}$				
Tiny Fern	3	$\frac{1}{8}$					0													$\frac{3}{4}$	$\frac{1}{4}$				
guadua	100	8	2	1	0	0	0	1	0	1	2	0	1	1	2	2	1	0	0	7	2	2	27		
oldhamii	55	4	1	0	1	1	0	0	1	0	1	1	0	1	0	0	1	0	0	9	$1\frac{1}{2}$	1	20		
textilis	40	2	0	0	0	2	0	1	0	0	1	1	0	0	0	0	1	0	2	7	$\frac{3}{4}$	1	15		
tulda	70	4	1	1	0	2	0	0	0	1	2	2	1	2	1	1	1	0	2	6	$\frac{3}{4}$	1	27		
tuldoides	55	$2\frac{1}{4}$	1	0	0	1	0	0	1	1	0	2	0	1	0	0	1	0	1	7	$\frac{3}{4}$	1	20		
ventricosa	55	$2\frac{1}{4}$	1	1	2	1	0	0	0	0	0	1	0	1	0	0	1	0	1	7	$\frac{3}{4}$	1	15		
vulgaris	50	4	2	2	1	1	0	0	0	2	2	2	0	1	0	0	0	0	1	7	$\frac{3}{4}$	0	27		
Vittata							1																		
Dendrocalamus																									
asper	100	8	1	1	0	0	0	2	0	1	2	1	2	0	1	2	0	2	0	6	1	2	27		
strictus	60	5	0	1	0	0	0	0	1	1	1	0	0	1	0	1	0	0	0	7	1	2	27		

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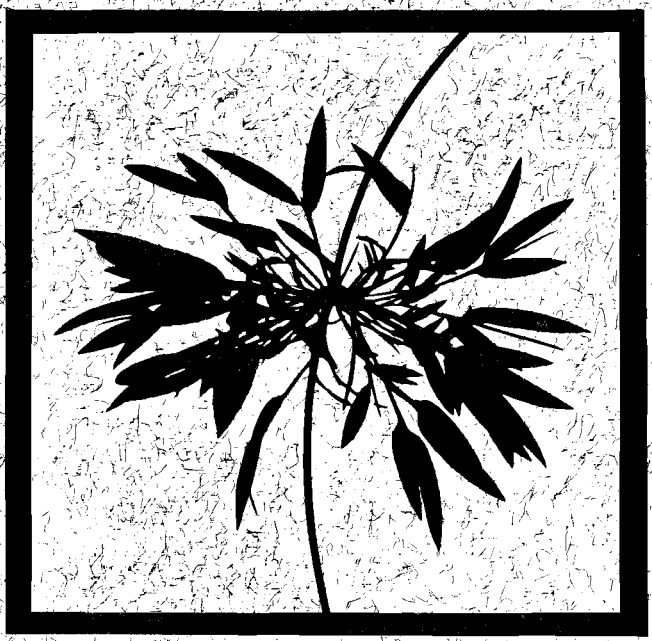

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CONTENTS

Max. Riedelsheimer*: **Some Preliminary Notes on the Culture of Bamboo in South Bavaria**

The possibility of growing evergreen shrubs, trees, etc... in South Bavaria under *average* conditions is very limited because temperatures often go as low as - 20° C in a "normal" winter and down to -25° to -30° C in a severe one. Due to the discouraging conditions, interest in growing exotics in the garden has generally not been very keen. Those who were not to be defeated certainly tried to introduce bamboo - that most decorative plant - into their gardens, but some of the plants died outright while most of the remainder were a continual eye-sore after each winter and had to be removed. Sometimes, of course, when local weather had been milder than average, successful culture was possible. After World War II interest in exotics increased sharply, but it was not until 25 years ago that the first truly adaptable bamboo appeared in our gardens. It was the species *Arundinaria murielae* Gamble which was first collected in China by Ernest H. Wilson who remarked that it was the most handsome bamboo he had ever seen. At Wilson's request Gamble named the species after Wilson's daughter Muriel (1). The species, which recently flowered, has now been renamed *Thamnocalamus spathaceus* (Franch.) Soderstrom.

This bamboo has now become so common, especially in the Munich area, that one can hardly miss seeing it; especially when, after winter, the strikingly delicate leaves enhance each garden that has given a home to this beautiful bamboo. How did it happen that this particular bamboo became so popular? By coincidence, the climate in the mountains of Hupeh province, China, its home, must be quite similar to ours. Unlike many others this bamboo suffers in continuous hot weather; our relatively cool spring and summer is just exactly what it seems to need. It tolerates temperatures down to about -20° C but at -24° C its limit is reached and it can be damaged most severely.

Since scores of bamboos have been introduced, others have been tried as well. The *Sasas* which are natives of Japan and the surrounding area (having a climate comparable to ours, with deep snow) are protected in winter, so they need not tolerate cold below about -15° C; this reduces their adaptability to our area. Species of *Phyllostachys*, many of which are most handsome bamboos, grow to impressive dimensions in warmer parts of Germany. Their place of origin is at lower elevations mostly in Eastern China, though they are cultivated as far north as Peking. Even there they rarely experience temperatures below -15° C, that being the point below which serious damage is sustained. Among the other genera none seem to be hardy below the critical -15° C except *Sinarundinaria nitida* (Mitf.) Nakai which is closely related to *T. spathaceus* (2).

S. nitida also originally comes from the high altitudes of North-central China; it is the second hardiest bamboo in our area and like *T. spathaceus* it prefers cool

* Wuermstrasse 17, 8031 Stockdorf vor Muenchen, West Germany.

temperatures during the growing season, though its adaptability to warmth seems to exceed that of Wilson's bamboo.

Having two bamboos renowned for both their beauty and proven adaptability, who would ask for more? Making inquires of sources that became available in China I have learned that about 15 species growing at higher elevations in China are considered to belong to this group of bamboos. One of them reached the U.S. in 1941 (U.S.D.A Plant Introduction No. 143541). Through the most generous help of Mrs. Ruth Drury McClure I have learned that this species almost certainly did not survive quarantine (*Phyllostachys bissetii* McClure which was introduced on the same occation did, however, survive) so that one need not look for this bamboo in an American garden (3).

I would like to mention at this point that contrary to some advice in the literature (4) bamboos of this group cannot be readily propagated by rhizomes alone. In fact, I have never succeeded in doing so with either of the species mentioned above. So if you want to obtain a propagule, make sure it has a few culms with viable buds.

Travel to remote areas of Central China has now become possible. In fact, a group of English plant fanciers (including at least one who is interested in bamboos) is said to have gone to Central China in the autumn of 1980, so that perhaps we can hope for new bamboos which are possibly even better adapted to our area and to others with similar climates.

Listed below are a few bamboos that have been cultivated for several years under the conditions mentioned above. They have invariably proven to be inferior in hardiness and cannot be recommended for general cultivation in our area. They are listed in their approximate order of hardiness.

Phyllostachys aureosulcata McClure
Phyllostachys nigra (Lodd.) Munro Cv. Bory Mak.
Phyllostachys bissetii McClure
Pseudosasa japonica (Sieb. & Zucc.) Mak.
Phyllostachys flexuosa A. & C. Riv.
Sasa palmata (Marl.) Nak. Var. *nebulosa* Suzuki
Sasa kurilensis (Ruppr.) Mak. & Shib.
Sasa veitchii (Carr.) Rehder
Sasa tessellata (Munro) Mak. & Shib.
Phyllostachys nigra (Lodd.) Munro
Arundinaria viridi-striata (Regel) Mak.
Shibataea kumasasa (Zoll.) Nak.
Phyllostachys viridi-glaucescens A. & C. Riv.
Phyllostachys aurea A. & C. Riv.
Phyllostachys nidularia Munro
Semiarundinaria fastuosa (Marl.) Mak.
Arundinaria simonii A. & C. Riv.
Arundinaria pumila (Mitf.) E. G. Camus
Yushania anceps (Mitf.) Lin

Arundinaria gigantea ssp. *macrosperma* (Michaux) McClure
Tetragonocalamus angulatus Nak.
Chimonobambusa marmorea (Mitf.) Mak.

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Richard Haubrich*: **Handbook of Bamboo Cultivated in the United States. Part III: The Sasas**

Introduction

In Japan bamboos are divided into two groups, the bamboo group and the Sasa group. Sasa is a general term that designates several genera of mostly small or dwarf bamboo. According to Suzuki (1978), the Sasa group consists of all bamboos with persistent culm leaf sheaths. They are divided into two subgroups - genera that usually have a single branch per culm node and those which have three or more branches at a node. The present article describes the first subgroup which consists of 4 genera. A total of 9 species belonging to 3 of the 4 genera are cultivated in the U.S.

Section 1 describes the common characteristics of the 9 species. Section 2 is an explanation of Table 3 which summarizes the species characteristics. Section 3 describes each of the 9 species and gives information about their distribution in the U.S. I have followed Suzuki in naming the 7 species that occur in Japan. The synonyms following each species name are only a partial list in most cases; a more complete list is given by Suzuki (1978). The references used in the descriptions of each species in Section 3 are given after the names. Section 4 gives the details of locations mentioned in Section 3. I am indebted to Jim Smith for the locations of species growing in the eastern U.S.

1. Common Characteristics

1.1. The Plants

The bamboos of this group can be distinguished from all others by culm leaf sheaths that are persistent and by branches which occur singly at each culm node except for *Pseudosasa* which may have 2 or 3 branches per node at upper culm nodes.

Not all dwarf bamboos belong to the three genera treated here. Those not included have three or more branches per node. It is not always easy to count the branches on young or poorly developed plants since branching is often not completely developed until the culms are more than one year old.

1.1.1. The Genus *Sasa* Makino & Shibata

Sasa is a genus of small or medium size bamboos which are usually no more than 6 or 7 ft. tall. The rhizomes are long and spreading resulting in the open clump habit typical of a running bamboo. Suzuki (1978) lists 35 species of the genus which are natives of Japan, Saghalien, the Kuriles and Korea. There are in addition 7

* 1101 San Leon Court, Solana Beach, California 92075.

subspecies, 28 varieties and 23 forms. Before Suzuki's revision of the genus it consisted of over 400 species, many based upon unstable or environmentally induced characteristics. Suzuki's classification differentiates species by hairs on the culm leaf sheath and on the lower surface of foliage leaf blades. Hairs on the upper surface of blades or on culm nodes are regarded as of minor importance. As a result of the revision Suzuki states "the number of species has, as a matter of coarse, markedly decreased."

Culms ascending, often arching, without branches or with a single branch to a node; internodes with or without hairs; nodes prominent with or without hairs.

Culm leaf sheaths persistent, generally shorter than the internodes, hairy or hairless; oral setae radiate, deciduous, sometimes lacking entirely; blades lance-shaped.

Foliage leaves palmately or pinnato-palmately arranged towards the top of culms or branches, 4 to 9 in number; sheaths with or without hairs; oral setae covered with tiny bristles over their entire length, radiate, deciduous, sometimes lacking from the first; ligules about 1/16 in. tall, straight or rounded above; blades narrowly lance-shaped to ovate, transverse veinlets well developed, forming a tessellate patern with the longitudinal veins, hairy or hairless on both surfaces or hairy only beneath.

