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# BAMBOO

IN THE UNITED STATES:  
Description, Culture, and Utilization

*Agriculture Handbook No. 193*



# BAMBOO

IN THE UNITED STATES:  
Description, Culture, and Utilization

By *Robert A. Young* and *Joseph R. Haun*,  
with key to the genera by *F. A. McClure*

UNITED STATES DEPARTMENT OF AGRICULTURE

Crops Research Division, Agricultural Research Service

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**T**HE 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.



Growth Through Agricultural Progress

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# BAMBOO

## IN THE UNITED STATES:

### Description, Culture, and Utilization<sup>1</sup>

By ROBERT A. YOUNG, *collaborator*, and JOSEPH R. HAUN, *horticulturist*

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The bamboos are woody stemmed perennial grasses, usually ever-green in climates to which they are adapted; those of temperate regions renew their leaves in spring. Bamboos constitute the subfamily Bambusoideae of the grass family, Poaceae (Gramineae). Among the 700 or more species, the aerial stems, or culms,<sup>3</sup> range in mature heights from a foot or two to 100 feet or more (figs. 1 and 2). The culms,

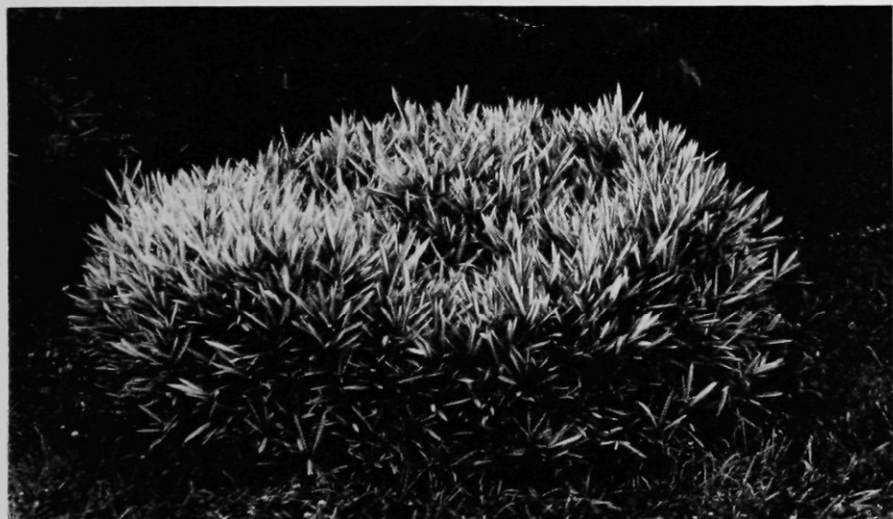


FIGURE 1.—A clump, 2 feet high, of *Arundinaria variegata*, a low-growing hardy running bamboo with white-striped leaves. Roots are curbed to prevent spreading.

<sup>1</sup> Discussion includes some bamboos grown in the Canal Zone and Puerto Rico.

<sup>2</sup> The authors gratefully acknowledge invaluable assistance from Agnes Chasé, of the Smithsonian Institution, and Paul G. Russell and the late David A. Bisset and Sidney F. Blake, of the Crops Research Division, U.S. Department of Agriculture.

<sup>3</sup> The aerial stems of all grasses, including bamboos, are technically called culms, whether large or small.

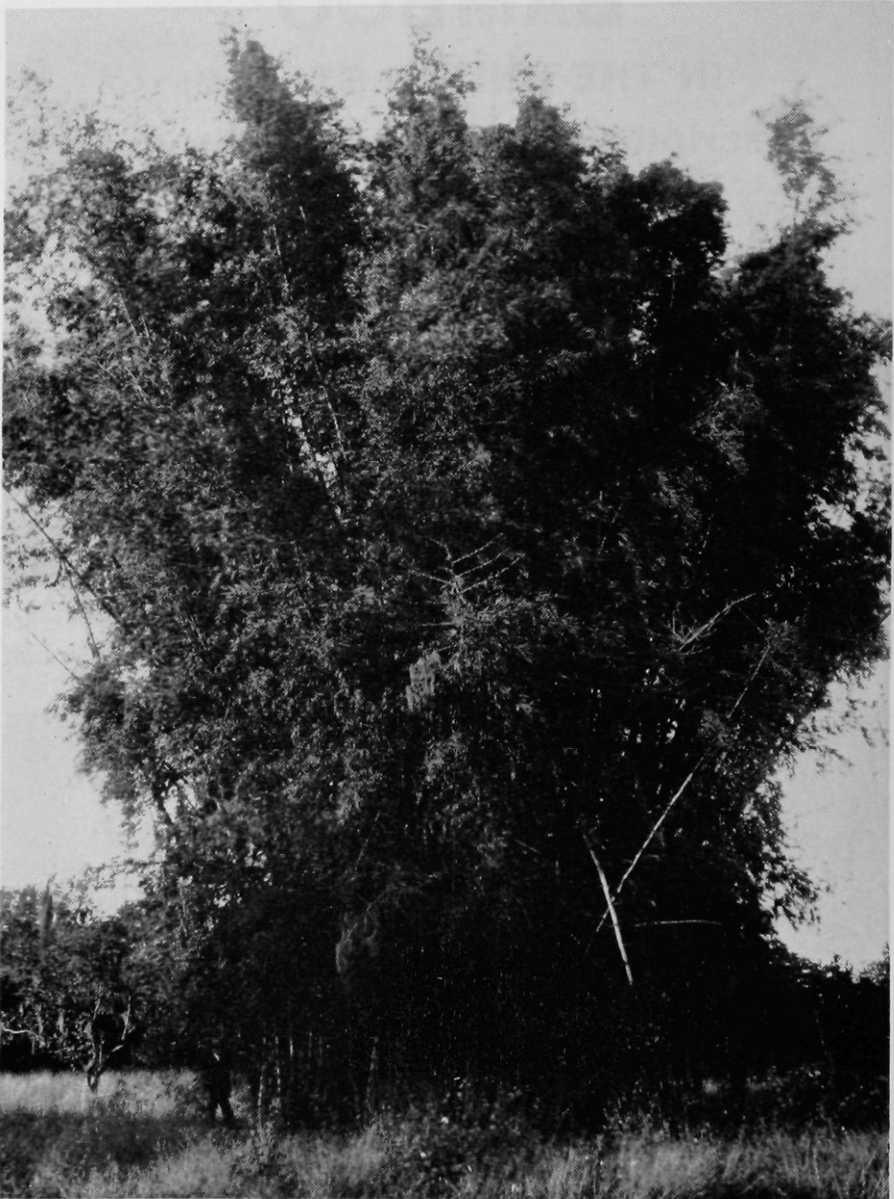


FIGURE 2.—A clump, 75 feet high, of *Bambusa arundinacea*, the great thorny bamboo of India, in southern Florida. It was later killed in an exceptional freeze.

like those of many ordinary grasses, usually are hollow between the nodes, or "joints," but in a few bamboos some or all of the internodes are more or less filled with a softer wood. The wood is always hardest near the surface of the culm and contains increasing amounts of pith between the wood fibers toward the inside. Some tropical bamboos have vinelike climbing stems, and others are thorny.

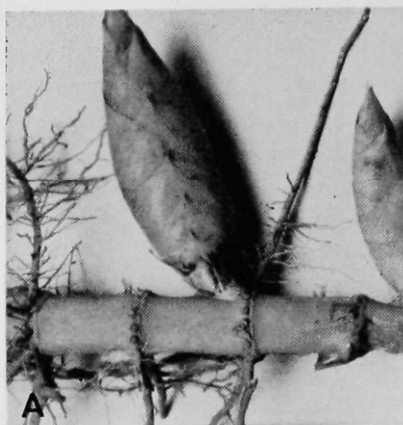
Many bamboos are of great economic value, and some are among the most graceful and beautiful of all plants. With their diversity in size, wide range in cold endurance, and varying habits of growth, they are valuable ornamentals in the milder parts of the temperate zones as well as in tropical and subtropical regions. Bamboos serve innumerable economic uses in the countries in which they grow; they serve more uses for more people than any other group of plants in the world. The uses include shelter and other structures of all kinds, implements, weapons, utensils, artwork, clothing, paper, and food.

In the United States, where only two species of bamboo occur naturally, most people have been familiar with bamboo chiefly in its traditional uses for fishing poles (including split rods), rug poles, plant stakes, and, in earlier years, phonograph needles. Only in very limited areas, mostly in the milder parts of the country, has there been real recognition of the decorative value of living bamboo. During World War II, because of shortages of industrial materials and in consequence of the observations and experiences of members of the armed services in the Tropics and the Orient, the possibilities of wider utilization of bamboo in Western industry were explored.

The rare flowering of most bamboos and the consequent difficulty in the past of properly classifying and naming many of them has resulted in much confusion in names, both in nursery catalogs and in other bamboo literature. One of the objectives of this handbook is the elimination of uncertainties with respect to the names of some of the better known or more important exotic bamboos now being grown in the United States.

## NATURE OF BAMBOO GROWTH

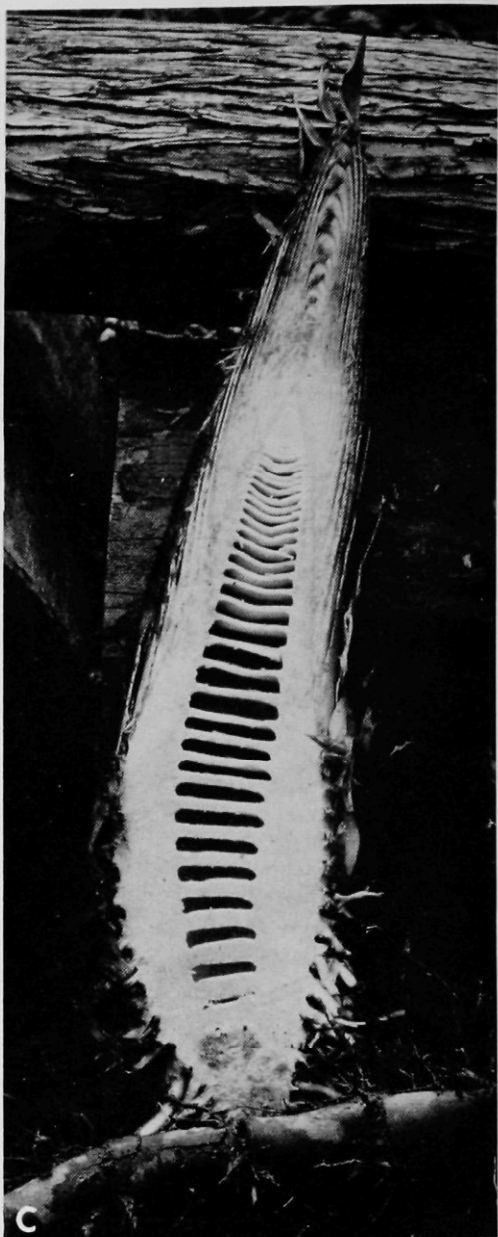
Bamboos, like perennial grasses generally and many other plants, are colonial in their habits of growth; that is, all culms are connected by rhizomes with other culms. A bamboo plant consists of two somewhat distinct parts: (1) The aboveground jointed culm, with its root-bearing base, branches, and leaves; and (2) the underground jointed rhizome (fig. 3) from which the culm arises. The rhizome also bears true roots at its nodes. Bamboo leaves are easily distinguished from those of other grasses as the blade is narrowed into a short slender petiole at its base instead of encircling the stem as in corn (maize) and other cereal-crop plants; they are borne on branches or twigs, not on the culm itself except at the very tip. A single bamboo plant, whether grown from seed or from a vegetative division, has at first only one culm; but in each succeeding year one or more new culms come from below the soil surface.



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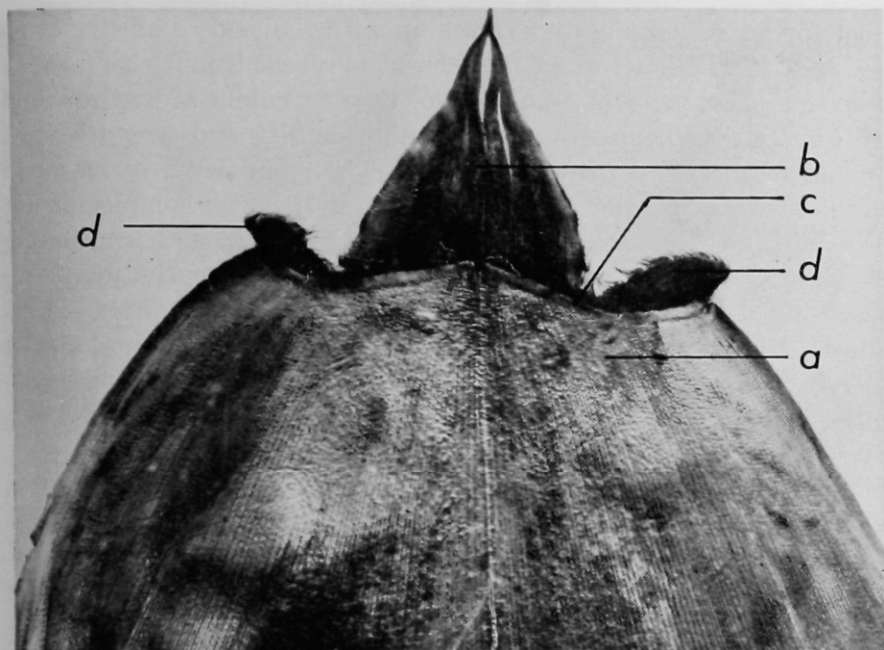


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FIGURE 3.—Sprouts of the giant running bamboo *Phyllostachys pubescens* (*P. edulis*): *A*, Sprouts just beyond the bud stage on rhizome, taken in midwinter; *B*, a large shoot emerging from the ground in midspring; *C*, a large shoot split open to show nature of the nodal diaphragms and relation of the shoot to its rhizome. (Approximately one-third natural size.)