1.1.2. The Genus *Sasaella* Makino

Sasaella, which contains 13 species all native to Japan, resembles rather closely the genus *Sasa*. It differs by having culms which are strictly erect unlike most *Sasas*. In addition the oral setae of both culm and foliage leaves of *Sasaella* have bristles only near the base and are smooth above. Branching usually consists of one per node but a few species have 2 or 3.

I have been unable to find any plants of the genus *Sasaella* growing in the U.S. Further examination of some as yet unidentified plants, however, may turn up members of the genus growing here.

1.1.3. The Genus *Sasamorpha* Nakai

The genus *Sasamorpha* differs from *Sasa* in the following characteristics. The culm nodes are not prominent and the culm leaf sheaths are longer than the internodes so that before branching occurs the young culms are completely covered by the sheaths. Oral setae of the foliage leaves are entirely lacking. The number of foliage leaves at the ends of culms and branches is from 2 to 5, less than for most *Sasas* and *Pseudosasas*. Two species of *Sasamorpha* are native to Japan and Korea, one species is native to China.

1.1.4. The Genus *Pseudosasa* Makino & Nakai

Pseudosasa differs from *Sasa* and *Sasamorpha* by having more than a single branch per node some of the time on the upper part of culms. The culm leaf sheaths are longer than the internodes on the lower part of culms. The two species described here grow taller than any of the *Sasas* or *Sasamorphas*. Three species of *Pseudosasa* have been described from Japan and one species from Taiwan. Several other species have been assigned to this genus by various authors.

1.2. Growth and Hardiness

All nine species are running bamboos. Under favorable conditions the *Sasas* are said to spread rampantly and to be invasive. They can be controlled by surrounding the plant with a barrier that extends about 2 ft. below the ground and a few in. above. Control can also be obtained by simply mowing down the new shoots when they come up in an undesirable location. *Pseudosasa japonica* is much less invasive and can be controlled by simply cutting the new culms which stray too far from the mother plant.

All nine species grow best in partial shade. The native habitat of many *Sasas* and *Sasamorphas* is under a canopy of trees on the forest floor. Although they tolerate full sun, the leaves tend to burn and the plants are not as attractive or as large as they are when partially shaded.

The new shoots appear primarily in spring, though in warm climates like Southern California shooting often occurs to some extent throughout the year. All members of the group are hardy bamboos which can survive temperatures down to about 0° F. Burial by snow helps preserve the plants, but the parts left above the snow may be killed by temperatures below 5° F.

1.3. Propagation

The bamboos of this group are easily propagated by simple plant division. Plants that have grown in the ground or a pot can usually be divided into several new plants by separating a few culms with their attached rhizomes and roots for each new plant. As with most bamboos, division should be done before the new shoots appear, which is from November to February in Southern California. However, I have divided plants of this group at all times of the year without great loss of material.

2. Species Characteristics

Table 3 summarizes those characteristics which are helpful in the identification of the 9 species.

Columns 1 and 2 give the maximum height in feet and the maximum diameter in inches of the culms of each species. The ultimate height varies somewhat with climate and sunlight. Plants are usually smaller when grown under warm and sunny conditions.

Column 3 is a 0, 1, or 2 for culms that are usually straight, somewhat curved or very curved. Column 4 is 0 for green culms, 1 for culms that become blotched with smokey brown after a time, and 2 for culms that turn purplish with age.

Column 5 is 0 or 1 for culm internodes that are hairless or with some hairs. The hairs may fall off with age. Column 6 is 0, 1, or 2 for young culms that are covered with a little, a moderate amount, or much white powder.

Column 7 is 0, 1, or 2 for culm nodes that are not prominent, moderately prominent or very prominent. The prominence is due mostly to the nodal ridge which is the swelling of the culm immediately above the sheath scar. Column 8 is 0, 1, or 2 for nodes which are hairless, with short hairs, or with long hairs.

Column 9 is 0, 1, or 2 for culm leaf sheaths that are hairless, moderately hairy or very hairy. Suzuki (1978) regards sheath hairs as a major distinguishing characteristic of species. Column 10 is 0, 1, or 2 for oral setae which are usually not developed, sometimes developed, or commonly developed. Even when commonly developed the oral setae may fall off with age.

Columns 11 and 12 describe sheath hairs and oral setae on foliage leaves in the same way that columns 9 and 10 do for culm leaves. Columns 13 and 14 give the length and width of the foliage leaf blade in inches. The leaf sizes are for the largest leaves of mature plants grown under favorable conditions. Small plants often have leaves that are significantly smaller than the sizes given here.

The upper surface of the foliage leaf blades of all 9 species are usually hairless or almost so. Column 15 is 0 for blades which are almost hairless on the lower surface and 2 for blades with short, dense soft hairs on the lower surface.

3. The Species

***Pseudosasa japonica* (Siebold & Zuccarini) Makino**
[*Arundinaria japonica* Sieb. & Zucc. ex Steudel, *Sasa japonica* (Sieb. & Zucc.) Makino]
Arrow bamboo, Metake, Ya-dake

Lawson 1968; Lin 1978; Suzuki 1978; Young and Haun 1961.

Arrow bamboo is native to a wide area of Japan and Korea south of 40° north latitude. It has been cultivated in Europe since 1850 and in the U.S. for about 100 years. It makes an excellent screen or hedge because of its thick foliage and its tendency to spread rather slowly.

P. japonica is widely grown as an ornamental in the U.S., and it is sold by several nurseries. There are stands of mature plants in botanic gardens from Southern California to British Columbia including the San Diego Zoo, Quail, The Huntington, LASCA, and Strybing. In the East it grows at the Arnold Arboretum, the Brooklyn Botanic Garden, the National Arboretum, and the National Zoo.

Culms up to 18 ft. tall and 3/4 in. in diameter, erect and straight, arching near the top under the weight of the leaves; internodes up to 12 in. long, hairless; nodes somewhat oblique, not prominent, hairless.

Culm leaf sheaths longer than the internodes, densely covered on the back with long, downward directed hairs which later fall off, margins hairless; auricles small or lacking; oral setae few or lacking.

Branches straight and semierect, one per node, rarely 2 or 3 from the upper nodes.

Foliage leaves, 4 to 7 in number towards the top of culms and branches; sheaths hairless; auricles lacking; oral setae usually lacking, rarely developed, white and smooth; blades 10 to 14 in. long by 1 to 1 1/2 in. broad, hairless, dark green above, light green beneath.

***P. japonica* Var. *tsutsumiana* Yanagita**

Suzuki 1978.

Tsutsumiana differs from the typical form by having culm internodes which are abnormally swollen on the sides opposite buds. The shape of the internode is much like that of the lower end of a green onion. The swelling is not pronounced on small culms and even on large ones it is not obvious when hidden underneath the persistent, long, culm leaf sheaths. The sheaths are sometimes removed for ornamental purposes to accentuate the deformed internodes.

Small plants of *tsutsumiana* are most easily distinguished from the typical form by observing the rhizomes which have internodes which are more markedly swollen than those of the culms.

***Pseudosasa usawai* (Hayata) Makino & Nemoto**
[*Arundinaria usawai* Hayata, *Pleioblastus usawai* (Hayata) Ohki, *Pseudosasa japonica* (Sieb. & Zucc.) Mak. Var. *usawai* (Hayata) Muroi]

Lin 1978.

P. usawai is a new introduction that was obtained by the Huntington from the Taiwan Forestry Research Institute early in 1979. After two years in quarantine, two small potted plants were recently released. The species is native to Taiwan where according to Lin (1978) it is "Widely distributed in thickets and on open grasslands throughout the island, usually scattered and associated with broad-leaved forests at altitudes to 1200 m. (3940 ft.)."

Culms up to 16 ft. tall and 3/4 in. in diameter, erect and straight; internodes deep green, hairless; nodes slightly prominent, with a ring of aerial roots around the lower ones.

Culm leaf sheaths light purple at first, then green or yellow-green, or pale brown when mature, margined on the sides with long brown hairs, otherwise hairless on the back; auricles lacking; 2 or 3 brown oral setae; ligules straight, dark brown.

Branches one per node at lower nodes, 2 or 3 at upper nodes in dense clusters.

Foliage leaves, 2 to 6, sometimes up to 12 per branch; sheaths margined with hairs along the sides, otherwise hairless; auricles lacking; tufts of brown oral setae; ligules convex, rounded; blades dark green above, light green below, 4 to 12 in. long by 1/2 to 1 1/2 in. broad, hairless on the upper surface, covered with dense soft hairs on the lower surface.

***Sasa nipponica* Makino & Shibata**
[*Arundinaria nipponica* Mak., *Bambusa nipponica* Mak.]
Miyako-zasa

Suzuki 1978.

S. nipponica is a native of Japan whose natural range extends along the Pacific side of the islands north to the southern edge of Hokkaido. It is a small *Sasa* which differs from the others treated here by its slender, generally unbranched culms which whither and die each year after being replaced by new ones.

S. nipponica is not distributed in the U.S. I know of only a few small potted plants which appear to be healthy and growing.

Culms up to about 3 ft. in height and 1/4 in. in diameter, usually whithering after the first year; internodes hairless; nodes hairless, strongly prominent, globular.

Culm leaf sheaths hairless with radiate oral setae.

Branches often lacking or sometimes single branches arise from basal nodes.

Foliage leaf sheaths hairless; oral setae radiate, rarely lacking; blades oblong lance-shaped or lance-shaped, up to 8 in. long by 1 3/4 in. broad, with dense soft hairs on the lower surface, hairless on the upper surface.

***Sasa oshidensis* Makino & Uchida Forma *flavo-variegata* Uchida**
Ohshida-zasa

Suzuki 1978.

The natural range of this species is on the Pacific side of Honshu, Japan. Only the form *flavo-variegata* appears to be cultivated in the U.S. It differs from the typical form with green leaves by having leaves that are longitudinally striped with golden yellow. The plant makes a very attractive ornamental having the largest variegated leaf of any bamboo grown in the U.S. Since there are only a few small potted specimens in this country, it will be some time before the species can be widely distributed.

Culms up to 6 ft. tall and 1/4 in. in diameter, ascending, usually curved; internodes strewn with minute, downturned hairs, sometimes hairless; nodes somewhat prominent with long hairs at the upper portions.

Culm leaf sheaths a little shorter than the internodes, densely covered with spreading long hairs.

Branches one per node from the upper part of the culms.

Foliage leaves 5 to 9 in number toward the top of culms and branches; sheaths hairless, blades green with longitudinal yellow stripes, 8 to 12 in. long by 1 1/2 to 2 in. broad, hairless on both surfaces.

***Sasa palmata* (Marliac) Nakai Forma *nebulosa* (Makino) S. Suzuki**
[*Arundinaria paniculata* Mak. f. *nebulosa* Mak., *Bambusa palmata* Marl. f. *nebulosa* Mak., *Sasa nebulosa* (Mak. & Shib.) Ohki, *S. palmata* (Marl.) Mak., *S. paniculata* f. *nebulosa* Mak. & Shib., *S. paniculata* Var. *ontakenis* Camus f. *nebulosa* Mak. & Shib., *S. senanensis* Nak. f. *nebulosa* Rehd.]
Chimaki-zasa

Lawson 1968; Suzuki 1978; Young and Haun 1961.

S. palmata is a native of Japan whose natural range extends as far as 47° north on Saghalien Island. It was first brought into this country by the U.S. Department of Agriculture in 1925. It is reported to cover large mountainous areas in Japan where the small culms are sometimes used as a source of pulp in making hardboard.

S. palmata with its large bright green leaves is an outstanding ornamental. Lawson (1968) states that it is very invasive, but plants I have seen growing at the Huntington and at Strybing did not appear to be spreading rapidly. The species may grow more rapidly in cool climates. It grows well, however, in Southern California and makes an excellent pot plant that tolerates both sun and shade but looks better when grown in at least partial shade.

S. palmata is the most widely distributed dwarf bamboo in the U.S. I have seen it growing in several places along the Pacific Coast as far north as British Columbia. In the East it is growing at the Arnold Arboretum and at the National Zoo.

Suzuki (1978) lists Forma *nebulosa* as having culms with dark blotches differing from the typical form which has immaculate green culms. I can find no evidence that the typical form exists in the U.S.

Several plants of this species have flowered in Southern California during the past few years. A potted specimen in my yard after flowering for 5 months has produced about a dozen seed. Ten other plants of mine show no sign of flowers even though some are divisions of the same mother as the one in flower. The later is growing vigorously, producing new culms, new leaves and more flower stalks. None of the seed from my plant or from other flowering plants in the area have as yet germinated.

Culms up to 7 ft. tall and 1/2 in. in diameter, usually curved from the base, thick walled; internodes white powdery below the nodes, hairless, at first green, later often blotched with brown; nodes hairless.

Culm leaf sheaths hairless except for the margins, covering up to about 3/4 the length of the internode.

Branches, one per node, usually few in number from lower and middle nodes.

Foliage leaf sheaths hairless; oral setae radiate, frequently lacking; blades oblong lance-shaped, thick and leathery, bright green, up to 15 in. long and 3 1/2 in. broad, hairless on both the upper and lower surfaces.

***Sasa takizawana* Makino & Uchida Var. *lasioclada* (Makino & Nakai) S. Suzuki**
[*Neosasamorpha lasioclada* (Mak. & Nak.) Tatewaki, *Sasa lasioclada* Mak. & Nak.]
Takizawa-zasa

Suzuki 1978.

This native of Japan comes from the Pacific side of Hokkaido and northern and central Honshu. Var. *lasioclada* has hairs on the foliage leaf sheaths which are hairless in the typical form. Plants in Southern California were obtained as rhizomes in February 1980 from Alabama as *Arundinaria amabilis*. In a little over a year the rhizomes sprouted and have grown vigorously producing many small culms that look nothing like *A. amabilis*. The plants match the description of *S. takizawana*, but since they are only a little over one year old, the identification is still tentative.

Culms up to 6 ft. tall and 1/4 in. in diameter, ascending, rather erect; internodes hairless or covered just below the nodes with minute downturned hairs; nodes hairless, not too prominent.

Culm leaf sheaths near the base of the culm a little shorter than the internodes, covered with spreading long hairs mixed with minute, downturned hairs.

Branches one per node at most upper and middle nodes.

Foliage leaves, 5 to 8 at the tops of culms and branches; sheaths covered with short hairs; blades 8 to 11 in. long by 1 1/4 to 2 1/4 in. broad, hairless on the upper surface, covered with soft short hairs on the lower surface.

***Sasa veitchii* (Carrière) Rehder**
[*Arundinaria albo-marginata* Mak., *A. veitchii* Brown, *Bambusa albo-marginata* Mak., *B. senanensis albo-marginata* Fr. & Sav., *B. veitchii* Carr., *Sasa albo-marginata* Mak. & Shib.]
Kuma-zasa

Lawson, 1968; Suzuki 1978; Young and Haun 1961.

S. veitchii is native to a rather small area of Japan; it is, however, widely cultivated as an ornamental in that country. In the U.S. it is fairly widely distributed growing as far north as British Columbia on the Pacific Coast. In California it grows at Strybing and at Castro Valley.

The margined leaves make this a striking and interesting plant. The change in color of the margin is not due to frost damage as it occurs even on plants grown in frost free areas.

Culms 3 to 5 ft. high by 1/4 in. in diameter, curved from the base; internodes rather short, purplish, powdery at first, hairless; nodes hairless.

Culm leaf sheaths densely covered with spreading long hairs; branches one per node at a few of the lower nodes.

Foliage leaf sheaths hairless; oral setae developed, radiate; blades oblong lance-shaped, thick and leathery, dark green, the margin in a band around the entire leaf, turning to straw color in late summer and fall, up to 10 in. long by 2 in. broad, hairless on both the upper and lower surfaces.

Sasa

***Sasamorpha borealis* (Hackel) Nakai**

[*Arundinaria borealis* Mak., *Bambusa borealis* Hackel, *Pseudosasa spiculosa* Mak., *Sasa borealis* Mak. & Shib., *Sasa spiculosa* Camus, *Sasamorpha purpurascens* Nak. Var. *borealis* (Hackel) Nak.]

Suzu-dake

Suzuki 1978.

S. borealis is native to both Japan and Korea growing as far as 44° north in Hokkaido. It is an attractive plant that grows a thicket of slender, straight and erect culms with rather sparce, large, dark green leaves. The species is rare in the U.S. and I know of only a few small potted specimens.

Culms to 6 ft. tall and 3/8 in. in diameter, erect and straight; internodes strewn with minute downturned hairs, frequently almost hairless; nodes not prominent, with dense, long upturned hairs.

Culm leaf sheaths covered with long hairs sometimes mixed with fine downturned ones.

Branches one per node from most upper nodes.

Foliage leaves, 2 or 3 in number towards the top of culms or branches; sheaths purplish, strewn with minute hairs, frequently hairless; blades about 10 in. long by 1 1/2 in. broad, entirely hairless or with sparse hairs only at the base beneath.

Sasa

***Sasamorpha tessellata* (Munro) Nakai**

[*Bambusa ragamowski* Wheeler, *B. tessellata* Munro; *Sasa tessellata* (Munro) Mak. & Shib.]

Freeman-Mitford 1896; Lawson 1968.

This striking bamboo was introduced into England from China in about 1845 (Bean, 1907) and into the U.S. from England much later. Munro's (1868) original

description states "I have seen only dried leaves of this species when sewn together and in the state so largely used by the Chinese in packing their tea." His description is of course not too complete but the species is distinctive because it has the largest leaves of any bamboo in cultivation.

S. tessellata grows well in pots. It does best without too much sun and it tolerates complete shade. It appears to be the best species of bamboo for growing indoors.

S. tessellata is one of those bamboos that has flowered only rarely. From the time of its introduction into England until 1979, a period of over 130 years, there is no record of it ever having flowered (McClure 1966, p.278; McClintock, 1979). In April, 1979 a plant in my yard began to flower. By August it had produced about 100 seeds. Of these some 12 seedlings resulted of which 6 survive as healthy, vigorous plants. They all resemble the mother without significant distinctions. The mother plant stopped flowering after about 6 months and regained full vegetative vigor within another 6 months.

Culms up to 7 ft. tall and 1/2 in. in diameter, erect, or more commonly curved from the base due to the weight of the leaves; internodes covered towards the top with minute, sharp hairs, dark green at first, turning purplish green to purple with age; nodes only slightly prominent.

Culm leaf sheaths longer than the internodes, often overlapping the sheaths above, covered with short wooly hairs, fringed on the sides with long, straight, brown hairs especially toward the bottom of the sheath.

Branches, one, rarely two per node.

Foliage leaf sheaths hairless; auricles and oral setae usually lacking; blades large, up to 24 in. long and 4 in. broad, hairless or nearly so on both surfaces.

4. Plant Locations Mentioned in the Text

Arnold Arboretum: The Arnold Arboretum, The Arborway, Jamaica Plane, Boston, MA 02130.

Brooklyn Botanic Garden: The Brooklyn Botanic Garden, 1000 Washington Ave., Brooklyn, NY 11225.

Castro Valley: Inadomi Nursery, 3726 Castro Valley Blvd., Castro Valley, CA 94546.

Huntington: The Huntington Library and Botanic Gardens, 1151 Oxford Rd., San Marino, CA 91108.

LASCA: The Los Angeles State and County Arboretum, 301 North Baldwin Ave., Arcadia CA 91006.

National Arboretum: The United States National Arboretum, New York Ave., N.E., Washington, DC.

National Zoo: The National Zoo, Connecticut Ave., Washington, DC.

Quail: Quail Botanic Gardens, 230 Quail Gardens Dr., Encinitas, Ca. 92024

San Diego Zoo: The San Diego Zoo, Balboa Park, San Diego, CA. 92104

Strybing: The Strybing Arboretum, Golden Gate Park, 9 th Ave. and Lincoln Way, San Francisco, CA.

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Table 3 The Sasas

Species	Culm								Culm Leaf		Foliage Leaf				
	Total Culm			Internode			Node		Sheath		Sheath		Blade		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	ht	diam	curve	color	hair	pow-der	prom-inent	hair	hair	oral setae	hair	oral setae	lgth	wdth	lower hair
Pseudosasa															
japonica	18	$\frac{3}{4}$	0	0	0	0	0	0	2	0	0	0	12	$1\frac{1}{4}$	0
Var. *tsutsumiana*	18	$\frac{3}{4}$	0	0	0	0	0	0	2	0	0	0	12	$1\frac{1}{4}$	0
usawai	16	$\frac{3}{4}$	0	0	0	0	0	0	1	2	1	2	10	1	2
Sasa															
nipponica	3	$\frac{1}{4}$	2	0	0	0	2	0	0	2	0	2	8	$1\frac{3}{4}$	2
oshidensis F. *flavo-variegata*	6	$\frac{1}{4}$	1	0	1	0	1	1	2	1	0	1	10	$1\frac{3}{4}$	0
palmata Var. *nebulosa*	7	$\frac{1}{2}$	2	1	0	2	2	0	0	0	0	0	15	$3\frac{1}{2}$	0
takizawana Var. *lasioclada*	6	$\frac{1}{4}$	0	0	1	0	1	0	2	1	2	1	9	$1\frac{3}{4}$	2
veitchii	5	$\frac{1}{4}$	2	2	0	2	2	0	2	0	0	2	10	2	0
Sasamorpha															
borealis	6	$\frac{3}{8}$	0	0	1	0	0	2	2	0	1	0	10	$1\frac{1}{2}$	0
tessellata	7	$\frac{1}{2}$	2	2	1	1	0	0	1	0	0	0	24	4	0

Figure 1. *Sasa nipponica.* Photo by the author.

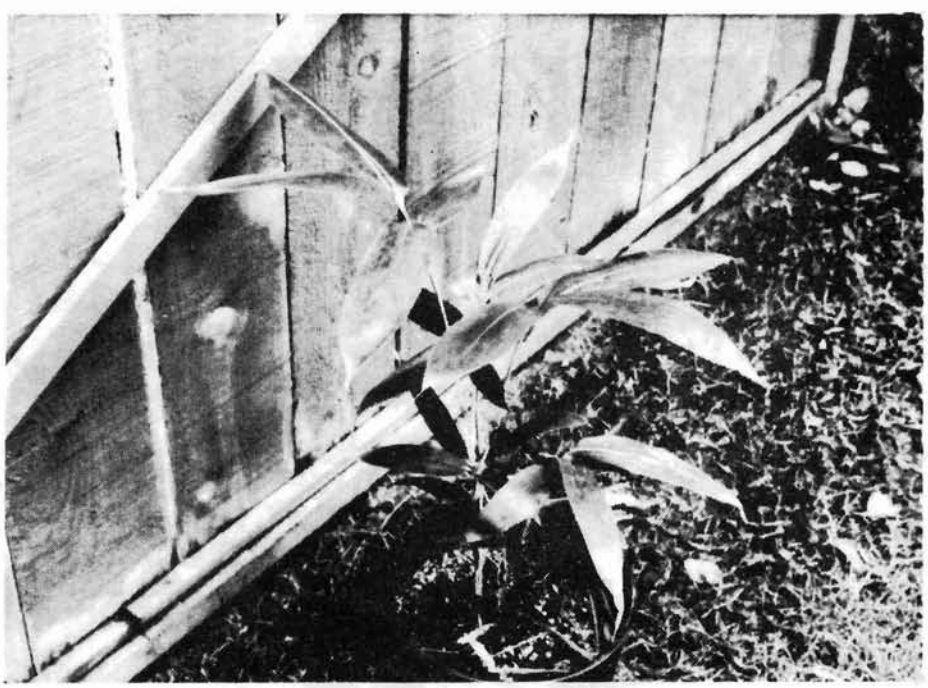

Figure 2. *Sasa palmata.* Photo by the author.