The culm sheaths (fig. 4), one at each node of the young growing culm, are conspicuous structures of the bamboo culm. In all bamboos the sheaths carry distinctive characters that are both convenient and





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FIGURE 4.—Upper section of a large culm sheath of the tropical, clump-type bamboo *Bambusa vulgaris* showing one type of the structures that are important in classification and in identification of all bamboos: *a*, Sheath proper; *b*, sheath blade; *c*, ligule; *d*, pair of auricles (slightly unequal), with fringe of bristles on margins. (Two-thirds natural size.)

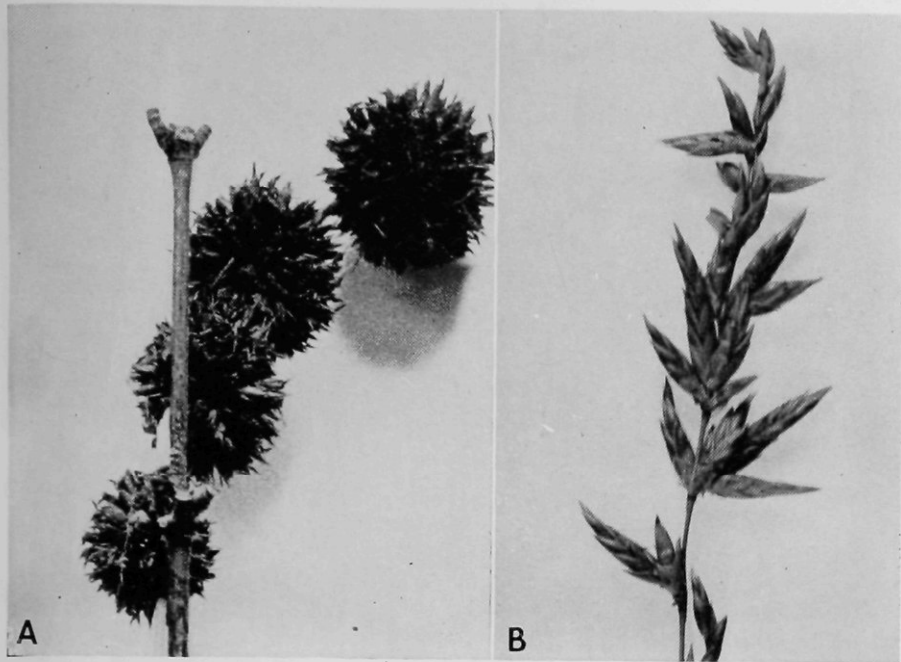
essential for identification. These characters, when fully recognized, make identification comparatively easy and sure. For this reason, especially if more than one kind of bamboo is being grown, a grower should give some attention to the differences in appearance between the sheaths of the different kinds. In relation to the points of origin on the culm, the complete sheath is considered as a specialized leaf, in which the sheath proper, attached to and encircling the node, is greatly enlarged and otherwise specialized; the blades of the lowest sheaths are reduced to mere scales but those of sheaths higher on the culm gradually are more leaflike. More details of the culm sheaths are given under descriptions of bamboo species.

The precise mode of development of the bamboo plant, including the branching habit of the culm, varies widely among the different species. All bamboos, however, are alike in several important respects: (1) The new culms that appear every year are formed mainly from food material stored in the rhizomes and roots of the plants; (2) the culms complete their growth in height and diameter in a relatively short period—5 to 8 weeks—except for some of the larger tropical species, which may require up to 3 or 4 months; (3) the

shoot for a new culm always comes up with the same diameter at its base that it will have when full height is reached, much as does an asparagus shoot; and (4) the wood of the new culms, at first soft and full of sap, does not attain its maximum density and strength until the end of the third growing season. The culm never increases in height or diameter after its initial growth in height is completed; but the new culms that come up in a new planting in each succeeding year usually will be taller and thicker than those of the preceding season, until the maximum size possible under the conditions is attained. Because of the rapid growth of the individual culms, almost entirely from stored food material, the production of large culms depends upon the previous development of an extensive connected system of the underground storage organs—rhizomes and roots.

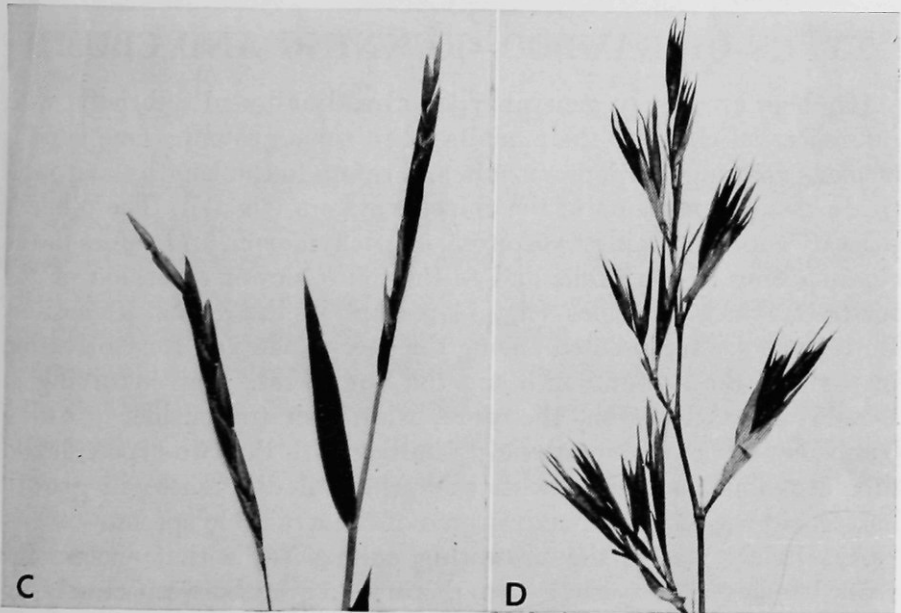
Bamboo flowers are small and inconspicuous and are formed in variously shaped clusters (fig. 5) resembling those of many ordinary grasses. The flowering of bamboo is of practical importance to growers, for in most species flowering occurs only after many years of growth, and, when a heavy crop of seed is set, the entire plant usually dies. All vegetative propagations from any single bamboo seedling, wherever grown, usually flower at approximately the same time. When flowering of a bamboo of the hardy, running type is profuse, even though little or no seed is formed—which often is the case—the plants make but little new growth, leaf formation practically ceases, and it frequently takes at least 3 to 5 years for the plants to recover sufficiently to resume production of culms of marketable size. These statements, however, hold true only if the original planting stock was all from the same seedling source. If some of the planting units were of one or more other seedling origins, such plants presumably will have different flowering periods. A few bamboo species flower rather sparingly, and in these there usually is no serious interruption to vegetative growth. A bamboo of the tropical, clump type that flowers completely with entire suppression of leaf formation, usually soon dies even when little seed is set. Therefore, a commercial grower of bamboo may well feel concern when a grove is observed to be producing flowers. For bamboos now in cultivation, however, it is not at present possible to predict when they may flower. Several species of medium-sized and giant species of the hardy running type introduced from the Orient between 1890 and 1909 had not yet flowered in 1960.

The seed varies greatly in size, shape, and other characters among the different sections of the bamboo group, but in nearly all the species under consideration the “seed” is technically called a grooved caryopsis and somewhat resembles a grain of wheat, rye, or other similar cereal (fig. 6).



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FIGURE 5.—Flowering branches from four genera of bamboos: A, *Dendrocalamus strictus*; B, *Bambusa arundinacea*; C, *Arundinaria simonii*; and D, *Phyllostachys nigra*.

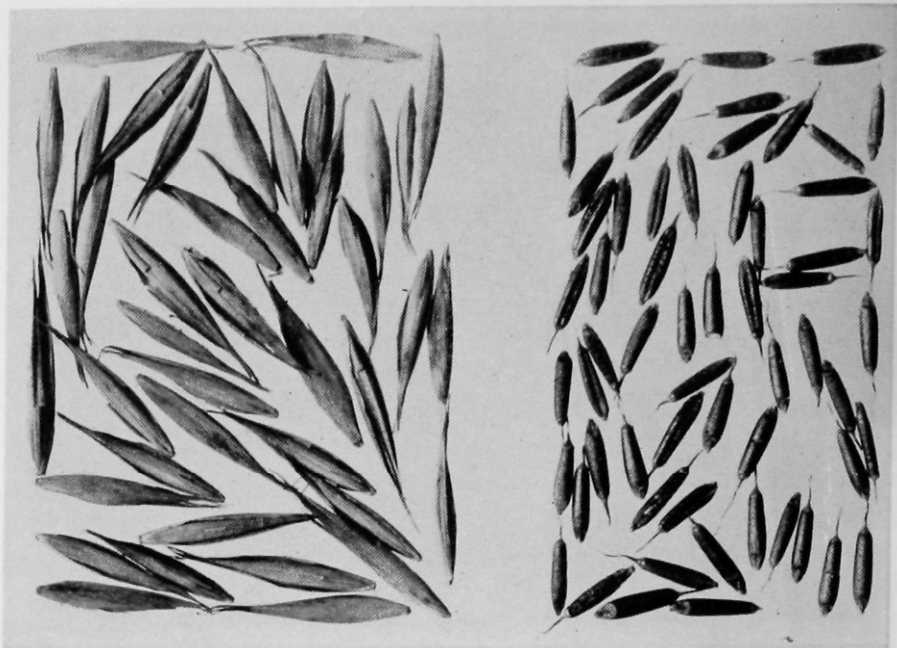


FIGURE 6.—Seeds in the hull and cleaned seeds of a hardy bamboo, *Phyllostachys aurea*, grown near Victoria, British Columbia, Canada. (Slightly enlarged.)

## TYPES OF BAMBOO—RUNNING AND CLUMP

Bamboos are of two general types, already alluded to briefly, with reference especially to their habits of rhizome growth. One type is termed “running,” or leptomorph, and refers to the lengthy and relatively slender extension of the rhizome system (fig. 3). The other is termed “clump-forming,” cespitose, or pachymorph, and refers to the close spacing of the culms and to the much slower extension of the relatively thick rhizomes (fig. 7), except in the genus *Melocanna*. Both types are represented among the species adapted for cultivation in parts of the Lower South and the Southwest. Persons living in a mild-wintered region, therefore, who wish to consider growing bamboo and who are not already familiar with the two types, should first acquaint themselves with the principal differences in growth habits and the climatic requirements of the available species.

As already stated, the protecting culm sheaths that enclose the fresh bamboo shoots usually are distinctive even between closely related species and exhibit important characters useful for identification. They gradually change in size, shape, and other details from base to apex of the culm. A sheath from about the eighth node above the base of a culm exhibits the distinguishing characters at their best. In the genus *Phyllostachys*, all but the lower sheaths fall by the time the culm has completed its growth in height; but in others sheath fall



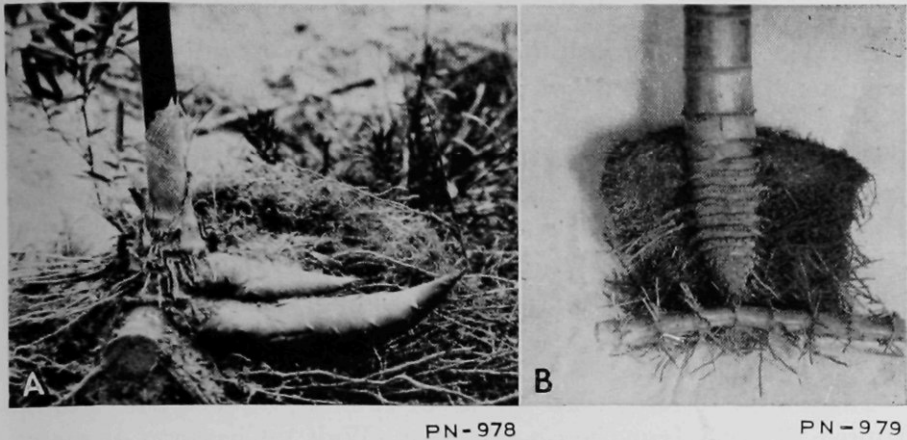


FIGURE 7.—Views of modes of origin of bamboo culms: *A*, New culm (2 inches in diameter) of clump-type bamboo *Bambusa tuldooides*, with basal sheaths attached, grown from base of an earlier culm (now removed), with two horizontal rhizomes beginning to turn upward to develop into culms. *B*, Base of large culm (4 inches in diameter) of the giant hardy running bamboo *Phyllostachys bambusoides*; note roots growing from its base and from the rhizome from which the culm grew.

usually is more or less delayed. The complete sheath consists of: (1) The sheath proper, encircling the shoot, or culm; (2) the sheath blade, more or less leaflike except on sheaths near base of culm, attached on the outer side of the sheath close to its apex; and (3) the ligule, an upward projection, often slight, terminating the sheath proper on the inner side of the blade; the ligule may or may not be fringed with hairs, and the length of the upward projection and other details are variable among species. (See fig. 4.) A hand lens often is needed to examine the ligule. A pair of "auricles," more or less prominent, is present at the base of the sheath blade in most species; they usually are fringed with hairs (bristles, or oral setae).