Figure 3. *Sasamorpha tessellata.* Photo by the author.

Jim Smith*: **Some Cold Hardiness Observations on the Temperate Bamboos**
Part I - Western New York

My interest in the temperate bamboos began while working one summer at White Flower Farm in Litchfield, Connecticut. In the back of one green house were 5 or 6 pots of a bamboo and it was my duty to see that they were watered each morning. These were plants of *Phyllostachys aureosulcata* McClure, the Yellow Groove bamboo, dug from the side of a house in southern Connecticut.

I found this intriguing - bamboo in Connecticut? Going through old English garden books I found that many bamboos native to eastern China and Japan grow well in Britain. With this in mind, I decided to experiment. At the end of the summer I purchased a pot of bamboo and planted it at my parents home in Orchard Park, near Buffalo, New York.

Orchard Park lies in the middle of U.S.D.A. Plant Hardiness Zone 6 (0° to -10° F.). Winter lows of -5° F. are not unusual and during the coldest winters temperatures of -20° F. have been recorded. The growing season averages 165 days and there is about 100 inches of snow annually. Favored locations along Lake Erie, the city of Buffalo and the Niagara Peninsula, do not record 0° F. every year and the absolute lows range from -8° to -15° F. These areas enjoy a growing season of 180 days or longer and a lessor amount of snow - usually under 70 inches. In the traditional "snowbelt" areas south of Lake Ontario and east of Lake Erie, the growing season is shorter, winters are colder and the snowfall is nearly twice that of Orchard Park. Some otherwise tender plants survive due to heavy snow cover. Summers are warm and sunny and there is usually sufficient rainfall so that droughts rarely occur.

In the spring of 1969 rhizomes of *Phyllostachys bambusoides* Sieb. & Zucc., *P. bissetii* McClure and *P. vivax* McClure were planted. *P. vivax* initially did well and seemed as cold hardy as *P. aureosulcata*, but the clump later died due to an unknown cause. *P. bambusoides* and *P. bissetii* grew but showed a lack of vigor, were not as hardy and were eventually destroyed.

In the spring of 1972 I purchased a clump of *P. flexuosa* A. & C. Rivière from Panfield Nurseries on Long Island. This was planted next to *P. aureosulcata* on a north facing slope in full sun partially sheltered from prevailing southwest winter winds. Both bamboos now form a small grove 10 x 20 feet. They are kept in bounds on one side by a drainage ditch and by mowing over stray new shoots each spring. Some of the shoots have appeared 15 or more ft. from the grove and mowing is a practical means of control. Due to reliable snow cover we do not often experience deeply frozen ground and the only mulch used has been leaves and grass clippings. Without fertilizer maximum height has been 12 ft. with culm diameters of 1 in.

1079 Ashbury St., San Francisco, Ca. 94117

The leaves of both *P. aureosulcata* and *P. flexuosa* are not injured at 0° F. Some leaf burning occurs at -3° F. and usually severe culm damage is evident below -5° F. Heavy snows can bury some culms and during the severe 1977 blizzard the entire grove was buried and remained undamaged. In an unusually mild winter when temperatures do not go below zero, both bamboos have remained evergreen.

There is a 20 ft. tall grove of *P. aureosulcata* and a 15 ft. tall grove of *P. aurea* A. & C. Rivière in Buffalo. These were planted in the 1960's and went through 15 successive winters without any appreciable leaf damage. The lowest temperature recorded in that garden had been -5° F. I do not know how they fared during the severe 1978-79 winter when it fell to -10° F. in the city.

Plants of *Arundinaria viridi-striata* (Regel) Makino were planted in 1969. This has been a very satisfactory bamboo and is not as rampant as other members of its genus. The culms have withstood -10° F., but the leaves become semideciduous as winter sets in. It makes an excellent ground cover holding the leaf variegation best in partial shade.

Pseudosasa japonica (Sieb. & Zucc.) Makino is evergreen to about +5° F. and the culms survive temperatures of about zero. Unless snow covers the culms, they are always killed to the snowline. In a protected place in Niagara Falls I have seen plants come through a few winters undamaged.

Sasa palmata (Marl.) Nakai, *S. pygmaea* (Miquel.) Kurz and *S. tessellata* (Munro) Makino & Shibata have grown well here. *S. palmata* and *S. tessellata* remain evergreen to +10° F. and the low culms are often buried by snow. *S. pygmaea* is semideciduous and easily becomes a noxious weed not controlled by mowing.

Sinarundinaria nitida (Mitf.) Nakai has been absolutely hardy surviving undamaged during the record winters of 1976-79. During February 1979 we recorded 9 nights of zero or below with one night of -15° F. and the next to -22° F. Above the snowline there was no damage to the twigs, culms or previous season's "whips".

S. nitida and the similar *Thamnocalamus spathaceus* (Franchet) Soderstrom, formerly *Sinarundinaria murielae* (Gamble) Nakai, are nonrunning bamboos well suited for small gardens. They have the unusual habit of sending up most new shoots in late summer and early fall (late August and early September here). These "whips" winter over and branch out the following spring. Both are nearly deciduous loosing most of thier leaves by Thanksgiving and they are not as handsome as *Phyllostachys* in the winter months. Both species do best in moist soil and semishade. I believe these bamboos are usefully cold hardy in the warmer parts of U.S.D.A. Zone 5 (-10° to -20° F.) in the eastern U.S. Plants are difficult to obtain and slow to propagate, but worth seeking out.

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Stephen M. Young*: **Observations on the Morphological Variations and Distribution of *Bambusa guadua* Humb. et Bonpl. in Ecuador**

Introduction

Recently I had the opportunity to study and collect many of the bamboos of Ecuador. The project, geared toward a general survey of the bamboos, was carried out under the direction of Dr. Thomas R. Soderstrom of the Smithsonian Institution and sponsored in Ecuador by Dr. Lauritz B. Holm-Nielsen of the Catholic University in Quito. The funding was provided by the Eppley Foundation for Research. During the course of the year-long study I began to realize, as had other collectors before me, that there exist general distribution patterns and morphological or growth variations of the most common tropical species there, *Bambusa guadua.*

Regions

Ecuador is the fourth smallest republic in South America. It lies between Colombia and Peru on the west coast and consists of three main geographic areas.

Two parallel cordilleras of the Andes mountains run down the center of the country. This high mountainous region is composed of dry basins interspersed with the cones of more than thirty volcanos. To the west lies the coastal region, composed of both wet and dry lowlands and low hills. To the east of the mountains is the Oriente, the forested eastern slopes of the Andes that gradually descend to the Amazon basin below.

Background

On both sides of the mountains *Bambusa guadua* grows in abundance. A destinctive bamboo, it was first described by Humboldt and Bonpland after their travels through South America in the beginning of the 19th century. The species was subsequently described by Kunth who gave it the name *Guadua angustifolia.* Today, after further revisions, it is known once more as *Bambusa guadua* Humb. et Bonpl.

Dr. F.A. McClure made a serious study of guadua, as it is commonly known, during his collecting in Ecuador in 1945. A description of the plant can be found in his monumental book, "The Bamboos," along with a discussion of the three morphological variations that he discovered during his research there.

The first of his variations is the Milagro strain which was said to have flowered annually. Unfortunately there is very little additional information pertaining to other physical characteristics of this variation.

The second one involved a strain called "caña mansa" (meaning tame or gentle). This differed from the typical form, or "caña brava" (meaning fierce or

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aggressive), by weaker development of branches and spines and a difference in leaf shape.

The third strain consisted of a clump he observed outside of the town of Vinces in the province of Guayas. It was characterized by the absence of long thorny branches around the base of the culm.

After extensive observation, collection and study of the collections of Dr. McClure and others I have defined four different guadua morphological variations and three corresponding areas of distribution. (see map)

Variations and Distributions

The first variation is similar to the one that Dr. McClure describes in Vinces but normally occurs in northwestern Ecuador in the provinces of Esmeraldas and Carchi. The culms are without buds on the central one third of the stem. The buds on the lower one third are dormant unless the culm is injured or cut after which they begin to grow into long spiny branches. (figs. 1 and 2) The foliage branches on the upper one third of the culm have few or no spines.

It is a growth form that is simple to recognize, easy to collect and abundant in the areas where it occurs.

Along the Cayapas River in northern Esmeraldas large stands of this type can be seen growing along the river bank but are absent in the interior of the forest. This may be due to the hilly terrain where slopes are too steep for guadua growth. The tremendous amount of precipitation the area receives during the year may also contribute to this pattern by leaching essential nutrients from the soil.

A comparable climatic situation occurs in the Amazon lowlands with a corresponding pattern of guadua distribution.

The second growth variation is characterized by nodes that are all gemmiferous (bud bearing). In both the upper and lower one third of the culm the buds develop into spiny branches. (fig. 3) The buds on the central portion of the culm remain dormant. The individual plants usually grow to a height of 20 m. or more and diameters can reach up into the 12 cm. range.

This is the variation known most commonly as "caña brava," the name used by McClure to describe the typical and most common form of coastal guadua.

Its area of distribution includes all of the coastal plain south of Esmeraldas. From an average altitude of 1200-1500 m. in the east, guadua extends out into the coastal plain to the dry regions of the west where the amount of precipitation is too small to support its growth. Often its range will extend into these dry regions along streams and rivers or atop high mist-covered ridges where sufficient moisture is available.

The third variation also has nodes that are all gemmiferous. It is distinguished from the second by size, abundance of spines and culm durability. The height of the culms rarely exceed 20 m. Diameters are usually 10 cm. or less. Branches in the lower one third of the culm are not highly developed and their spines are fewer, shorter and less pointed. Its durability is also surpassed by the more common typical form.

This is the variation known and described by McClure as "caña mansa." Its distribution coincides with that of "caña brava" but seems to occur in areas of less fertility and moisture. Additional factors also responsible for its appearance are: selective culling of only the best culms from a clump, physical effects of disease and insects, and incomplete description of the plant by collectors.

The fourth variation is simply a smaller version of "caña brava." It has a similar pattern of branch distribution and the branches are also very spiny. The average height of a culm, however, is only 10 to 15 m. with a few exceptionally tall ones. Diameters rarely exceed 10 cm. (fig. 4)

This is the "Oriente" variation. So-called because of its distribution throughout this geographic region of Ecuador. Here the distribution can be divided into two zones of abundance.