The hardier bamboos are all of the running, or rapid-spreading, type and, with few exceptions, they withstand minimum temperatures ranging from about 10° F. down to -7°, with but little injury even to the leaves. The young shoots appear during spring. The leaves of all these running bamboos, when viewed under a hand lens, differ strikingly from those of the tropical, clump type in having numerous cross veins between the finest of the parallel veins. This is called tessellated venation. In this group are all the hardy timber bamboos of China and Japan, which are the only ones that have proved adapted to much of the southeastern quarter of the United States and most of the Pacific coast region (fig. 8). Along the Atlantic coast, a few of the hardiest kinds endure ordinary winters as far north as Philadelphia, Pa., with little injury.

The extent of injury to any bamboo at a given minimum temperature varies somewhat with the exposure to bright sunlight or to high winds at the time. Some of the hardy running bamboos have shown partial adaptability to tropical regions at altitudes near 1,000 feet or higher. *Phyllostachys aurea* (Carr.) A. & C. Riv. and *P. bambusoides* Sieb. & Zucc. have been reported as apparently doing well in Hawaii at about 800 feet above sea level. However, the quality of wood of the culms of cold-hardy bamboos growing in tropical latitudes is reported to be inferior. The running bamboos are not suitable for growing near buildings or where space is otherwise much limited, though a few spread more slowly than others.

There are two recognized species of running bamboo native to the United States—*Arundinaria gigantea* (Walt.) Chapm. (*A. macrosperma*), the canebroke bamboo or southerncane, rarely reaching a height of 30 feet, and the much smaller *A. tecta* (Walt.) Muhl. A deciduous form, *A. tecta* var. *decidua* C. D. Beadle, is found in western North Carolina including the vicinity of Biltmore and Asheville. Several other somewhat distinct geographical forms that have been included in *A. tecta* have been reported in earlier years from various localities in the Southeastern States by the late Mr. Beadle. It is possible that one or more of these on further study may be found entitled to separate botanical status. The culms of *A. gigantea* are rather thin walled but are used locally for fishing poles and some other purposes. Neither of the native species is of further economic importance except possibly for grazing by livestock.

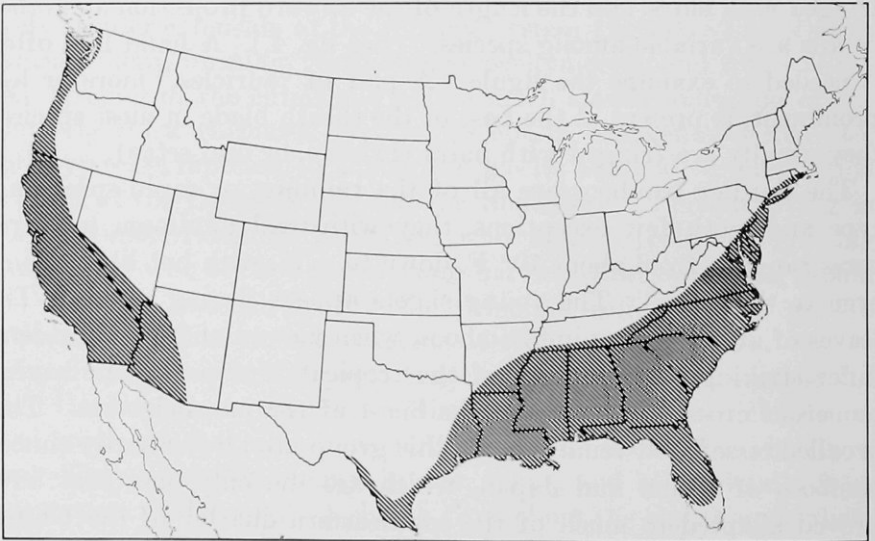


FIGURE 8.—Map showing areas where the hardy running bamboos can be grown, if moisture is available and altitude is not too great.

Bamboos of the clump type are all of tropical or subtropical origin, and most are killed back to the ground or severely injured by even a few degrees of frost. Several species, however, endure temperatures ranging from  $26^{\circ}$  down to about  $16^{\circ}$  F., with only minor injury. The oriental hedge bamboo, *Bambusa multiplex* (Lour.) Raeusch. (*B. nana*), is one of the hardiest of these. Besides the typical form of the species, several horticultural varieties, or cultivars, (Alphonse Karr, Fernleaf, Silverstripe, etc.) have long been grown in the South Atlantic and Gulf States and in the milder parts of California and the Southwest where adequate moisture is present. The northern limit on the Atlantic coast for the hardiest of these varieties is at about Charleston, S. C., and in severe winters they suffer cold injury there. In California, these hardy varieties can be grown in many localities near the coast and in the interior valleys wherever moisture is adequate and the minimum temperature does not fall below  $16^{\circ}$  F. except at intervals of many years (fig. 9).

The clump bamboos are less objectionable than are those of the running type for growing in limited spaces, as near buildings. However, the true roots will extend out as far as 25 feet from a mature clump and will take both moisture and fertility from the soil to that distance. None of the clump bamboos that are climatically adapted to any part of the mainland of the United States are at present considered promising for cultivation here for industrial uses.

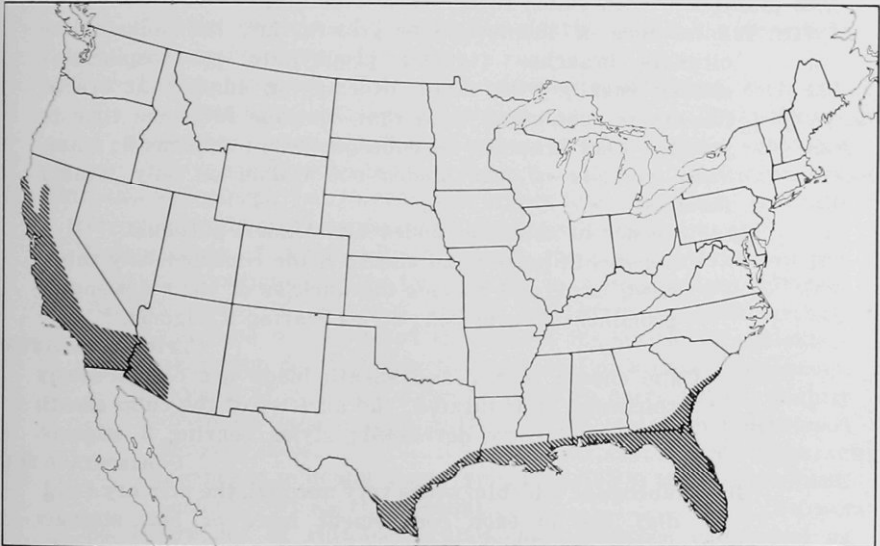


FIGURE 9.—Map showing areas where the more cold-resistant, tropical, clump-type bamboos can be grown, if moisture is available and altitude is not too great.

## GENERIC KEY TO BAMBOOS UNDER CULTIVATION IN THE UNITED STATES AND PUERTO RICO

As currently classified in taxonomic literature,<sup>4</sup> the bamboos known to be under cultivation in the United States represent 21 genera. The following key indicates the characteristic features by which these genera may be distinguished. The classification of many of these genera still rests, however, on tenuous and uneven criteria. Some of the generic concepts were originally based wholly or largely on characters of their rarely available flowers and fruits. Other genera were segregated wholly on the basis of vegetative characters.

The following key is based on vegetative characters as far as is possible at present. However, it has been necessary to rely upon characters of the reproductive organs for differentiating certain genera. This necessity reflects the uneven characterization of genera that still prevails. With the present lack of popular knowledge of the bamboos, the identification of many kinds must still be left to the specialist.

- 1a. Rhizomes pachymorph, i.e., the rhizome proper short, thicker than the culm that emerges from its tip, and not "running."
- 2a. Rhizome neck much longer than the rhizome proper; clump habit dumetose, i.e., with widely spaced culms; midculm branches slender, subequal.....MELOCANNA.
- 2b. Rhizome neck shorter than the rhizome proper; clump habit caespitose, i.e., with culms rather close together.
- 3a. Inflorescence of indeterminate growth, i.e., the spikelet-like ultimate branches (typical prophyllate pseudospikelets) clothed basally with small, overlapping amplexant bracts, the bracts subtending buds that continue for some time to produce other branches (pseudospikelets); stamens 6; transverse veinlets of leaf blades not visible or only weakly manifest.
- 4a. Branches at midculm nodes all slender, subequal.  
Culm sheath proper and sheath blade conspicuously thickened, hard, and brittle; the auricles of the culm sheath prominently developed; styles bearing 2 stigmas.  
CEPHALOSTACHYUM.
- Culm sheath proper and sheath blade not conspicuously thickened or indurated; the auricles of the culm sheath not prominently developed; styles bearing 3 stigmas.  
SCHIZOSTACHYUM.
- 4b. Branches at midculm nodes very unequal, the primary (middle) one in each complement more or less strongly dominant.
- 5a. Culms weak, clambering, not self-supporting, the midculm internodes very long and very thin-walled,

<sup>4</sup> Owing to the still tenuous bases of their segregation as genera—*Sasamorpha* (from *Sasa*) and *Pleioblastus* (from *Arundinaria*)—the names *Sasamorpha* and *Pleioblastus* have not yet been accepted for general use in the United States.



fragile and easily crushed; spikelets typically with a single perfect flower.

Spikelets pedicellate, the lemmas and paleas loosely convolute; fruit sulcate, the pericarp moderately thickened at the very apex only, the apex crowned by the pubescent, rather fragile, base of the style.

ELYTROSTACHYS.

Spikelets not pedicellate, the lemmas and paleas tightly convolute; fruit not sulcate, the pericarp greatly thickened and indurascens throughout, the apex narrowed and prolonged in a tapered persistent, glabrous beak ----- OCHLANDRA.

5b. Culms self-supporting, not clambering, the midculm internodes not conspicuously elongate, the walls not fragile or easily crushed.

6a. Rachilla segments very short, not disarticulating.

Spikelets few-flowered, the terminal floret of each spikelet usually well developed, perfect; stamen filaments free ----- DENDROCALAMUS.

Spikelets several-flowered, the terminal floret of each spikelet rudimentary; stamen filaments fused or connected by a membrane -- GIGANTOCHLOA.

6b. Rachilla segments elongate—up to half the length of the lemma—promptly or tardily disarticulating.

Keels of palea winged ----- GUADUA.

Keels of palea not winged ----- BAMBUSA.

3b. Inflorescence of determinate growth, i.e., emerging complete, the ultimate branches not typical pseudospikelets, and not continuing to branch; spikelets pedicellate; stamens 3; transverse veinlets of leaf blades clearly manifest (obscure in *Thamnocalamus falconeri*).

Lower branches of the inflorescence prophyllate, each subtended by a conspicuous bract ----- THAMNOCALAMUS.

Lower branches of inflorescence not prophyllate, not subtended by a conspicuous bract ----- SINARUNDINARIA.

1b. Rhizomes leptomorph, i.e., the rhizome proper long, "running," generally more slender than the culms that arise from its lateral buds.

7a. Inflorescence of indeterminate growth, the ultimate branches prophyllate pseudospikelets terminating in nonpedicellate spikelets.

8a. Internodes of rhizomes, culms, and branches each strongly flattened or channeled throughout its length on one side—above the point of insertion of a bud or branch complement.

Branches at midculm nodes typically in pairs, robust, slightly unequal; occasionally with a small, third one developed between them ----- PHYLLOSTACHYS.

Branches at midculm nodes typically 3 to 5 in each complement, slender, very short, subequal ----- SHIBATAEA.

8b. Internodes of rhizomes, culms, and branches cylindrical or nearly so.

Culm sheaths fugacious, abscissing completely; auricles and oral setae typically very prominently developed (but sometimes lacking entirely) on culm sheaths; bracts at the base of pseudospikelets smaller than the lemmas, without leaflike apical appendage ----- SINOBAMBUSA.

Culm sheaths abscissing promptly but incompletely, remaining lightly attached at the middle of the base for a short time after they dry; auricles and oral setae lacking on culm sheaths; bracts at the base of pseudospikelets larger than the lemmas, often bearing a small leaflike apical appendage ----- SEMIARUNDINARIA.

- 7b. Inflorescence of determinate growth, the ultimate branches terminating in pedicellate spikelets.
  - 9a. Branches typically solitary at midculm nodes.
    - 10a. Culm nodes more or less prominently inflated above the sheath scar; culms commonly tillering, usually ascending, not strictly erect; oral setae of leaf sheaths scabrous; stamens 6 in each flower----- SASA.
    - 10b. Culm nodes not prominently swollen above the sheath scar; culms normally not tillering, more or less strictly erect.
      - Oral setae wholly lacking in leaf sheaths; stamens 6 in each flower----- Sasamorpha.<sup>5</sup>
      - Oral setae of leaf sheaths few or none, glabrous; stamens 3 (rarely 4 or 5) in each flower----- PSEUDOSASA.
  - 9b. Branches typically more than one at each midculm node; stamens 3 in each flower.
    - 11a. Culm sheath blade minute; rapid growth of shoots (new culms) initiated in autumn or late summer ----- CHIMONOBAMBUSA.
    - 11b. Culm sheath blade well developed; rapid growth of shoots (new culms) initiated in spring to early summer.
      - Oral setae of leaf sheath scabrous----- ARUNDINARIA.
      - Oral setae of leaf sheath glabrous-----Pleioblastus.<sup>5</sup>

## HARDY RUNNING BAMBOOS

In the running, or leptomorph, bamboos, to which all the hardier kinds belong, the new culms usually appear above ground in mid-spring, at varying space intervals. A more or less open thicket is produced and, with the giant species, eventually a forest (fig. 10). The culms arise from lateral buds on underground rhizomes. These buds slowly develop during warm periods through the winter, then more rapidly as spring advances. The most rapid growth of the new culm usually occurs when it has attained about one-half of its ultimate height. With a giant species, a culm 4 inches or more in diameter has been known to increase in height as much as 36 inches in 24 hours in hot moist weather during its period of most rapid growth. As previously stated, the culms complete their external growth in 5 to 8 weeks, though the wood is at first soft and does not become mature in density and hardness until the end of the third growing season. This latter fact makes necessary the marking in a permanent manner of each culm of a producing bamboo grove with

<sup>5</sup> See footnote 4, p. 12.

the year of its emergence if the culms are to be used for any purpose requiring strength and durability. See page 53.

With completion of the vertical extension of the culms, usually in June, new branch rhizomes begin to develop and, in a well-established

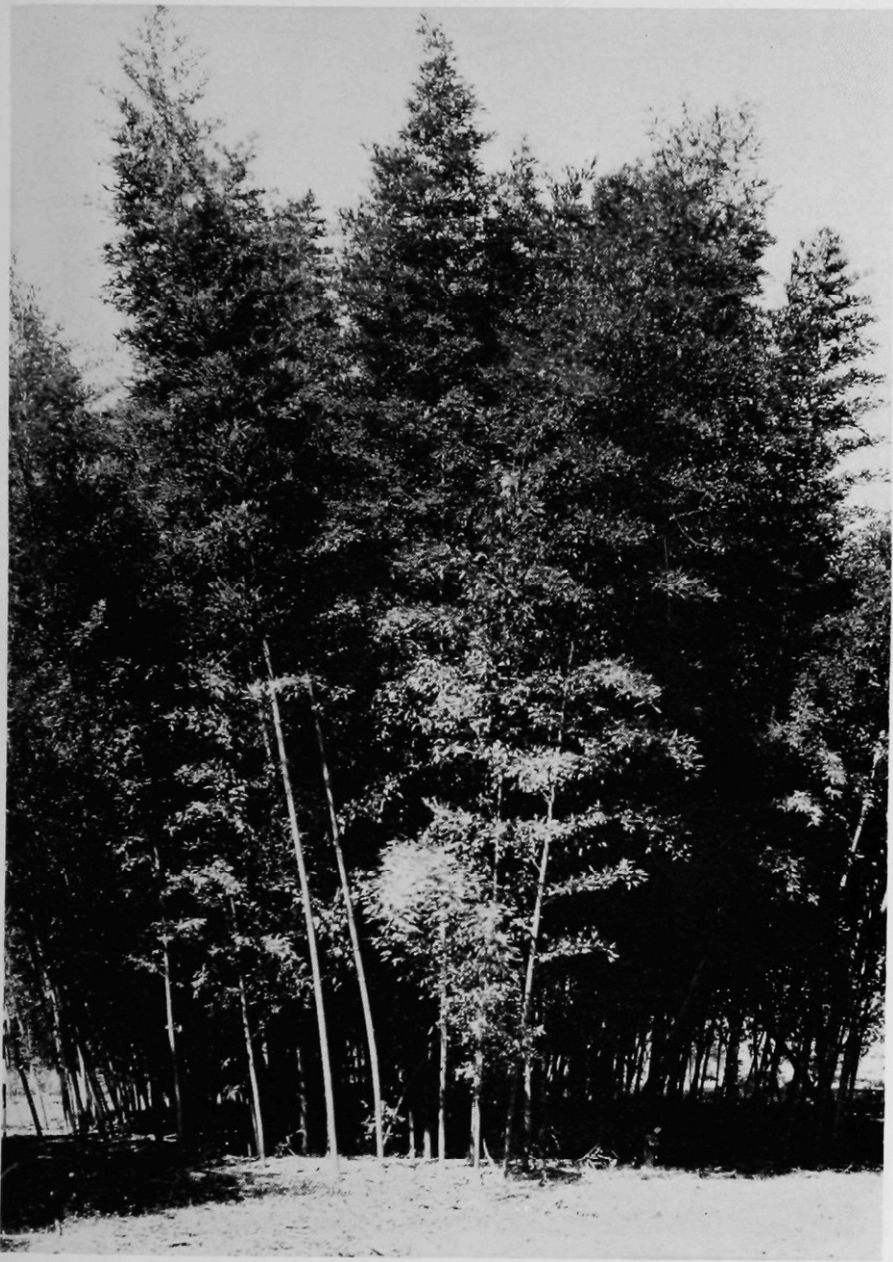


FIGURE 10.—Plot of a giant hardy running bamboo, *Phyllostachys viridis* (*P. sulphurea* var. *viridis*), 30 feet across, at the U.S. Plant Introduction Station near Savannah, Ga. Tallest culms here are about 43 feet high and  $3\frac{1}{2}$  inches in diameter near the base. The plot is kept within bounds by breaking off new shoots that start in spring outside the set limits.

colony of a tall species of bamboo, may sometimes extend 15 to 25 feet underground before the end of the season. These new rhizome branches ordinarily come from lateral buds on rhizomes of the preceding year. In the important genus *Phyllostachys*, especially, which comprises nearly all the economically important running bamboos, the terminal bud of a rhizome usually dies before active growth begins in the following season; this results in the sprouting of one to several lateral buds just back of the terminal (fig. 11). By repeated rebranching the rhizomes grow in all directions if conditions are favorable, and this habit results in the development of the extensive connected rhizome system essential for the ultimate production of culms of maximal size for any given species. A rhizome system must function as a unit, a single reservoir of food material, for the production of large culms.

Thus, in a planting of a running bamboo, as many separate and distinct ramifying rhizome systems will develop, with their branches crossing and intermingling, as there were of the original plants. Even under the most favorable conditions of climate, soil, and moisture, the giant hardy bamboos produce their largest possible culms—50 to 75 feet high—only after 12 to 15 years from the time of setting of small plants. Some species of smaller stature may produce their tallest culms in a shorter period. There are differences in vigor of growth among closely related bamboos, even when the ultimate maximum heights are nearly the same.

The running bamboos of oriental origin already in cultivation in this country belong to seven different genera—*Phyllostachys*, *Arundinaria*, *Semiarundinaria*, *Sasa*, *Pseudosasa*, *Chimonobambusa*, *Shibataea*, and *Sinobambusa*, in approximate order of their importance. Most of these genera are fairly distinctive in growth habits. The species of greater potential economic value are nearly all of the large genus *Phyllostachys*, which comprises all the hardy giant bamboos of China and Japan and many medium-sized and smaller species. Comprehensive descriptions and a key to the species of *Phyllostachys* may be found in U.S. Department of Agriculture Handbook 114(4). Two other oriental bamboos, *Arundinaria amabilis* McClure, obtained by the U.S. Department of Agriculture direct from China, and *A. simonii* (Carr.) Riv., introduced earlier by way of Europe, are also of considerable potential importance. *A. amabilis*, known widely in the trade as “tonkin cane,” is imported in substantial quantities into this country. This species is used especially for making split-bamboo fishing rods but also for vaulting and ski poles, plant stakes, and other purposes. As already mentioned, the new shoots of these bamboos ap-



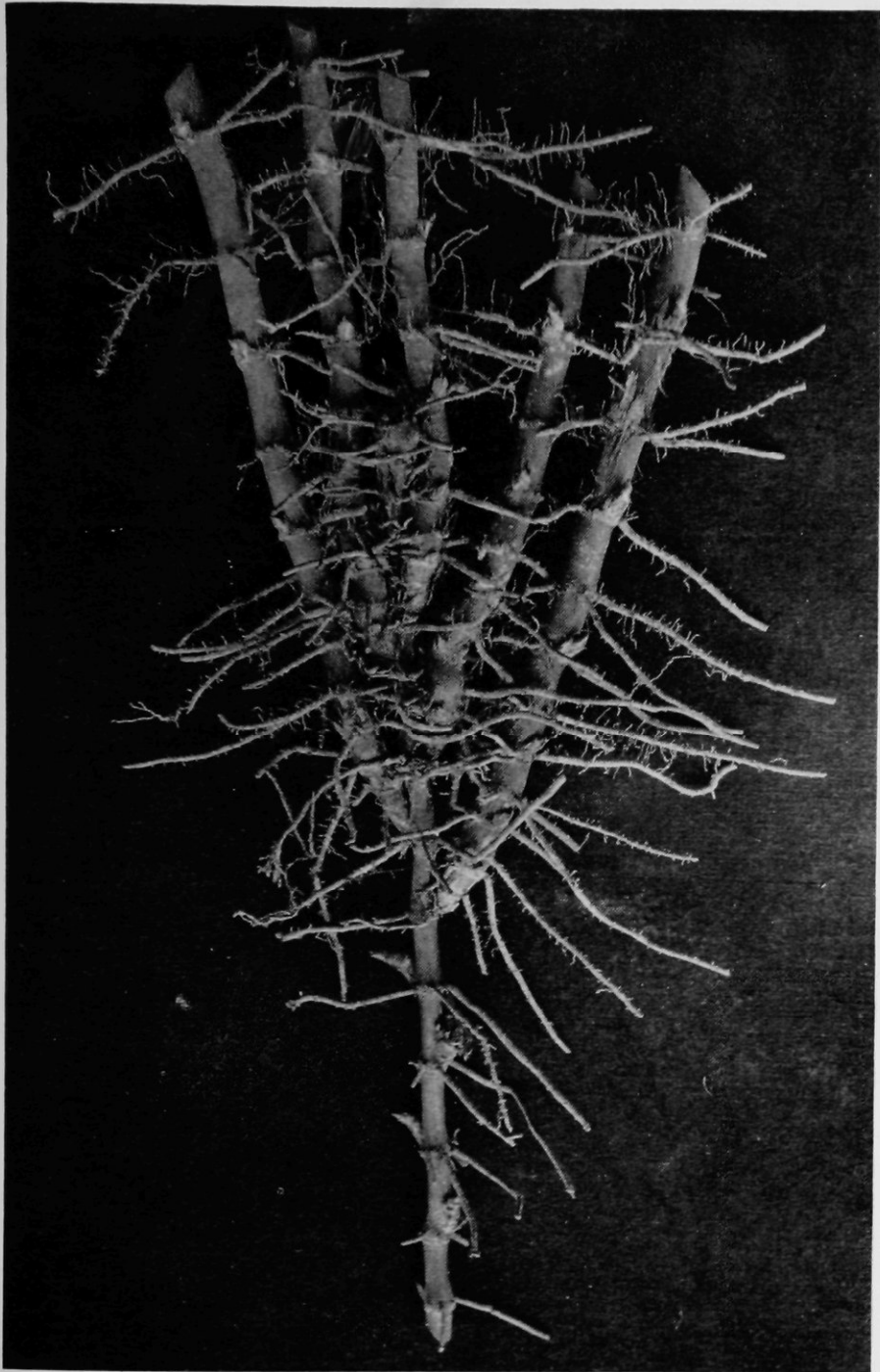


FIGURE 11.—New branch rhizomes of a running bamboo, *Phyllostachys meyeri*, developed from the buds immediately back of the dead tip of the older rhizome. These are slightly larger in diameter than the parent rhizome and have true roots arising from the nodes.

pear in spring. And those of the known species of *Phyllostachys*, *Arundinaria*, *Pseudosasa*, and *Semiarundinaria* are edible when cooked; however, they are scarcely worth while for table use if under 1 inch in diameter. Shoots of some species of *Phyllostachys* are bitter or acrid when raw. Suggestions for preparation and cooking are given under Utilization of Bamboo.

## Running Bamboos of Present Importance for Cultivation in the United States

More than 60 species and varieties of running bamboos of oriental origin have been introduced into the United States. Of these, more than half were first imported directly from China or Japan after 1900 by the U.S. Department of Agriculture and nearly all the remainder by way of Europe by the Department or by private agencies. Two of the giant species of *Phyllostachys*, *P. bambusoides* Sieb. & Zucc. and *P. pubescens* Mazel ex H. de Leh. (*P. edulis*), were successfully introduced from the Orient by private persons as early as about 1890, and the medium-sized species *P. aurea*, by another in 1882. *Pseudosasa japonica* (Sieb. & Zucc.) Makino (*Arundinaria japonica*; *Sasa japonica*), a fairly hardy ornamental Japanese species growing 10 to 16 feet high and rather widely established in cultivation here, is believed to have been brought by way of Europe in the 1860's. Although definite record has not been found of the successful introduction of other hardy bamboos earlier than 1900 it is probable that some were introduced but did not become generally distributed.