The first zone includes the eastern slopes of the Andes as they descend to the lowlands in a gradual series of foothills, unlike the steep slopes of the western cordillera that descend sharply to the coastal plain. From an altitude of 1500-1600 m. guadua is evident along the fertile rivers of this region extending into the surrounding forest where the slopes are not too steep. Occasionally clumps can be seen reaching up to altitudes of 1700 and 1800 m. (fig. 5)

Below 600 m. the terrain levels off considerably and the distribution of guadua changes. Now it can be found only along major rivers and in the adjacent forests where silt from the volcanic soils of the Andes is able to collect and where sunlight is most available. The heavy precipitation and subsequent low fertility of the soils, along with the tall, sunlight-blocking forest canopy prohibit its growth in the interior of the forest. (fig. 6) Along the black-water rivers and streams which are fairly common in this region, guadua is not present. The low fertility, acidic conditions and periodic flooding of the river banks prevent it from growing here.

In general, guadua is more abundant in western Ecuador than in the east. This may be the result of a number of factors but I believe topography, forest depletion, and soil fertility are principally the cause of this inequality. The fertile soils of the west are less steeply sloped than those of the eastern foothills and therefore more conducive to guadua's growth. Consequently as the virgin rain forest of the coastal plain was cleared by man for agriculture and grazing, guadua began to thrive in areas where sunlight was never before available. In the east the soils of the Oriente lowlands are less fertile than those of the west, thereby restricting its growth.

This inequality is also evident in the use of guadua products by the people who live in these regions. It is correspondingly less in the east than in the west.

Conclusion

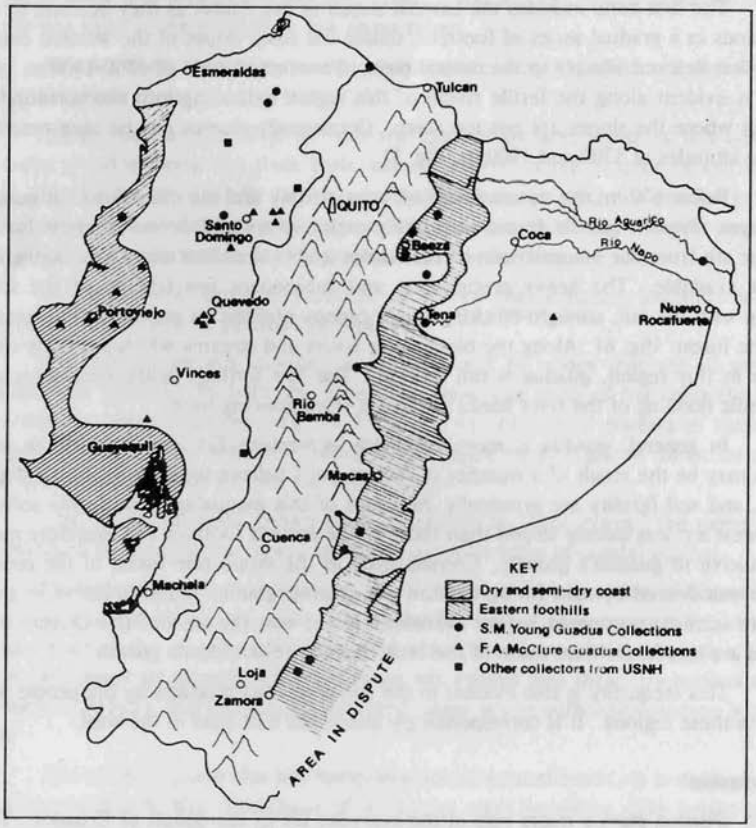
Guadua plays a major role in the everyday life of the people of Ecuador. This is especially true on the coastal plain where at least 90% of the buildings are constructed in part or entirely of guadua.

Unfortunately, as its use becomes more widespread, there continues to be a great lack of scientific literature concerning this interesting and important species.

The four morphological variations of guadua that I have described here were observed after extensive travel throughout the country of Ecuador during the span of one year. Their detailed descriptions remain to be completed but after much scientific neglect and only casual observation the definition of these four variations may help to understand the complex nature of this wide-ranging, useful, and beautiful bamboo.

References

McClure, F.A., 1966. *The Bamboos - A Fresh Perspective*, Cambridge: Harvard University Press, xv+347 pages.



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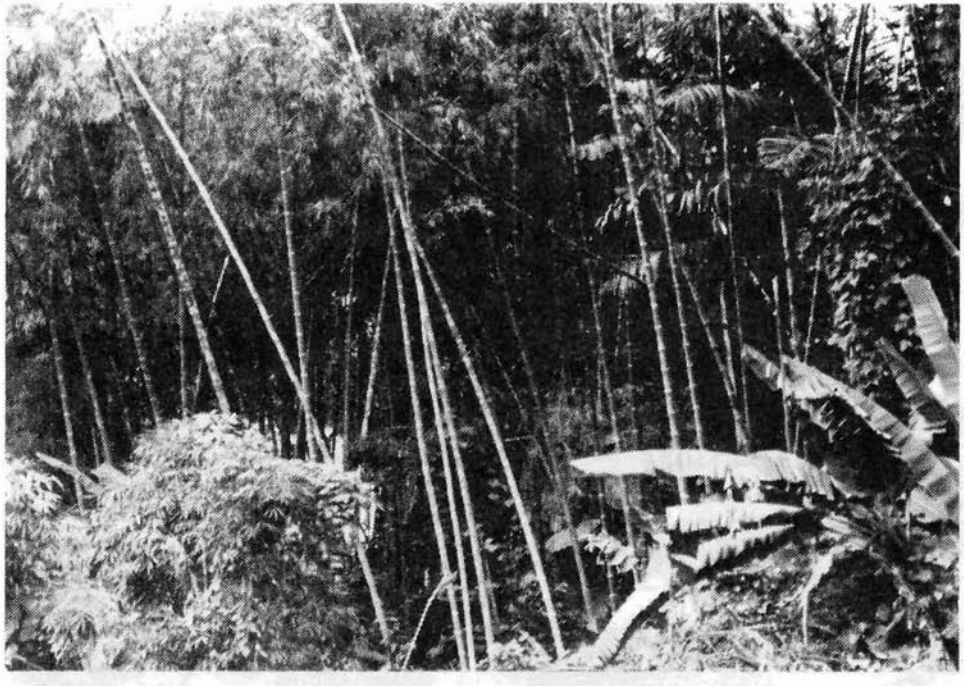

Figure 1. The Esmeraldas variation provides many branchless nodes for quality construction and added beauty. All photos by the author.

Figure 2. The absence of lower branches in the Esmeraldas variation provides easy access to a clump. Note the developing branch on the cut stem.

Figure 3. The spines of the lower branches of Oriente and Coastal guadua make entering a clump difficult.

Figure 4. A machete illustrates the small diameter of a majority of the Oriente guadua.

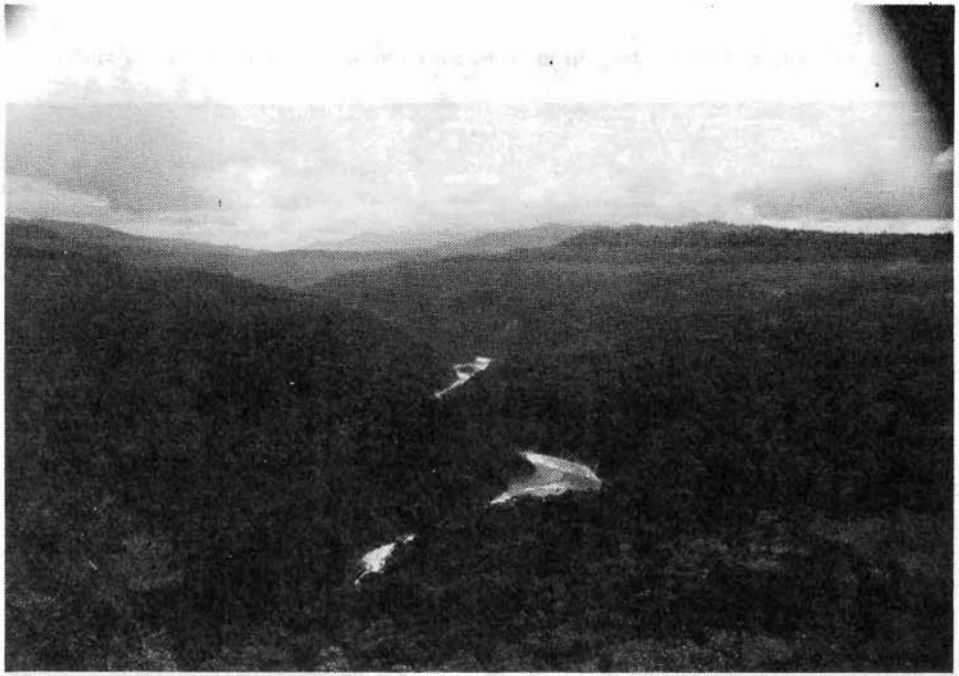

Figure 5. The Quijos River as it flows through the foothills of the Eastern Range on its way to the Napo river.

Figure 6. Oriente guadua growing on the banks of the Napo River near the town of Coca.

Richard Haubrich*: A Selected, Annotated Bibliography on Bamboo

I have chosen from the vast literature on bamboo 26 books and articles which I believe will be of interest and value to those seeking a basic, broad knowledge of the plant and its uses. Each entry is followed by an annotation aimed at revealing the contents of the work. The comments are my own except for those in quotes which are taken directly from the abstract or introduction to the article and those following the word "Contents" which are a listing of the Table of Contents of the article.

Most of the items listed should be available at local libraries or through interlibrary loan. Several of the more recent publications may still be in print and available from book stores or the publishers.

Austin, Robert, Koichiro Ueda and Dana Levy

1970. *Bamboo*, Weatherhill, New York and Tokyo. 215 pp., Illus., Sixth Printing, 1978.

The major part of the book is devoted to photographs and brief descriptions of bamboo plants and the many useful articles made from them. The remainder of the book describes the versatility, growth and cultivation of bamboo plants.

Backer, C.A. and R.C. Bakhuizen van den Brink Jr.

1968. *Flora of Java*, v. 3, 238. Poaceae (Gramineae), key to bamboos, p. 511; description of species, pp. 627-641, Wolters-Noordhoff N.V. - Groningen - The Netherlands.

The key is based on the culm leaves. Eight native and exotic genera containing 31 species are described. The descriptions are quite detailed but there are no illustrations.

Bailey, Liberty Hyde and Ethel Zoe Bailey, revised and expanded by the Staff of the Liberty Hyde Bailey Hortorium

1976. *Hortus Third*, MacMillan Pub. Co. Inc., New York. 1290 pp.

Listed in dictionary format by genus and species are the plants most commonly cultivated in the U.S. Nine genera of bamboos containing a total of 55 species and varieties are briefly described. Botanic names, authors and synonyms are given along with some information on culture and distribution in the U.S. This book is important because it is often used as an authority for the botanic names of cultivated plants in the

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U.S.

Camus, E.G.

1913. *Les Bambuseés - monographie, biologie, culture, principaux usages*, P. Lechevalier, Paris. 2 volumes: Text 215 pp. and Atlas 101 plates, in French.

Describes all of the bamboo species known at the time, over 485. The plates contain ink drawings of the plant parts of 260 of these. There is an index of scientific names which includes many synonyms. There is also an index of common names and a bibliography.

Calderón, Cleofé E. and Thomas R. Soderstrom

1980. The Genera of Bambusoideae (Poaceae) of the American Continent: Keys and Comments, *Smithsonian Contr. to Bot.*, No. 44. 27 pp.

"The history of the grass subfamily Bambusoideae is reviewed and nomenclatural problems of subfamilial and tribal level are explored. Characters are presented to distinguish the subfamily from all other grasses and differentiating features of the two major groups of bamboos - herbaceous and woody - are included. Keys are given for the tribes and genera of herbaceous American bamboos and genera of woody American bamboos, the latter based principally on vegetative characters. A conspectus of the subfamily also appears, with a list of all 37 genera recognized in the American continent, each with nomenclatural and taxonomic notes. Comments on the morphology of the bamboo plant and the systematic value of some characters, especially vegetative, are given in the introduction."

Everett, Thomas H.

1980. *The New York Botanical Garden Illustrated Encyclopedia of Horticulture*, Garland Publishing, Inc., New York & London. 10 volumes, Illus.

Contains a 3 page general discussion under "Bamboos" of characteristics, uses, cultivation, and pests. Fourteen genera are described alphabetically throughout the Encyclopedia. The individual species are described in a somewhat random order under each genus. Most species descriptions are adequate for a horticultural profile of the plant, but some descriptions are quite brief. Most of the species described are cultivated in the U.S. but others are not and a few are not cultivated in either Europe or the U.S. On the other hand there are several species which are cultivated in the U.S. (especially on the West Coast) which are not mentioned. Most descriptions are accurate but there are a few significant errors.

Gamble, J.S.

1896. The Bambuseae of British India, *Ann. Roy. Botan. Garden Calcutta*, 7: 1-133. Atlas Plates 1-119. Reprinted 1966 by Micro Methods Ltd., Yorkshire, England and Johnson Reprint Corp., New York, NY.

Covers all species known at the time which are natives of India, Burma and Malaya. Each of 115 species are described in detail and illustrated in a full page plate which contains drawings of culms, branches, leaves and flowers. There are also notes on habitats and the relationships between species. The 15 genera are separated into 4 subtribes. There are keys to the subtribes, genera and species; the keys rely heavily on floral characteristics. This is a valuable and useful book on species descriptions. The recent reprint can often be found in libraries.

Hidalgo López, Oscar

1974. *Bambú su Cultivo y Aplicaciones en: Fabricación de Papel, Construcción, Arquitectura, Ingeniería, Artesanía*, Estudios Técnicos Colombianos Ltda, Bogotá, Colombia, 318 pp. + xvii, Illus., in Spanish.

The giant tropical bamboo *Bambusa guadua* Humboldt & Bonpland is the most useful species in Latin America. Native to Colombia this bamboo finds its widest range of applications in that country. After listing many of the bamboo species of the world, the book describes the basic morphology of bamboos and in particular guadua. The major portions of the book are on applications with pictures and detailed drawings of the construction and manufacture of bamboo products.

Hidalgo López, Oscar

1978. *Nuevas Técnicas de Construcción con Bambú*, Estudios Técnicos Colombianos Ltda., Bogotá, Colombia. 137 pp. + xii, Illus., in Spanish.

The book is richly illustrated with pictures and detailed diagrams showing how bamboo is used in construction.

Contents:

1. Nuestro bambú "la guadua"
2. Estructuras tipo "A" para beneficiaderos de café
3. Armaduras tridimensionales para techos
4. Bambú - cemento
5. Concreto reforzado con cables de bambú

Hidalgo López, Oscar

1981. *Manual de Construcción con Bambú - Construcción Rural-1*, Estudios Técnicos Colombianos Ltda., Bogotá, Colombia, 71 pp., Illus., in Spanish.

This is a book of illustrated construction methods. Each page consists of labeled detailed drawings of construction procedures.

Contents:
A. Generalidades
B. Materiales de construcción derevados del bambú
C. Uniones y amarres
D. Construcción de estructuras
E. Acueductos
F. Puentes

Hsiung, Wen-Yue, ed.

1981. *Bamboo Research*, v.1, Nanjing Technological College of Forest Products, Nanjing, China. 122 pp., Illus.

Contains 13 research articles by 18 contributors. According to Dr. Hsiung's preface:

"Bamboos constitute an important part of the forest resources of China. As evidenced by the historical records, unearthed antiques, roots of Chinese characters and the wide use of bamboo products in the daily life of the people, bamboos are closely associated with the development of Chinese civilization and play an important role in Chinese economics even today."

"This is the first volume of 'Bamboo Research' Monograph edited in English. It contains thirteen articles related to taxonomy, anatomy, physiology, silvicultural management, entomology, pathology, culm forms, combustion values and preservation of bamboos. All of them have been published in Chinese periodicals recently. Through the monograph we wish to exchange information of bamboo research with our colleagues both in China and abroad. We also welcome articles of bamboo studies and comments from them."

Contents:
A revision of some genera and species of Chinese bamboos
Arundinaria Michaux and its distribution in China
Acidosasa - a new genus of Chinese bambusoideae
Intercalary meristem and internodal elongation of culm shoots
An investigation on flowering and rejuvenation of *Phyllostachys vivax* stands
Purification and identification of DNA in *Phyllostachys pubescens*
The anatomical structure of culms of *Phyllostachys pubescens* Mazel ex H. de Lehaie

A study on the classification of *Phyllostachys pubescens* stands
The structure of culm form of *Phyllostachys pubescens*
Combustion values of bamboos
Studies on culm brown rot of *Phyllostachys viridis*
Bionomics and control measures of the bamboo shoot borer moth, *Atrachea vulgaris* Butler
An experiment on bamboo preservation

Lawson, Alexander H.

1968. *Bamboos - A Gardener's Guide to Their Cultivation in Temperate Climates*, Taplinger Publ. Co., New York, NY. 192 pp., 18 plates, 9 line drawings.

Growth, care, cultivation, propagation and uses are discussed in the first five chapters. Chapter 6 describes in some detail 57 species, varieties and cultivars which are established in England. An additional 39 bamboos which are less commonly grown are briefly described. The practical minded plant descriptions are easy to read. They give one an acquaintance with each type of plant, at least as it grows in England. The descriptions are not sufficiently precise, however, to allow one to easily distinguish one species from another.

Lin, Wei-chih

1968. The Bamboos of Thailand (Siam), *Special Bulletin of Taiwan Forest Res. Inst.*, No. 6. 52 pp., 35 figs.

A survey of bamboos in Thailand giving the description, distribution and utilization of 42 species belonging to 10 genera. The purposes of the survey were "(1) to introduce excellent quality and high yield exotic tropical species from Thailand to Taiwan for propagation; (2) to investigate the bamboos and collect specimens from Thailand; and (3) to collect literature concerning the bamboos of Thailand." Eight species are illustrated with full page drawings of their plant parts.

Lin, Wei-chih

1970. *La Culture du Bambou à Madagascar*, Centre de Formation pour l'Artisanat du Bambou Sino-Malagasy. 20 pp, 7 figs., in French.

Contains the description and distribution of 35 native and exotic bamboo species belonging to 12 genera. About half the booklet is devoted to the culture of bamboo.

Lin, Wei-chih

1978. Subfamily 6. Bambusoideae, *Flora of Taiwan*, 5: 706-783, Epoch Publishing Co., Ltd., Taipai, Taiwan. 39 full page plates.

Contains descriptions of 15 genera, 40 species, 3 varieties and 10 cultivars which grow in Taiwan. Most of the species have been introduced for their possible economic uses. A key to the species based on vegetative characteristics is provided. Plant parts of most species are illustrated by drawings on full page plates.

Marden, Luis and Jim Brandenburg

1980. Bamboo, the Giant Grass, *National Geographic*, 158: 503-529. Oct., 1980. Illus.

An illustrated story of bamboo, the plant and its many uses. Included is much information about *Arundinaria amabilis* which is cultivated in China for its valuable wood. There are several excellent colored photos and diagrams including a map of the native bamboo regions of the world, a photo of a massive bamboo scaffolding and drawings of culms of 7 species.

McClure, F. A.

1955. Bamboos, in J. R. Swallen, Grasses of Guatemala, in P. C. Standley and J. A. Steyermark, eds., *Flora of Guatemala*, pt. II, *Fieldiana* (Botany), v. 24, pt. II.

Contains 2 keys to the bamboo genera of Guatemala, one based on floral characteristics, the other a field key based on vegetative characteristics only. The bamboos and other grasses are arranged by genus in one alphabetical sequence. Thirteen native species belonging to five genera are described along with 25 exotic species and varieties belonging to 7 genera. Keys are given for the species of each genus. Most of the species descriptions are extensively detailed. A few of the species have illustrations of their plant parts.

McClure, F. A.

1957. *Bamboos of the Genus* Phyllostachys *under Cultivation in the United States*, Agriculture Handbook No. 114, U.S. Depart. of Agriculture. 69 pp., 53 figs.

"This Handbook provides a key for the field identification, without flowers or fruits, of the 34 bamboos of the genus *Phyllostachys* (24 species and 10 horticultural forms, herein designated as cultivars (cv.)) that have been successfully introduced into the United States. Another cultivar was added after the key was completed. These bamboos are all native to China. A description of each entity, based on the living plant, is provided for the user's convenience in checking the identifications he makes by means of the key."

The key relies heavily on the culm leaves. It is therefore useful as a field key only in spring when the culm leaves are available. There are line drawings of the upper part of the culm leaf for each species.

Contents:

McClure, F. A.

1966. *The Bamboos - A Fresh Perspective*, Harvard University Press, Cambridge, Mass. 347 pp., 99 figs.

This book covers the major part of McClure's life long work with bamboo. Part I covers the vegetative phase of the mature plant, the reproductive phase, and the seedling. Part II describes 7 important species and reviews methods of propagation. Part III describes the flowering and fruiting behavior of 30 different species and concludes with a discussion of bamboo taxonomy. Appendices contain a key to the genera of bamboos cultivated in the U.S., a glossary and an index of scientific names used in the text.

McClure, F. A.

1973. Genera of bamboos native to the New World, T. R. Soderstrom (Editor), *Smithsonian Contr. to Bot.*, No. 9, 148 pp., 48 figs.

This is McClure's 2nd and final book, published 3 years after his death. The American bamboos are classified into 17 genera, four of which are described here for the first time. Each genus is described, its relationship with other genera discussed and its range of habitats given. A list of all known species, along with synonyms is given for each genus. The plant parts of the type species of each genus are illustrated by one or more full pages of line drawings. Descriptions of new genera and species are given in Latin along with an English translation. A key to the genera relies on floral as well as vegetative characteristics. A few genera have keys to the species. Most species listed are not described, but each is supplied with the complete reference to its original description. There is a 9 page list of references, and an 18 page glossary of special terms used for

bamboo.

Munro, William

1868. A Monograph of the Bambusaceae, including descriptions of all the species, *Trans. Linn. Soc. London*, 26: 1-157. 6 plates; reprinted 1966 by S. R. Publishers Ltd., Yorkshire England and Johnson Reprint Corp., New York, NY.

Describes all the bamboo species of the world known at the time - 21 genera containing a total of 219 species. The introduction and the comments on each species are in English; the descriptions of the genera and species are in Latin. Keys to the genera and species are based primarily on floral characteristics and are in Latin. There are six full page plates of drawings of the plant parts of 6 species.