All of the many introduced bamboos now in this country have some potential economic or ornamental value, but some are outstanding; detailed descriptions are given here of those that are considered to be of greater importance for one or more reasons, such as uses, large size, or extent of present distribution in the country. The other species are listed with approximate heights only.

The largest hardy running bamboos are all members of the genus *Phyllostachys*. Several kinds that reach truly giant heights (50 to 70 or more feet) at full maturity and that are already established in cultivation here are: *P. bambusoides* Sieb. & Zucc., *P. nigra* (Lodd.) Munro cv. HENON McClure (*P. nigra* var. *henonis*), *P. pubescens* Mazel ex H. de Leh. (*P. edulis*), *P. viridis* (Young) McClure (*P. sulphurea* var. *viridis*), and *P. vivax* McClure.

## Descriptions of Important Species of Running Bamboos

### *Arundinaria amabilis* McClure.

TONKIN BAMBOO; TONKIN CANE.

Tonkin bamboo is a semihardy bamboo cultivated in a limited, mountainous area in southern China. There, under favorable condi-

tions, culms are up to 40 feet high and  $2\frac{1}{2}$  inches in diameter at the base; they are cylindrical, straight, and with nonprominent nodes. The primary branch at each branch-bearing node usually gives rise later to one or a few laterals from its base. Leaves, three to eight near tip of branch or twig, are 4 to 14 inches long and  $\frac{1}{2}$  to  $1\frac{1}{2}$  inches wide, smooth above, slightly rough beneath, and scabrous on both margins.

New culm shoots appear in midspring. Culms are moderately thick walled and tough and strong at full maturity (3 years old). Small mature culms are extensively utilized for florists' plant stakes and other purposes. Large ones have special uses such as vaulting and ski poles and particularly for making split-bamboo fishing rods, for which they are preferred to any other bamboo.

Tonkin bamboo has withstood a temperature of  $13^{\circ}$  F. without loss of leaves, and the culms are reported to have survived  $8^{\circ}$  with no apparent injury. This species is adapted climatically to the gulf region, the Atlantic coast probably as far north as Wilmington, N.C., and most of the Pacific coast.

**Arundinaria simonii** (Carr.) A. & C. Riv. (*Pleioblastus simonii*).

SIMON BAMBOO.

Simon bamboo is a hardy bamboo, both useful and ornamental. Culms are 18 to 24 feet high under favorable conditions, cylindrical, up to  $1\frac{3}{8}$  inches in diameter at the base, and with nonprominent nodes. Branch-bearing nodes have a primary branch, followed by two others arising quickly from its first two basal nodes, and later all three usually rebranch from the base. Leaves, clustered two to four at tips of branches or twigs, are narrow-oblong and 3 to 12 inches long and  $\frac{3}{8}$  to  $\frac{3}{4}$  inch wide. An occasional leaf may have one or more slender white stripes, and in the cultivar 'Silverstripe' the striping becomes extensive. The rhizomes are slower spreading than in most running bamboos.

The young shoots appear in spring; though seldom thick enough to be important for food, these are edible and are free from acidity. Culms of suitable size and mature age (3 years) are reported to be excellent for fishing poles and for shuffleboard cues, as well as for plant stakes. Qualities of wood of culms resemble those of tonkin bamboo.

This species is adapted to the gulf region, the Atlantic coast possibly as far north as Philadelphia, Pa., and the Pacific coast region where temperatures as low as  $0^{\circ}$  F. do not occur oftener than every 3 or 4 years.

**Arundinaria variegata** (Sieb.) Makino (*Sasa variegata*).

## DWARF WHITESTRIPE BAMBOO.

Dwarf Whitestripe bamboo is a handsome little Japanese bamboo. Culms are 2 to 3 feet high. Usually there is a single branch at one, or sometimes two, of the nodes; but occasionally a secondary branch arises from base of the primary. Leaves, usually clustered near tips of culms and branches, are conspicuously whitestriped (fig. 1), oblong-lanceolate, rounded at base, 2 to 6 inches long and up to 1 inch wide, and finely pubescent beneath. Leaves and upper parts of culms and branches usually die during the winter in cold climates, but new branches form below; new culms and new leaves develop in midspring.

This bamboo makes an attractive ground cover and is especially effective in artificial clump form when the rhizomes are confined by a metal or concrete curb sunk into the ground.

This species is adapted for growing on the Coastal Plain from the gulf region to New York City and on the Pacific coast, with winter mulch in northern areas. Growth usually is less satisfactory in the more southern areas.

**Arundinaria viridi-striata** [Regel] Makino (*Bambusa viridi-striata*; *Pleioblastus viridi-striatus*).

*A. viridi-striata* is an ornamental dwarf Japanese bamboo. Culms are 1½ to 2½ feet high and usually bear a branch from one node during the first year and one or two more in the second year. Leaves are lanceolate, 2 to 5 inches long, usually yellowish striped in spring and early summer but mostly becoming plain green later, and nearly smooth above and velvety pubescent beneath. The leaves tend to curl in bright sunlight in summer; this attractive little bamboo is, therefore, best grown in partial shade.

This species can be grown on the Coastal Plain from the gulf to Philadelphia, Pa., and on the Pacific coast. But it does not usually make so good growth where summers are long as it does farther north. A winter mulch is desirable in the north.

**Phyllostachys aurea** (Carr.) A. & C. Riv. (*Bambusa aurea*).

## FISHPOLE BAMBOO.

Fishpole bamboo is a medium-sized hardy bamboo, native to China but long cultivated also in Japan. This probably was the first species of *Phyllostachys* to be successfully introduced into this country—in 1882 by George H. Todd, a grower, at Montgomery, Ala. Culms are up to 30 or more feet high; many—sometimes nearly one-half—have one or more variously shortened internodes in the basal region or higher, sometimes with nodes obliquely inclined, which occasionally

form attractive designs simulating a tortoise-shell pattern. A pure planting of *P. aurea* can be identified with ease and certainty by the culms with these odd characters. Leaves, two or three on a twig, are small—commonly 3 to 4½ inches long and ½ to ¾ inch wide. Culm sheaths are smooth, pale olive-green to pale rosy-buff when fresh, with a few small brown spots. Sheath blades are lance-shaped on lowest sheaths, long strap-shaped on intermediate ones, and more leaflike on highest ones. Ligules have a prominent fringe of hairs.

The new edible shoots, which appear in midspring, are nearly free from acidity when raw. For many years large quantities of the high-quality mature culms have been imported into the United States for use as fishing poles. Selected culms with unusual patterns of nodes and internodes make distinctive fishing poles and walking sticks. The culms are useful also for light clothes poles, bean poles, and plant stakes.

Fishpole bamboo withstands temperatures about down to 0° F. This species is adapted to the entire southeastern Coastal Plain at least as far north as Norfolk, Va., and to the Pacific coast except the extreme south.

***Phyllostachys aureosulcata* McClure** (earlier misidentified as *P. nevini*).

YELLOWGROOVE BAMBOO.

Yellowgroove bamboo is a hardy bamboo from Chekiang Province, China. Culms are up to 33 feet high and 1½ inches in diameter at the base. Leaves, usually two or three on a twig, are up to 6 inches long and to ¾ inch wide on new culms but much smaller on older ones. In early midspring the species is easily recognized by the pale-green culm sheaths with many slender whitish stripes, a pair of prominent auricles at base of the lance-shaped sheath blade, and sheath blades that are bristled except on sheaths near base of culm. Further identifying characters are: (1) The greenish-yellow sulcus on internodes (above branch attachments), in contrast to the green of rounded parts of internodes, during the first year or two of the life of a culm; (2) a slight roughness to the touch at first on the internodes of new culms; and (3) occasional culms with a striking zigzag growth involving two or three of the lower nodes and internodes, rarely seen in any other bamboo.

The new shoots, which appear in early midspring, are edible. Although the wood is not of highest quality, mature culms are useful locally for fishing poles, clothes poles, plant stakes, and other similar uses.

This species is adapted to the gulf region, the Atlantic coast perhaps as far north as Philadelphia, Pa., and most of the Pacific coast to the Columbia River and possibly farther north.



**Phyllostachys bambusoides** Sieb. & Zucc. (*P. quilioi*; *P. reticulata*).

MADAKE (Japanese name); GIANT TIMBER BAMBOO;  
 JAPANESE TIMBER BAMBOO; HARDY TIMBER BAMBOO.

Madake (pronounced mah-dah'kay) is one of the largest and most valuable industrially of several giant hardy timber bamboos native to China and is one of those that have long been cultivated also in Japan. Its earliest introduction into the United States was probably around 1890. Culms are up to 72 feet or more high and 5¾ inches in diameter at the base; internodes are at first glossy dark green, and without any white powder. The two branches at each branch-bearing node are unequal, the smaller arising from the base of the larger; sometimes there is a third, still smaller, one. Leaves are oblong, pointed, commonly 2½ to 6½ inches long and ½ to 7/8 inch wide, and often slightly wavy. Culm sheaths are greenish to buff or often reddish, lowest ones darker, all heavily spotted or blotched with brown, and with surface almost free of hairs; auricles and bristles on all but lowest six or eight sheaths. Sheath blades on lower sheaths are dark, short, lance-shaped, and often reflexed and crinkled; but on higher sheaths the blades gradually become strap-shaped and green or variously striped with pink or buff.

The edible new shoots, which appear in late midspring, are somewhat acrid when raw. Shoots of medium and large diameters are in demand in northern markets for oriental food products. The culms are moderately thick walled, and those of mature age are rated among the best in wood quality of the species of *Phyllostachys*. Because of this, this species is preferred among the larger hardy bamboos for construction and other industrial uses. The small and medium-sized culms produced during the early years of a new plantation are suitable for plant stakes and bean, rug, and fishing poles. Split fishing rods said to be of good quality also have been made experimentally from split larger culms.

This important bamboo is adapted to the gulf region, the Atlantic coast as far north as Norfolk, Va., and the Pacific coast from central California northward where winter temperatures are cool but do not go below 0° F.

**Phyllostachys bambusoides** Sieb. & Zucc. cv. CASTILLON McClure  
(*P. bambusoides* var. *castilloni*; *P. reticulata* var. *castilloni*).

CASTILLON BAMBOO.

Castillon bamboo is a medium-sized strikingly ornamental variety of *P. bambusoides*. This cultivar is of Chinese origin, but it was introduced into Japan at an early date and from there was brought

to France about 1886. In 1925 it was introduced from England into this country by the U.S. Department of Agriculture and later widely distributed though it had been imported and established earlier by Henry Nehrling at Gotha, Fla. Heights of culm up to about 30 feet have been recorded. Culms are bright yellow with a bright-green longitudinal stripe or panel on the sulcus of internodes having branches at their base; the rounded yellow sides of internodes are sometimes narrowly streaked with green. The Castillon bamboo differs little in external characters from the typical form of the species except in its smaller stature, the bright-yellow color of the rounded parts of the internodes of culms and branches, and the occasional cream pinstripes in some leaves.

The wood is perhaps a little less strong and the edible young shoots have lighter colored culm sheaths and are somewhat less acrid than the typical form. This attractive bamboo with its bright culms striped with green is useful as an ornamental where space is not much limited or in smaller spaces if a curb can be sunk into the ground to confine the running rhizomes.

This cultivar endures temperatures almost to 0° F. with damage only to leaves. It is adapted to the gulf region, the Atlantic coast as far north as Norfolk, Va., and the Pacific coast about to the Columbia River.

**Phyllostachys dulcis** McClure (earlier misidentified as *P. henryi*).

SWEETSHOOT BAMBOO; Chinese name, PAH KOH POO CHI.

Sweetshoot bamboo is a hardy bamboo from Chekiang Province, China. Culms are up to 40 feet high and 2¾ inches in diameter at the base, strongly tapered, and often strongly curved. The nodal ridges are fairly prominent. Internodes are dull green, often finely striped with cream or paler green, surface strongly ribbed-striate, in new culms at first with considerable loose whitish powder, especially below nodes, and with more dense deposits of powder with age. Leaves are usually 3¼ to 4 inches long and ⅝ to ¾ inch wide, sometimes larger, and lower surface usually densely pubescent near base and sometimes throughout. Culm sheaths are smooth, somewhat glaucous, and greenish cream with small brown spots and streaks but becoming pale straw color when dry; auricles at base of sheath blade are prominent and bristled; ligules are strongly convex. The lower sheath blades are lance-shaped to strap-shaped, and those toward the tip are boat-shaped, and all are strongly crinkled.

The new shoots are nonacrid, of excellent cooking quality, and emerge in early spring. This is said to be one of the most highly esteemed edible bamboos of central China, where it is called "vegetable bamboo." Culms are inferior in quality to other bamboos for industrial purposes where strength is required.

Under favorable conditions this species may produce culms of maximum size in 7 or 8 years, but it suffers from drought. It has endured temperatures of about 0° F., but is not a vigorous grower where low temperatures are common. The sweetshoot bamboo is adapted to the gulf region, the Atlantic coast as far north as Norfolk, Va., and the Pacific coast except the extreme south and north.

### ***Phyllostachys flexuosa* A. & C. Riv.**

*P. flexuosa* is a hardy Chinese bamboo. Culms are up to 30 or more feet high and to 1¾ inches in diameter at the base, and usually erect, straight or often somewhat zigzag, or flexuous; the latter suggests the specific name *flexuosa*. Leaves, two or three on a twig, are commonly 2 to 5 inches long and ¾ to ⅝ inch wide. The culm sheaths are greenish beige spotted with brown, with purplish close-set veins, and smooth; the lowest sheaths are sometimes a solid deep purple. Sheath blades are narrow and mostly bent back or strongly arched.

The edible new shoots, which appear about midspring, are slightly acrid when raw. Although the wood is of only medium quality, the mature culms can be used for fishing poles, plant stakes, and many other purposes.

Two or more forms of different seedling origins are in cultivation in this country; one of these has withstood -8° F., with some foliage injury only. This species is adapted to the gulf region from southeastern Texas to Georgia and Florida, the Atlantic coast about as far north as Philadelphia, Pa., and the Pacific coast perhaps to Vancouver.

### ***Phyllostachys meyeri* McClure.**

#### MEYER BAMBOO.

Meyer bamboo is a moderately hardy bamboo obtained in 1908 from Chekiang Province, China. Culms are up to 35 feet high and 2 inches in diameter at the base and with dense foliage. Leaves are somewhat narrowly lance-shaped, 2 to 5 inches long and ⅝ to ½ inch wide, and usually two to five on a twig on new culms and two or three on a twig on older culms, but twigs are numerous. Culm sheaths are greenish buff more or less spotted and blotched with brown, somewhat glaucous, fringed along base with a narrow band of minute white hairs but otherwise entirely glabrous, and without auricles or oral setae; ligules are of medium height, with convex or nearly truncate margin, and at first ciliate but later smooth. The plant much resembles *P. aurea*, but there is never any of the irregular crowding of the lower nodes of the culm as in that species, and the ligules of the culm sheaths are higher and without the prominent fringe of hairs typical of *P. aurea*.

The new shoots, which appear in midspring, are edible. Mature culms of the Meyer bamboo are rated among the finest and strongest of the genus *Phyllostachys*. They are especially good for fishing poles—the longer ones for salt-water fishing—and also for the harvesting of nuts. Those of the larger diameters are good for heavy plant stakes, and the branched tops of all culms make excellent supports for vines such as lima beans and sweetpeas.

This valuable species is adapted to the gulf region, the Atlantic coast at least as far north as Norfolk, Va., and most of the Pacific coast.

***Phyllostachys nigra* (Lodd.) Munro (*Bambusa nigra*).**

BLACK BAMBOO; Japanese name, KUROCHIKU.

Black bamboo is a fairly hardy and very graceful black-culmed bamboo, native to southern China but long cultivated also in Japan. Several different seedling forms are in cultivation which vary slightly in certain respects, such as ultimate height or rate and intensity of blackening of the culms, and rate of rhizome extension. Culms are up to 26 feet high and  $1\frac{1}{4}$  inches in diameter at the base and at first green but gradually becoming—usually by the end of the first season—nearly or quite solid black or, rarely, purplish black. There is often a third, small branch at upper culm nodes and rarely a fourth diminutive one. Leaves are rather small—commonly 3 to  $3\frac{5}{8}$  inches long and  $\frac{3}{8}$  to  $\frac{1}{2}$  inch wide but sometimes half again as long and wide. Culm sheaths are greenish buff to pale or ruddy buff, unspotted, and sparsely pubescent. Sheath blades are green, broadly to narrowly triangular, and more or less wavy, especially on larger culms; auricles and bristles are purplish and prominent except on lowest sheaths.

New shoots, which appear in late midspring, are edible. The black bamboo is a favorite garden ornamental because of its graceful foliage and growth habits and its black culms. Although the culms are never very large and are rather thin walled, the wood is fairly hard and is used extensively by cabinetmakers for indoor work in the Orient.

The black bamboo is adapted to the gulf region, the Atlantic coast at least as far north as Norfolk, Va., and on the Pacific coast where temperatures do not go below 0° F.

***Phyllostachys nigra* (Lodd.) Munro cv. HENON McClure (*P. puberula*; *P. nigra* var. *henonis*).**

HENON BAMBOO; Japanese name, HACHIKU.

Henon bamboo is an exceptionally graceful giant hardy bamboo, native to southern China but long cultivated in Japan. The Henon

bamboo is considered by botanists to be the true biological species and the smaller, black-culmed form to be of garden origin, but the latter was described and named first and so the true species must be treated as a variety, or cultivar. Culms are up to 54 feet high and 3½ inches in diameter at the base (in the south). Branching habit and leaves are the same as in the typical form of the species (p. 25). The handsome young shoots are easily distinguished from those of other giant bamboos in that the culm sheaths are of an unspotted tawny hue, tinted with wine, and softened with an inconspicuous coating of brown hairs; each sheath is surmounted by an erect crinkly green blade with a pair of dusky auricles, fringed with bristles, at its base. When sheaths of new culms fall, the surface of internodes is bright green but somewhat dimmed by a thin film of white powder; later this powder becomes an off-white, which further obscures the green. New culms at first are rough to the touch from a coating of short stiff hairs; these hairs later fall away.

New shoots, which appear in late midspring, are rather bitter or acrid when raw and slightly fragrant when cooking (bitterness is removed by change of water in cooking). Culms are rather thin walled, but the wood is rated high in strength for its thickness.

Though apparently of southern origin, the Henon bamboo has endured minimum temperatures down to  $-5^{\circ}$  in Maryland, with only partial killing of leaves. This species is adapted to the gulf region, the Atlantic coast perhaps as far north as Philadelphia, Pa., and most of the Pacific coast to the Columbia River and possibly farther north.

### **Phyllostachys nuda McClure.**

*P. nuda* is an exceptionally hardy bamboo from Chekiang Province, China. Culms are up to 34 feet high and 1⅝ inches in diameter at the base; internodes are copiously and loosely powdery at sheath-fall and slightly ribbed-striate. Leaves are commonly 3 to 4 inches long and ⅜ to ½ inch wide but sometimes half again as long and wide. Culm sheaths have rather prominent veins and are glabrous, grayish wine, white-powdery, and the basal ones are blotched with wine, but the upper ones, unspotted; ligules are prominent. Sheath blades are relatively short, crinkled, and spreading away from the culm. Culm sheaths and leaf sheaths are without auricles or bristles. *P. nuda* resembles *P. arcana*, but it can be distinguished from it by the shape of the ligules of the culm sheath—those of *P. nuda* have truncate apexes but the ligules of *P. arcana* are strongly convex.

Edible young shoots are of excellent quality and only slightly acrid when raw. The mature culms are not of the highest industrial quality but are useful locally for fishing poles, plant stakes, and similar purposes.



In a mature grove near Washington, D.C., *P. nuda* has withstood  $-7^{\circ}$  to  $-8^{\circ}$  F., with only minor injury to foliage. This species is adapted to the gulf region from southeastern Texas eastward, the Atlantic coast perhaps as far north as Philadelphia, Pa., and on the Pacific coast probably as far north as Vancouver.

***Phyllostachys pubescens*** Mazel ex H. de Leh. (*P. edulis*, earlier misidentified as *P. mitis*).

MOSO BAMBOO; Japanese name, MOSO-CHIKU.

Moso bamboo is the largest and handsomest of the giant hardy running bamboos and is native to China. Culms sometimes reach heights of 75 feet or more and have basal diameters up to 8 inches in China and Japan. Heights of 60 feet have been attained in this country. Culms are a little larger in diameter for their height and more tapering than those of most bamboos; the internodes are gray green and at first densely velvety pubescent but later white-powdery. The leaves are very small—usually 2 to 3 inches long and about  $\frac{3}{8}$  inch wide but somewhat larger on young culms. The foliage is more feathery and attractive than that of any other species of the genus. Culm sheaths are hairy, greenish smoky, and densely spotted with brown.

The new shoots appear in early midspring. Because of the large size of shoots ultimately produced in a well-managed grove, the moso bamboo ranks as one of the most valuable of the hardier bamboos for the commercial production of edible shoots in China and Japan. In quality, the regular spring shoots are somewhat inferior to those of many other species of *Phyllostachys*. However, in the Orient, the much less developed and more tender "winter shoots," often dug as early as December, are of great excellence and highly esteemed as a delicacy. The value of moso bamboo shoots from groves in Japan is reported sometimes to be about equal to that of the mature culms marketed. Large quantities of the canned shoots have been exported from China and Japan to the United States in past years. The fresh shoots are fragrant when cooking, but they are bitter or acrid when raw; the acidity is removed by a change of water in cooking. The wood of the culms is softer than in most related species, but the larger culms especially, because of their size, are utilized for numerous purposes in the Orient. And doubtless these culms may later be found of value in this country for various special uses.

Moso bamboo, although in time attaining great size in a favorable environment, is much more difficult to propagate vegetatively than other species of *Phyllostachys*. Newly propagated plants make slow growth and often fail where soil and moisture conditions are less than the best. This species is hardy down to about  $3^{\circ}$  F. It is

adapted climatically to the northern gulf region, the Atlantic coast as far north as Wilmington, N.C., and on the Pacific coast perhaps to the Columbia River.

***Phyllostachys viridi-glaucescens* (Carr.) A. & C. Riv.**

*P. viridi-glaucescens* is a medium-sized hardy Chinese bamboo; it has been grown in Europe since 1846. Two or more clones, differing somewhat in several respects, appear to be in cultivation. The one here described was obtained from England in 1937 under the name *P. mitis*. Its true identity as *P. viridi-glaucescens* was recognized several years later; it differs from another known clone in being more vigorous and apparently of greater ultimate height. Culms are up to 35 feet high and 2 inches in diameter at the base, straight, nearly or quite erect, and green but white-powdery at sheath-fall. Leaves are commonly 4 to 5 inches long and  $\frac{1}{2}$  to  $\frac{3}{4}$  inch wide but sometimes less than half as large or up to 7 inches long and 1 inch wide. Culm sheaths are narrow at the apex, pale buff tinged with green and strewn with many small brown spots and blotches, loosely powdery, scabrous, and stiff-hairy; auricles, usually two but sometimes one or absent, are long, narrow, and with few but prominent bristles; ligules are fairly long and narrow, more or less convex at the apex, and at first more or less fringed and ciliate. Sheath blades are ribbonlike, reflexed, and usually somewhat crinkled.

New shoots, which appear early in spring, are almost without acidity, or "bite," when raw. The culms have not been tested for their technological properties, but they appear to be of excellent quality and the plant appears to be well worth trial by interested growers.

The cold endurance of this bamboo is not definitely known, but it is estimated to be about  $-4^{\circ}$  F. This species is adapted to the gulf region from southeastern Texas eastward, the Atlantic coast possibly as far north as Philadelphia, Pa., and the Pacific coast at least to the Columbia River.

***Phyllostachys viridis* (Young) McClure (*P. mitis*; *P. sulphurea* var. *viridis*).**

*P. viridis* is a giant hardy Chinese bamboo (fig. 10). It was first introduced into Europe nearly a century ago. Its original habitat in China is unknown. Culms are 50 feet or more high and  $3\frac{1}{4}$  inches in diameter at the base, suberect, and often slightly curved. Internodes when examined with a lens have a distinctive pigskin-like (minutely dimpled) surface. Leaves are commonly 3 to 5 inches long and  $\frac{5}{8}$  to  $\frac{7}{8}$  inch wide; leaf sheaths have auricles and bristles well developed on young culms but often missing on older ones. Culm sheaths are

glabrous, smooth on margins, the lowest ones brownish yellow and graduating in color with the tip ones yellowish green, and all more or less blotched, spotted, or speckled with dark to light brown. Sheath blades are without auricles or bristles at base.

New shoots, which appear in midspring, are of excellent eating quality and practically free of "bite" when raw. The wood of the mature culms is reported to have excellent technological properties.

Near Washington, D.C., this species has shown cold resistance down to  $-8^{\circ}$  F. with injury to foliage only. It is adapted to the gulf region from southeastern Texas eastward, the Atlantic coast possibly as far north as Philadelphia, Pa., and most of the Pacific coast to Vancouver.

### **Phyllostachys vivax** McClure.

*P. vivax* is an unusually handsome giant hardy timber bamboo, with heavy drooping foliage, from Chekiang Province, China. Culms are up to 70 feet or more high and 5 inches in diameter at the base and erect or nearly so, more or less zigzag, or sometimes slightly curved. Internodes are glabrous, at sheath-fall perceptibly white-powdery just below nodes, and strongly and irregularly ribbed-striate. Leaves are commonly 4 to 6 inches long and  $\frac{5}{8}$  to  $\frac{3}{4}$  inch wide but sometimes much smaller or up to 8 inches long and to 1 inch wide and nearly or quite smooth beneath. Culm sheaths are thin, entirely smooth and without auricles and bristles, creamy buff, a little white-powdery, and with brown or some almost black spots; ligules are short and convex at apex; sheath blades are narrowly triangular to ribbon-shaped, reflexed, and crinkly. *P. vivax* closely resembles *P. bambusoides*, but it is a more rapid and stronger grower, has thinner walls, and sends up its shoots 2 weeks earlier.