Pohl, Richard W.

1980. Flora Costaricensis, William Burger (Editor), Family #15, Gramineae, *Fieldiana Botany*, New Series, No. 4, Field Museum of Natural History, Chicago, IL. 608 pp., 224 figs.

Describes all the grasses of Costa Rica including the bamboos and the herbaceous bambusoid grasses. The bamboos include all known native species, 22 from 8 genera, plus three introduced species. Tropical Costa Rica has a rich and varied flora. The native bamboos are found from the lowland rain forests and savannahs to the cool, clowded páramo which reaches elevations above 11,000 ft.

Soderstrom, Thomas R. and Cleofé E. Calderón

1979. A Commentary on the Bamboos (Poaceae: Bambusoideae), *Biotropica* 11(3): 161-172. 3 page bibl.

Reviews the taxonomy, ecology, biology, economic uses, silviculture and horticulture of bamboo. The bibliography lists many of the world's important references on these subjects.

"Bamboos, or tree grasses, comprise the most diverse and certainly least-understood group of plants in the grass family. Herbaceous grasses that occur in tropical shaded forests share similar anatomical and morphological features with the bamboos, and with them make up the grass subfamily Bambusoideae. Both groups have been inadequately collected, the herbaceous bambusoid grasses primarily because the plants often appear sterile when in full flower, and the bamboos because they bloom so seldom. The bamboos of Asia have received far more attention taxonomically than those of the New World, where many new genera and species are now coming to light due to recent explorations. Numerous biological problems are presented by the Bambusoideae, such as the phenomenon of cyclic flowering, modes of pollination, and types of sleep movements in the leaves. Also numerous cytological questions remain to be answered. Wherever man has come into contact with bamboo he has found multiple uses for it, from food in the form of new shoots, to construction and papermaking. Apart from such practical uses as these, many members of the subfamily are cultivated as ornamentals. The genera of Bambusoideae that occurs in Asia, Africa and Madagascar, and the New World are listed."

Suzuki, Sadao

1978. *Index to Japanese Bambusaceae*, Gakken Co., Ltd., Tokyo, Japan. 384 pp., Illus., in Japanese and English.

This large book measuring 9 by 12 in. describes all the major types of bamboo that grow in Japan, a total of 133 different species and major varieties plus many more minor varieties and forms. For each of the 133 types there is a full page, plate drawing of the culms, branches and leaves plus the flowers when known. Facing each plate is a full page containing a description in both Japanese and English, a black and white photograph of the growing plant, and a map of its distribution in Japan. Many of the species are also shown in one of the almost 100 color photographs which cover 16 pages. A complete key to the genera and species based on vegetative characteristics is given. The index of scientific names contains over 1400 entries which direct one to the main Index. Thus one can start with a synonym and find the preferred name under which the species is described in this book, or one can start with the preferred name and find all its synonyms using the main Index.

Young, Robert A. and Joseph R. Haun

1961. *Bamboo in the United states: Description, Cultivation and Utilization*, with a key to the genera by F.A. McClure, Agriculture Handbook No. 193, U.S. Dept. of Agriculture, Washington DC. 74 pp., 16 figs.

Contains fairly detailed descriptions of 24 running and 23 clumping, bamboos. The key to the genera is based partially on floral characteristics.

"The gradually increasing interest in bamboo among American farmers, gardeners and commercial users has made it desirable to bring together the essential information available concerning the types of bamboo that give most promise of value in the United States as sources of economic products or as ornamentals. Bamboo is so different in character, habits of growth, and culture from any other crop plant with which the American agriculturist is acquainted that it is necessary to provide a detailed description of the unique nature of bamboo as a basis for its utilization in agriculture. Brief mention is made of the two native bamboos of the southeastern United States, and a more detailed description of the important species of hardy oriental and of some tropical kinds that have

been introduced into cultivation during the past 75 years is given. Information on the propagation, culture, and utilization of bamboos is given."

Contents:
Nature of Bamboo Growth
Types of Bamboo - Running and Clump
Generic Key to Bamboos under Cultivation in the United States and Puerto Rico
Hardy Running Bamboos
Tropical, Clump-Type Bamboos
Cultural Information
Harvesting and Preparing Bamboo for Market
Bamboo Pests
Utilization of Bamboo
Literature Cited

Ueda, Koichiro

1960. *Studies on the Physiology of Bamboo, with Reference to Practical Applications*, Resources Bureau, Science and Technics Agency, Prime Minister's Office, Ref. Data No. 34, Tokyo, Japan. 167 pp. + xii, 38 figs., 57 photos, 64 tables.

Contains a great deal of information on bamboo as an economic crop suitable for many applications.

Contents:
I Physiology
- Bamboo Species
- Development of Bamboo
- Flowering and Death of Bamboo and the Proper Treatment
- Cytogenetic Studies

II Applications
- Characteristics for Management of Bamboo Grove and Importance of its Utilization
- Distribution of Bamboo Groves and Production of Sprouts and Culms in Japan
- Bamboo Cultivation

JOURNAL OF THE AMERICAN BAMBOO SOCIETY

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Two good quality copies of the manuscript, typed on one side only, on 8 1/2 by 11 inch paper are required. The format should follow the pattern as presented by the *Journal*. The first appearance of scientific names of the plants should be followed by the appropriate authorities. References should be listed alphabetically at the end of the paper unless they appear as footnotes. The references should then be in order of appearance at the end of the paper. Total length of the manuscript (including figures) should be no more than 30 pages of the *Journal* (about 480 words/page).

References should cite the author and date first. Then (for journals), the article name, journal name, volume number (in boldface), issue number, and pages. For books, the book title, publisher, and pages.

Figures should be submitted either as unmounted glossy photographic prints, or as black and white ink drawings suitable for photographic reproduction.

Make figures and captions large enough to be legible when reduced (if necessary). Lettering should be uniform. Each figure should have the author's name and the number of the figure on the back. Captions should be on a separate piece of paper (not on the figures) and figures should be consecutively numbered in Arabic numerals.

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RICHARD HAUBRICH

JOURNAL COMMUNICATIONS TO BE ADDRESSED TO THE EDITOR

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Richard Haubrich*: A Glossary of Bamboo Terms

The scientist uses a special vocabulary to make descriptions highly precise. This is especially true of the biologist who must describe the enormous detail and complexity of living things. Thus it is with the science of bamboos. Common words may have restricted, extended, or entirely different meanings while a host of strange new terms describe qualities of the plant which most of us have never seen.

Below I have listed those general botanical terms which occur often in the discussion of bamboos. In addition are terms used more specifically for grasses and bamboos.

abscission. Falling off.

acuminate. Tapering gradually to a slender point with somewhat concave sides, describes the tip of many bamboo leaf blades.

acute. Sharp-pointed, tapering to a point with straight to convex sides.

albino. A plant which is completely white or colorless due to a lack of chlorophyll. Some bamboo seedlings are albinos; these soon die.

antrorse. Directed upward or forward, the opposite of retrorse.

apex. The tip or top most part, lying away from the point of origin.

appressed. Pressed closely and flatly against something.

armed. Having thorns or spines like some species of the genus *Bambusa* Schreber.

attenuate. With a long slender taper, more gradual than acuminate.

auricles. Small earlike projections above the sheath, one on each side at the base of the blade of a bamboo leaf. The auricles may be prominent, small, or lacking altogether.

awn. A bristlelike extension of the midrib from the tip of a lemma or glume in some grass flowers.

bamboo. A plant belonging to the subfamily Bambusoideae of the grass

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family Gramineae (Poaceae) whose culms are woody. Also the culms (stems) from this plant or the wood of the culms.

Bambusoideae. A subfamily of grasses with foliage leaf blades that are typically broad, flat and attached to the sheath with a petiole (leaf stalk). There are two types of bambusoids, the bamboos with woody (hard) culms and the herbaceous bambusoid grasses with culms soft enough to be crushed with the fingers.

blade. The upper expanded or spreading part of a leaf formed by an extension of the sheath. In bamboos foliage leaf blades are separated from the sheath by a petiole.

bract. A modified, usually much reduced leaf of a grass inflorescence such as a prophyllum, lemma, palea or glume.

branch complement. The number, size distribution, and arrangement of branches that grow from a single midculm node. The definition also includes buds at the base of primary branches which may develop into secondary branches.

cane. The common name for some bamboos such as the native American Southern Cane (*Arundinaria gigantea* (Walt.) Muhlenb.); the term is also applied to nonbambusoid grasses; the culm or main stem of a bamboo plant.

caryopsis. The typical kind of grass fruit (grain). See fruit.

cespitose. Growing in a dense clump; describes a bamboo whose culms grow close together rather than spread apart. See unicespitose.

ciliate. Fringed with hairs along the margin.

clone. A plant or group of plants produced vegetatively from a single original seedling; each plant of the clone is therefore considered a genetic duplicate of the parent.

cordate. Heart shaped, as a leaf blade having the notched end at the base and the pointed end at the apex.

culm. The main stem of a grass.

culm leaf. A leaf that grows singly from each node of a bamboo culm below the level at which foliage leaves occur. The culm leaf typically has a large sheath and relatively small blade so that the whole is often referred to as the culm sheath. Culm leaves soon dry and turn brown often falling off but sometimes persisting on the culm.

culm node. The joint which divides a grass culm into segments. It consists of two rings which encircle the culm; the lower one is the sheath scar and the upper one is the nodal ridge, a swelling from which buds and branches arise.

cuneate. Wedge-shaped, triangular with the narrow part at the point of attachment; describes the base of some bamboo leaf blades.

deliquescent. Melting away or dissolving.

dentate. Toothed, margined with sharp teeth pointing outward.

determinate. Of limited growth, applied to a bamboo inflorescence whose growth occurs entirely within a limited time - the grand period of growth.

diaphragm. The transverse internal layer of wood at each stem node which makes the node solid and forms a partition between the hollow internodes.

distal. Away from the point of origin.

erose. Having a margin which is irregularly jagged.

exserted. Sticking out, protruding.

farinose. Covered with a mealy powder.

fascicle. A close bundle or cluster of flowers, stems, leaves or other organs.

fimbriate. Fringed, having a margin bordered with long threadlike structures usually thicker than hairs.

fistulose. Hollow like a pipe; characterizes the internodes of culms and branches of most bamboos.

floret. A grass flower plus the chaff (lemma and palea) which surrounds it.

flower. The reproductive unit of a flowering plant. In bamboos it is the upper part of a floret excluding the chaff (lemma and palea). It includes the part of the rachilla (flower stem) above the palea (inner chaff) plus the

staminate (male) or pistillate (female) organs or both.

fruit. The bamboo fruit is typically a caryopsis, defined as a single seeded, dry grain (like a grain of wheat or rice) in which the seed and its pericarp (layer of starch which will feed the seedling) are united.

fugaceous. Falling or withering away very early.

glabrous. Hairless.

glaucous. Covered with a removeable, waxy powder which gives the surface a whitish or bluish cast.

glume. A modified, usually much reduced leaf of a grass inflorescence, in general any bract except a prophyllum; in particular the term usually refers to the empty glumes which often occur in pairs at the base of a spikelet. McClure (1973) coined the term, transitional glume, as any of the sheathing structures of a spikelet above the prophyllum and below the first lemma subtending a complete flower.