The new shoots are free of acidity, or "bite," when raw.

The cold resistance of this species is undetermined, but it is believed to be near  $0^{\circ}$  F. It is adapted to the gulf region from southeastern Texas eastward, the Atlantic coast as far north as Norfolk, Va., and the Pacific coast probably to the Columbia River.

**Pseudosasa japonica** (Sieb. & Zucc.) Makino (*Arundinaria japonica*; *Sasa japonica*; *Bambusa metake* Hort.).

METAKE (Japanese name, pronounced may-tah'kay):

ARROW BAMBOO.

Metake, is a handsome, fairly hardy oriental bamboo. Its origin is in doubt, but it is grown widely in Japan and is said to occur abundantly in central Korea. It has been in cultivation in Europe for more than a century and in the United States probably for nearly a century. Culms are up to 18 feet high and  $\frac{3}{4}$  inch in diameter at

the base and bear semierect branches singly at the upper nodes. Leaves, in clusters of 4 to 12 near tips of branches, are 5 to 13 inches long and  $\frac{5}{8}$  to  $1\frac{3}{4}$  inches wide, glossy dark green above and somewhat glaucous beneath, and wedge-shaped at the base. Culm sheaths, except at lower nodes, are about as long as the internodes or longer and at first stiff-hairy but later becoming smooth; they do not fall off.

As Metake spreads less rapidly than many other running bamboos and has attractive foliage, it is valuable in decorative plantings in mild-wintered localities or as a tub plant in a sunlit conservatory.

Metake is grown scatteringly in most of the milder parts of the United States and usually remains evergreen where the temperature does not fall lower than about 5° F., though it suffers leaf damage. It is adapted to the gulf region from southeastern Texas eastward, the Atlantic coast as far north as Norfolk, Va., and the Pacific coast probably at least to the Columbia River.

**Sasa disticha** (Mitf.) E. G. Camus (*Bambusa disticha*; *B. nana* Hort.).

#### DWARF FERNLEAF BAMBOO.

Dwarf Fernleaf bamboo is an attractive, low-growing, Japanese running bamboo. The leaves are more or less closely two-ranked on the branches, which often gives the appearance of a fernleaf. Culms commonly grow 2 or 3 feet high in the open, but in shade they reach 5 feet. The branches tend to elongate and the leaf arrangement becomes more open when grown in the shade. Leaves are lance-shaped, rounded at base, green and smooth on both surfaces, and commonly 1 to  $2\frac{1}{4}$  inches long and  $\frac{3}{16}$  to  $\frac{3}{8}$  inch wide but sometimes larger.

When small or of medium size this pleasing little plant is dainty in appearance, but, as with other bamboos of this type, rhizomes will usually require curbing to prevent their extension into a lawn or other nearby plantings where eradication may be difficult.

The leaves are more or less injured at about 10° F., but they are replaced by new leaves in midspring. This species is adapted to the gulf region, the Atlantic coast probably as far north as Philadelphia, Pa., and the Pacific coast; but it does better toward the north.

**Sasa palmata** (Mitf.) E. G. Camus (*Bambusa palmata*; *Arundinaria palmata*).

*S. palmata* is a strikingly handsome medium-low, hardy oriental bamboo. This species originated in China or Japan and was introduced to this country by way of Europe. The first introduction here, as far as is known, was by the U.S. Department of Agriculture in 1925, and was distributed for some time under the misidentification of *S. senanensis*. Culms are up to 7 feet high and  $\frac{5}{16}$  inch in di-



aneter at the base, thick-walled, and often curved at the base. Internodes are at first green, white-powdery below nodes, but later often becoming much blotched with brown. Branches arise singly from some of middle and upper nodes of the culm, and, later, one or two secondary branches often grow singly from a primary. Leaves are oblong-lance shaped, rounded to broadly tapering at the base and fairly long pointed at the tip, 4 to 15 inches long and  $1\frac{1}{2}$  to  $3\frac{1}{2}$  inches wide, bright green above but silvery beneath, smooth on both surfaces, finely serrate on margins, and palmately clustered near the tips of culms and branches. Culm sheaths are about two-thirds to three-fourths the length of internodes, green and white-powdery at first, entirely smooth, and persistent; the sheath blades are very small.

This bamboo, with its large bright-green leaves, is an outstanding ornamental, which is useful where space is not too limited. It is an aggressive grower and when well established tends to spread rather rapidly. In Japan it is reported to cover large areas on mountains and to retard or prevent reforestation in those places. Although the culms are small they are used in small quantities as a source of pulp for manufacture of hardboard.

This species withstands cold to about  $0^{\circ}$  F., with leaf damage only. It is adapted to the gulf region, the Atlantic coast perhaps as far north as Boston, Mass., and the Pacific coast to the Columbia River or farther north. Apparently it is not well suited to the long summers of the south.

**Sasa veitchii** (Carr.) Rehder (*Bambusa albo-marginata*; *B. veitchii*; *Arundinaria veitchii*).

Japanese name, KUMAZASA.

*S. veitchii* is a low-growing Japanese bamboo. Culms may not exceed 2 to 3 feet high if grown in the sun, but they may attain a height of 4 to 5 feet in partial shade. Internodes are rather short, purplish, and at first powdery. Branches are single at nodes. The little culm sheaths at first are densely white-hairy. Leaves are broad, usually oblong, 2 to 7 inches long and  $\frac{5}{8}$  to  $1\frac{1}{2}$  inches wide, dark green above and glaucous or powdery beneath, well rounded to broadly tapering at base, and somewhat abruptly pointed at tip. In autumn, even before frost, the leaves have a tendency to turn straw color rather evenly around the entire margin, which gives a striking and interesting appearance. The leaves are similar to those of *S. palmata* except that they are smaller and dark green instead of light green. Like its near relatives, *S. veitchii* spreads fairly rapidly when well established.

This species is adapted to the gulf region, the Atlantic coast north at least to Norfolk, Va., and most of the Pacific coast, though it does less well in areas of long summers.



**Semiarundinaria fastuosa** (Marl.) Makino (*Arundinaria narihira*; *A. fastuosa*).

NARIHIRA BAMBOO; Japanese name, NARIHIRADAKE.

Narihira bamboo is an exceptionally stately and handsome bamboo. Culms are up to 25 feet high and  $1\frac{3}{8}$  inches in diameter at the base, thin-walled, and slightly zigzag. Internodes with branches at base are narrowly grooved above the branches. Branches are upright and often rebranched later, one to three at branching nodes of culm, but as taller culms are produced more and more of the lower nodes remain bare, as in other bamboos. Leaves, five to nine on a branch, are medium size (up to 7 inches long and  $\frac{3}{4}$  to 1 inch wide), rounded to tapering at base, sharp-pointed at tip, dark green and smooth above and gray green and slightly pubescent beneath, and with unequally serrate margins. Culm sheaths are thick, smooth, green at first but becoming purplish, and glossy inside; ligules are low, truncate, convex or concave, and ciliate on margin; sheath blades are rather short, linear-lance shaped, purple, minutely rough above and beneath, and sparsely and minutely ciliate on margins. Many sheaths remain attached at middle of base, conspicuously inclined at various angles, until late in season; this is a ready aid to identification.

New shoots, which appear in late spring, are edible and practically free of "bite" but mostly too small to be important for food. *S. fastuosa* is grown only for its decorative value. It is one of the species that have been used experimentally with success as a hedge, in part because the rhizomes are less rampant than in most running bamboos. With care, and removal of all leaves, clumps of four and five closely spaced culms 16 feet high have been successfully transplanted in early spring.

This species has withstood temperatures of  $-4^{\circ}$  F., with little injury to foliage but killed back to the ground at lower temperatures. It is adapted to the gulf region, the Atlantic coast probably as far north as Philadelphia, Pa., and the Pacific coast perhaps to Vancouver.

**Shibataea kumasaca** (Zoll.) Nakai (*Phyllostachys kumasaca*; *Shibataea kumasasa*, variant of *kumasaca*—pronounced "kumasasa" even though spelled "kumasaca"; *Bambusa ruscifolia*; *B. viminalis* Hort.).

Japanese names, OKAMEZASA and BUNGOZASA.

*S. kumasaca* is a small, broad-leaved, highly distinctive, ornamental Japanese bamboo. Culms are 3 to 6 feet high, slender, nearly solid, and half-round or somewhat triangular; nodes are prominent; the internodes are short (2 inches or less), and slightly zigzag. Branches, 3 to 5, are short ( $\frac{1}{4}$  to  $\frac{1}{2}$  inch long) and slender and each has a terminal leaf first year and sometimes a lateral also in the second

year. Leaves are ovate-lance shaped, sharp-pointed, 2 to 4 inches long and  $\frac{1}{2}$  to 1 inch wide, smooth above and minutely pubescent beneath, and serrate on both margins. Culm sheaths are membranous, purplish at first, and as long as the internodes or longer; sheath blades are diminutive. This unique plant, with its broad leaves resembling those of the genus *Ruscus* of the lily family, its odd branching habit, and extremely slender culms looks little like any ordinary bamboo. And the untrained observer would seldom recognize it as a bamboo or even as a member of the grass family. It might be called the ruscus-leaf bamboo.

The leaves are damaged at about 10° F., but as new leaves appear in late spring the plant can be grown over a considerable extent of latitude. This species is adapted to the gulf region from southeastern Texas eastward, the Atlantic coast at least as far north as Norfolk, Va., and most of the Pacific coast.

### Other Running Bamboos in Cultivation

	Approximate height Feet
<i>Phyllostachys angusta</i> McClure .....	22
<i>arcana</i> McClure .....	27
<i>bambusoides</i> cv. ALLGOLD McClure ( <i>P. sulphurea</i> ; <i>P. castillonis</i> var. <i>holochrysa</i> ; <i>P. reticulata</i> var. <i>sulphurea</i> ) .....	25
<i>bambusoides</i> cv. SLENDER CROOKSTEM McClure ( <i>P. reticulata</i> f. <i>geniculata</i> ) .....	48
<i>bambusoides</i> cv. WHITE CROOKSTEM McClure .....	35
<i>bissetii</i> McClure .....	21
<i>congesta</i> Rendle .....	43
<i>decora</i> McClure .....	24
<i>elegans</i> McClure .....	32
<i>glauca</i> McClure .....	34
<i>makinoi</i> Hayata. Height reported from Formosa .....	60
<i>nidularia</i> Munro. Typical form .....	33
<i>nidularia</i> cv. SMOOTHSHEATH McClure .....	30
<i>nigra</i> cv. BORY McClure ( <i>P. boryana</i> ; <i>P. nigra henonis</i> f. <i>boryana</i> ) .....	50
<i>propinqua</i> McClure .....	23
<i>purpurata</i> McClure. Typical form .....	18
<i>purpurata</i> cv. SOLIDSTEM McClure. Lower half of culm solid .....	18
<i>purpurata</i> cv. STRAIGHTSTEM McClure .....	33
<i>rubromarginata</i> McClure .....	32
<i>viridis</i> cv. ROBERT YOUNG McClure (earlier misidentified as <i>P. sulphurea</i> ). Yellow culms with green stripes .....	45

Approximate  
height  
Feet

<i>Arundinaria angustifolia</i> (Mitf.) H. de Leh. ( <i>Bambusa angustifolia</i> )	5
<i>basigibbosa</i> McClure	5
<i>chino</i> (Fr. & Sav.) Makino ( <i>Bambusa chino</i> ; <i>Pleioblastus maximowiczii</i> )	9
<i>chrysantha</i> Mitford ( <i>Sasa chrysantha</i> )	5
<i>funghomii</i> McClure	30
<i>gigantea</i> (Walt.) Chapm. ( <i>A. macrosperma</i> )	30
<i>graminea</i> (Mitf.) Makino ( <i>A. hindsii</i> var. <i>graminea</i> )	5
<i>humilis</i> Mitford ( <i>Sasa humilis</i> )	4½
<i>laydekeri</i> (Mitf.) Hook. f. ( <i>Bambusa laydekeri</i> ; <i>Pleioblastus chino</i> var. <i>laydekeri</i> )	5
<i>nagashima</i> (Marl.) Aschers. & Graebn. ( <i>Bambusa nagashima</i> )	4½
<i>pumila</i> Mitford ( <i>Sasa pumila</i> ; <i>Pleioblastus pumilus</i> )	2
<i>tecta</i> (Walt.) Muhl. ( <i>A. macrosperma</i> var. <i>tecta</i> )	8
<i>tecta</i> var. <i>decidua</i> C. D. Beadle	4½
<i>Chimonobambusa marmorea</i> (Mitf.) Makino ( <i>Bambusa marmorea</i> ). Semihardy only	5
<i>quadrangularis</i> (Fenzi) Makino ( <i>Bambusa quadrangularis</i> ; <i>Tetragonocalamus angulatus</i> ). Semihardy only	30
<i>Sasa kurilensis</i> (Rupr.) Mak. & Shib. ( <i>Arundinaria kurilensis</i> var. <i>genuina</i> )	10
<i>pygmaea</i> (Mitf.) E. G. Camus ( <i>Bambusa pygmaea</i> )	1
<i>tessellata</i> (Munro) Mak. & Shib. ( <i>Bambusa tessellata</i> ; <i>Arundinaria tessellata</i> ; <i>A. ragamowski</i> ; <i>Sasamorpha tessellata</i> ). Very large leaves	3½
<i>Sinobambusa intermedia</i> McClure. Semihardy only	7
<i>laeta</i> McClure. Semihardy only	16
<i>tootsik</i> (Mak.) Nakai ( <i>Bambusa tootsik</i> ; <i>Arundinaria tootsik</i> ). Semihardy only	20

### Propagation of Running Bamboos

Bamboos of all kinds are propagated almost entirely by vegetative means. This propagation method is desirable for retaining clonal identity and in many cases is the only means available as most species of bamboo flower and produce seed only at intervals of many years.