Gramineae. Also called Poaceae; the grass family of plants. See grass.

grass. A family of plants whose Latin name is Gramineae (also called Poaceae). Members of the family include wheat, corn, rice, bermuda, sugar cane , and bamboo. Grasses are characterized by jointed stems with solid nodes and (usually) hollow internodes. Leaves grow singly from each node alternating by 180 ° from one node to the next. Each leaf has three major parts: the sheath which attaches to the stem and completely surrounds it, the ligule at the top of the sheath, and the usually flat, linear, parallel-veined leaf blade.

gynoecium. The collective female part of a flower which may consist of several pistils; if there is only one pistil, gynoecium is synonymous with pistil.

herbaceous. Not woody.

herbaceous bambusoid grasses. Tropical small bamboo-like plants whose culms are not woody but soft enough to be crushed with the fingers.

hirsute. Hairy with rough, stiff hairs.

hispid. Hairy with stiff, bristly hairs.

hyaline. Translucent or transparent.

imbricate. Overlapping like shingles on a roof.

indeterminate. Capable of continuing growth. Applied to the type of bamboo inflorescence which has buds at the base of flowering branches (pseudospikelets) which are capable of producing at some later time new pseudospikelets.

inflorescence. The flower cluster of a grass which is made up of a number of compound flowers called spikelets. The inflorescence consists of a stalk called the peduncle, a main stem or rachis, and branches which bear the spikelets attached by their individual stalks, the pedicels.

internode. The part of a bamboo culm, branch, or rhizome lying between two nodes.

keel. A sharp fold which forms a ridge resembling the keel of a boat.

lanceolate. Lance-shaped, several times longer than broad and widest below the middle, tapering toward the tip with convex sides, as the leaf blades of some bamboos.

leaf. The bamboo leaf includes a sheath which surrounds and is attached to a stem (culm, branch, or twig) and a blade which is attached to the sheath apex. Bamboos have two distinct kinds of leaves, culm leaves and foliage leaves. The chlorophyll-bearing, petiolate (stalked), foliage leaf blade is often referred to (in a more restricted sense) as the leaf.

lemma. The outer of two bracts (chaff) enclosing a flower. Together with the inner bract, the palea, it forms the chaff surrounding a grass flower or fruit (the grain).

leptomorph. Describes a rhizome which is long and slender, typical of running bamboos. Such rhizomes are usually more slender than the culms arising from them, and they have internodes that are longer than broad with a central cavity. See monopodial. Ant: pachymorph

ligule. That part of a leaf which is the projection of the sheath up between the blade and the stem to which the leaf is attached.

linear. Long and narrow with almost parallel sides, as the leaf blades of many grasses.

lodicule. One of the small, scale-like structures that usually occur in a whorl of 3 immediately below the stamens at the base of the ovary in a bamboo flower. It forces the floret open when it blooms.

lumen. The hollow part of an internode such as the cavity inside a bamboo culm.

metamorph axis. A transitional underground stem between a typical rhizome and its culm. McClure describes 2 types: metamorph I is an extended culm neck with buds that can give rise to new metamorph I axes; metamorph II is the elongated transition between the apex of a rhizome and the base of a culm.

monopodial. Describes the type of rhizome typical of running bamboos in which the main rhizome continues to grow laterally underground with occasional branches that produce either culms or new rhizomes. See leptomorph, Ant: sympodial.

mucronate. Terminated by a short, sharp, abrupt point.

neck. The constricted basal part of a stem such as a rhizome neck or a culm neck.

nodal ridge. The swelling which often occurs at the node of a culm (branch or rhizome) above the sheath scar.

node. The often swollen joint of a segmented stem (culm, branch or rhizome) of a bamboo, at which a leaf is attached. See culm node.

oblong. Longer than broad with sides nearly parallel; oblong is broader than linear.

obsolete. Rudimentary, scarcely apparent, or lacking altogether.

obtuse. Blunt or rounded at the apex.

oral setae. Hairs or bristles that grow from the upper margins of auricles or from the upper margins of leaf sheaths (when auricles are lacking).

ovary. The swollen lower part of the pistil which contains the seed.

ovate. Egg shaped in outline, rounded at both ends and broadest below the middle.

ovule. The body that after fertilization becomes the seed.

pachymorph. McClure's term which describes the type of rhizome typical of clumping bamboos. The rhizome (exclusive of the neck) is short and usually thicker than the culm which grows from its terminal bud; it is circular in cross section tapering towards the ends. The internodes are shorter than wide, asymmetrically longer on the side having a bud, and solid (no central cavity). The nodes are not prominent (elevated of inflated). A single bud at each internode is asymmetrically dome shaped. See sympodial. Ant: leptomorph.

palea. The inner of two bracts (chaff) enclosing a flower. Together with the lemma (the outer bract) it forms the chaff surrounding a grass flower or fruit (the grain).

panicle. A branched inflorescence bearing spikelets on pedicels.

papillose. Having minute pimples.

páramo. The high region of the Andes in Central and South America that extends from the timberline at about 10,000 ft. up to the level of permanent snow at 15,000 ft. It is the home of species belonging to the genera *Swallenochloa* McClure and *Neurolepis* Meisner.

pedicel. The stalk of a spikelet (the basic unit of a compound grass flower). It is the internode of the stem immediately below the glumes (chafflike leaves that mark the base of the spikelet).

peduncle. The stalk of an inflorescence ; it lies immediately below the rachis (primary stem) extending from the first branch of the rachis down to the first sheath bearing node below it.

pericarp. The wall of the mature fruit which develops from the ovary wall.

persistent. Not deciduous, remaining in place for a long time as for example the culm leaves of *Pseudosasa japonica* (Sieb. & Zucc.) Mak.

petiole. A leaf stalk. In bamboos the petiole is the stem which attaches a leaf blade to its sheath. Foliage leaves have petioles while culm leaves often do not.

pilose. Hairy with long, soft hairs.

pistil. The female parts of a single flower. The gynoecium.

pluricespitose. A bamboo plant whose culms grow in separated multiple clumps which are interconnected by rhizomes.

Poaceae. Also called Gramineae, it is the grass family. See grass.

prophyllum. A sheathing organ, usually 2-keeled (with 2 longitudinal

ridges on its outer side) which grows from and surrounds the first node of a branch.

proximal. Situated near the point of reference or origin.

pruinose. Coated with a heavy, waxy powder. More pronounced than glaucous.

pseudospikelet. A spikelet-like flowering branch which contains branch buds near its base each of which is capable of developing into a new pseudospikelet.

puberulous. Minutely pubescent, covered with minute short, soft hairs.

pubescent. Hairy with soft, fine, short hairs.

raceme. An unbranched inflorescence which has spikelets with pedicels attached to the axis (rachilla).

rachilla. The central axis or stem of a spikelet, which bears the florets.

rachis. The primary axis (stem) of an inflorescence, which bears branches or spikelets.

retrorse. Directed backward or downward, the opposite of antrorse.

rhizome. The underground stem of a bamboo. It is segmented like the culm with nodes from which roots, culms and other rhizomes grow.

scabrous. Rough to the touch due to small projections such as short stiff hairs.

scandent. Climbing.

seed. The ripened, fertilized ovule which contains the embryonic plant. The bamboo seed is typically part of a fruit called a caryopsis which consists of the seed plus a starchy pericarp to which the seed is fused.

serrate. Saw-toothed with teeth pointing forward toward the apex.

serrulate. Minutely serrate.

sessile. Without a stalk, such as a leaf blade with no petiole.

setose. Covered with bristles.

sheath. The tubular part of a grass leaf that surrounds the stem.

sheath scar. The point of attachment of a leaf sheath to a culm or branch. See node.

shoot. Culm shoot or bamboo shoot; a young culm at a stage before it has reached its full height. Also the edible parts of very young shoots.

spathe. An usually large sheath surrounding or lying just below an inflorescence.

spike. An unbranched inflorescence with spikelets attached directly to the rachis (main stem).

spikelet. The basic unit of a grass inflorescence consisting of a stem (rachilla), one to several florets (flowers plus their lemmas and paleas) and two empty glumes (sterile chafflike leaves) underlying the florets.

spinulose. Having small spines.

stamen. The male or pollen producing part of a flower consisting of an anther (pollen bearing part) and a filament (a usually long thin stalk of the anther). Bamboo flowers have 3 to 6 or many stamens (rarely 2) in a single flower.

stigma. One of the feathery appendages at the tip of the ovary which receives the pollen. Bamboos have 2 or 3 stigmas (rarely one) in each flower.

striate. With fine longitudinal lines, channels, or ridges.

strigose. Having straight, sharp, stiff, flatly pressed hairs which are often basally swollen.

style. The stalk of a stigma connecting it to the ovary. In most bamboo flowers the stigmas are sessile without a distinct style.

subequal. Nearly, but not quite equal in size.

subtend. To lie immediatedly below something, such as the lemma and the palea which subtend a flower.

sulcate. Grooved or furrowed, like the groove on culm internodes above the point of branch attachment on many bamboos.

sympodial. Describes the type of rhizome typical of clumping bamboos in which rhizomes grow from the lateral buds of other rhizomes while the terminal buds produce culms. See pachymorph. Ant: monopodial.

taxonomy. The science of the classification of living organisms.

tessellation. A pattern of tiny squares or rectangles formed on bamboo leaves by longitudinal veins and distinct transverse veinlets. Tessellate foliage leaf blades are characteristic of hardy bamboos while tropical species tend not to show distinct tessellations.

tillering. Growing culms from basal, underground buds of other culms without an intervening rhizome.

tomentose. Covered with densely matted, short, woolly hairs.

unicespitose. A bamboo whose culms grow in a single clump, in contrast to pluricespitose where the culms of a single plant may grow in several separated clumps. See caespitose.

veins. The linear network of conducting and supporting tissues in leaves. The bamboo leaf has distinct primary and secondary veins which run longitudinally (parallel to the leaf's main axis) through the leaf sheath and blade. Transverse veinlets are also often present producing a pattern of tessellations (small squares or rectangles).

ventricose. Swollen, more on one side than the other.

villose. With long, soft, shaggy hairs.

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Clone Registration 1981

The following is a listing of all seedlings which were registered in 1981. We urge anyone who has raised bamboos from seed to register their seedlings and make propagules of those registered plants available to investigators if requested. Registration forms may be obtained from and requests for plant material made to the Editor. Again a reminder for those who possess registered plants, please report any significant changes in your plants to the Editor. Include the specific A.B.S. number associated with that plant.

Phyllostachys aurea A. & C. Riv.	ABS6-H-006
Phyllostachys elegans McClure	ABS10-H-001
Phyllostachys meyeri McClure	ABS9-D-001 to ABS9-D-004
	ABS9-E-011 to ABS9-E-015
	ABS9-H-005 to ABS9-H-010
Pleioblastus chino Fran. & Savat.	ABS8-C-001 to ABS8-C-006

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Two good quality copies of the manuscript, typed on one side only, on 8 1/2 by 11 inch paper are required. The format should follow the pattern as presented by the *Journal*. The first appearance of scientific names of the plants should be followed by the appropriate authorities. References should be listed alphabetically at the end of the paper unless they appear as footnotes. The references should then be in order of appearance at the end of the paper. Total length of the manuscript (including figures) should be no more than 30 pages of the *Journal* (about 480 words/page).

References should cite the author and date first, followed by (for journals), the article name, journal name, volume number (in boldface), issue number, and pages; and followed by (for books), the book title, publisher, and pages.

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