The most practical method of propagation of the running bamboos is by cuttings of the underground rhizomes. The young rhizomes readily produce rooted propagules without special treatment and thus are an easy method of propagation. The older rhizomes are of

much less value for propagation as the buds usually die within 2 or 3 years. The production of rhizomes for propagating new plants on a regular basis may, therefore, be accomplished most efficiently by routine planting of rhizomes and redivision of new rhizome growth from the resulting plants at intervals of 1 to 3 years.

The planting of rhizomes of the running bamboos should be done relatively early—between January and the end of March, depending upon latitude and the earliness of season. The primary consideration in timing is that the collection and division of rhizomes be well in advance of the “shooting,” or culm development period, which occurs from March to May; the time depending upon the climate, weather conditions of the area, and the species of bamboo.

Rhizome cuttings 12 to 13 inches long should be planted singly, end to end, in well-prepared soil, and covered to a depth of 5 to 6 inches. Rows may be 3 to 5 feet apart; the distance depending upon the type of cultivating equipment available. A well-drained site of relatively high fertility is desirable for a bamboo nursery. The young plants will respond to applications of a complete fertilizer such as 5-10-5 (not more than 1 pound per 100 feet of row) or well-rotted manure worked into the row before planting. It is extremely important that rhizomes be kept moist during the planting operations. They will not survive if permitted to dry out in the manner frequently practiced with many species of deciduous nursery stock that is moved in the “bare-root” condition. If a holding period is necessary for the rhizomes, they may be kept moist by covering with wet sawdust or sphagnum moss until planted. They must be kept well watered throughout the first season, particularly during the first 2 months while the new roots and culms are developing.

Different species or varieties of running bamboo should be separated by at least 7 to 10 feet in the nursery. There is considerable variation in vigor of growth among the different species; but, if the original plants are in good condition when planted, one or more new rhizomes usually should grow outward from each plant during the summer. This growth will not be evident, however, until the next spring when the new shoots from the rhizomes appear.

Ordinarily shoots will begin to appear above ground near the end of April if planting is done by the end of March. The plants generally should grow two seasons in the nursery, though 1-year-old plants may sometimes be large and strong enough at least for local transplanting. When left for 2 years, however, many more rhizomes will develop that will be useful in further propagation. The plants should be cut back to one-third or less of their height before being lifted for transplanting or shipping. Unless the plants are to be balled and burlapped it may be advisable to cut them back to the ground level.

In the nursery, new plants of the hardy bamboos will come up between the rows. If all the plants in the row and close to it are taken up at the end of the second year, this will leave a row of scattered young plants on each side that will be of good size for transplanting a year later. These, in the meantime, will send rhizomes back into the original row and in other directions, and from these newer rhizomes other plants will appear later. This process can be carried on for several years. Yearly fertilization will be needed, however, if vigorous growth is desired.

## TROPICAL, CLUMP-TYPE BAMBOOS

The clump-forming bamboos have relatively thick and short rhizomes that with few exceptions make little or no horizontal growth before turning upward at the tips to develop into new culms. The new shoot arises from a bud on the base of a recently developed culm that had a like origin; it is well supplied with tough fibrous roots growing from its base, which bring nourishment and moisture to the culm and furnish physical support. Practically all the clump bamboos are tropical or subtropical in origin, as indicated earlier, and only a few are adapted to a warm-temperate climate. Among the latter are certain species of the genus *Bambusa*, especially *B. multiplex* in its several varieties, *B. textilis*, and species of the Chinese genus *Sinarundinaria*, such as *S. nitida*, an exceptionally cold-resistant species. The outstanding characteristic of the clump bamboos is that, because of their slow rate of spread, the original plantings unless spaced too close together, remain as distinct clumps of culms instead of running together in thicket style within a short time as do the hardy running bamboos. The clump, cespitose, or pachymorph, introduced bamboos now growing in the warmest parts of the United States and in Puerto Rico are of about 11 genera; the most important of these are *Bambusa* and *Dendrocalamus*. Descriptions of the more important species of clump bamboos follow. The other species in cultivation are listed with approximate heights only.

### Descriptions of Important Species of Clump-Type Bamboos

***Bambusa arundinacea* Retz. (*B. spinosa*).**

GIANT THORNY BAMBOO.

Giant thorny bamboo is a giant thorny tropical edible bamboo, native to India. The date of earliest introduction into this country is uncertain, but it probably was in the first decade of this century. The culms have attained more than 95 feet in height and about 5½ inches in basal diameter in the Miami, Fla., area. It is reported to



grow even larger in the Asian Tropics. The internodes of the culms are fairly thick walled, but the wood is less dense than that of many other bamboos. The edible new shoots appear during autumn in southern Florida, but the culms usually do not extend their branches until the following spring. Leaves, five or six on a branch or twig, are 3 to 7 inches long and  $\frac{3}{8}$  to  $\frac{5}{8}$  inch wide. There are three branches at each of several of the lower culm nodes—a central large primary with a secondary pair of much smaller subequal ones; often there are also several diminutive twiglike branches. The primary branches are elongated and almost vinelike, with all the secondaries modified into short sharp thorns; the branchlets at the nodes of the lower primaries are modified into similar thorns. Higher on the culm, the branchlets and the secondary branches are gradually less thorny, or spiny, until near the top normal leafy ones only are found. The long thorny lower branches in time form an almost impenetrable barrier against larger animals that otherwise might eat or destroy the shoots at sprouting time. Culm sheaths are 9 to 12 inches long, hairy and orange-yellow on the outside while young, shining and prominently ribbed on the inside. Sheath blades are relatively short and broad, especially on sheaths of the lower nodes; they are distinguished by the dense appressed hairiness, blackish and furlike, on the inner surface and by their not being separable from the sheath as in most bamboos.

The edible new shoots are rather bitter and must be cooked in at least two waters. Although this species does not rate high in quality as a source of wood for paper pulp, it has been used for this purpose in India as it produces volume at a rapid rate where climate and soil are congenial.

This species withstands several degrees of frost, but it is injured or killed at temperatures lower than 27° F.

**Bambusa beecheyana** Munro (*Sinocalamus beecheyanus*).

#### BEECHEY BAMBOO.

Beechey bamboo is a large semihardy bamboo with edible shoots, native to southeastern China. It was introduced into southern California at an unknown early date and into southern Florida first in 1926 and again at later dates. The plants develop rapidly under favorable conditions, and culm heights up to 40 feet and culm basal diameters of about 4 inches in about 5 years from planting have been recorded in southern Florida. The culms are a rather bright green, strongly tapered, and often elliptic in cross section, and they form a somewhat open clump. The new shoots usually appear in late summer and early autumn in this country. Branches are few at a node

of the culm. Leaves, 6 to 10 on a branch or twig, are  $3\frac{1}{2}$  to 7 inches long and  $\frac{1}{2}$  to  $1\frac{1}{8}$  inches wide. Culm sheaths are glabrous except for a fine pubescence at the base, green at first but drying to a grayish brown, with veins becoming prominent and giving the sheath a striate appearance. The sheath is much wider at the base than at the apex, which is truncate, and is surmounted by a small, triangular, non-separable sheath blade that is a little narrower at base than at apex of sheath and without auricles; ligules, on lower eight sheaths, are  $\frac{1}{4}$  inch or less high, with erose margins.

Beechey bamboo is one of the more important sources of commercial bamboo shoots in southern China. In the production of edible shoots, it is necessary to mound up the soil around the bases of clumps every year, to exclude as nearly as possible all light from the younger shoots until they are dug, in order to prevent the development of an intense bitterness or acidity in the shoots. This is standard practice in China in growing this bamboo for its shoots.

This species has withstood temperatures down to  $20^{\circ}$  F.—about the same as for the better-known *Bambusa oldhami* (formerly miscalled *Dendrocalamus latiflorus* in California and Florida) and *B. tuldooides* (*B. thouarsi* Hort.). It is adapted to localities in southern Florida and southern California in which temperatures lower than  $20^{\circ}$  F. occur only at intervals of several years.

**Bambusa multiplex** (Lour.) Raeusch. (*B. nana*; *Leleba multiplex*).

HEDGE BAMBOO; ORIENTAL HEDGE BAMBOO.

Hedge bamboo is one of the most variable of all bamboos in cultivation. This variability explains its general adaptability for decorative planting and the early segregation of distinctive forms that from time to time have arisen during its long period under domestication. It has been found growing in the wild only in northern Kwangtung Province, in southern China. In its eight recognized forms, or cultivars, it is by far the commonest species of clump-type bamboo now in cultivation in the South Atlantic and Gulf States and in southern California. The varieties as observed range in maximum height from about 10 feet for the Chinese goddess bamboo, *B. multiplex* var. *riviereorum* Maire, to nearly 50 feet (under extremely favorable conditions) for *B. multiplex* cv. Silverstripe. The culms form a fairly compact clump, and they are rather slender for their height and, in taller specimens, usually more or less arched. There are marked differences between some varieties in culm and leaf characters. The culm internodes are rather long—the longest, usually the third from base of the culm, is up to 22 inches or more long.

The new shoots in all forms of *Bambusa multiplex* usually appear in midsummer or earlier, but the resulting culms of the larger and later sprouting ones commonly do not extend their branches and shed

their sheaths until the next spring. Sometimes the culm sheaths may remain partly attached for several weeks longer. They are usually slightly hairy; and the blade, decurrent at the base, with or without auricles, separates from the sheath when dry; in a few varieties the sheaths bear distinctive color markings. Branches range from a few to as many as 35, mostly very small, at a culm node. There is a primary branch of considerable length and a secondary pair of subequal smaller ones—one at each side—arising from two crowded basal nodes of the primary; and small to diminutive branches or twigs develop successively within a year from the much crowded basal nodes of the primary and secondary branches. Branchlets develop from the upper nodes of the primary branch and sometimes from those of the two secondaries also. The leaves, 5 to 11 on a branch or twig, are lance-shaped to narrow-oblong, rounded at the base, and strikingly glaucous, or silvery, beneath; they are variable in size, not only between some of the varieties but within them owing to differences in age of culm and in soil conditions. On first-year culms, as with bamboos in general, the leaves average larger than on older ones. All the forms of *B. multiplex* except the botanical variety *riviereorum*, the Chinese goddess bamboo, have flowered somewhat freely at one time or another.

The shoots are bitter and are rarely used for food. Culms of any variety of the hedge bamboo are often used locally for fishing poles and for some other purposes, but because of their rather thin walls and usually somewhat arched form they are not ideal for fishing poles. The fiber length of the wood is favorable for paper-pulp manufacture, but the thinness of walls and the relatively small diameter of culms, which rarely exceeds  $1\frac{3}{4}$  inches even in the larger varieties, may preclude this species as an important source of material for paper pulp.

Hedge bamboo is one of the most cold resistant of the tropical, clump-type bamboos; it has withstood temperatures down to 17° F. and slightly lower in some of its forms.

**Bambusa multiplex**, typical form (*B. argentea* Hort.; *B. nana* var. *normalis*; *B. nana* var. *argentea* Hort.; *Leleba multiplex*).

HEDGE BAMBOO; ORIENTAL HEDGE BAMBOO;  
Japanese name, HORAICHIKU.

The typical form of *B. multiplex* is considered to represent the original wild plant from which all other forms or varieties have arisen; this was long known to nurserymen and others in this country under the horticultural name *B. argentea*. The name alludes to the silvery undersurface of the leaves, which is common to all the forms of *B. multiplex*. The thin-walled, plain-green culms grow to 35 or

more feet high, with basal diameters of at least  $1\frac{1}{2}$  inches, where soil, moisture, and temperature conditions are favorable. Branches are few to as many as 35 at a node, one branch being relatively large, with a pair of subequal, somewhat smaller ones at its base, and the remainder small to diminutive. Leaves are plain green above and  $1\frac{1}{2}$  to 7 inches long and  $\frac{3}{16}$  to  $\frac{5}{16}$  inch wide. Sprouting time is about midsummer, and the new culms often do not branch and shed their sheaths until the next spring. The culm sheaths are without distinctive markings. This species is adapted to locations where winter temperatures do not often fall lower than  $17^{\circ}$  F.

**Bambusa multiplex** cv. ALPHONSE KARR Young (*B. alphonse-karri*; *B. nana* var. *alphonse-karri*; *Leleba multiplex* f. *alphonse karri*).

ALPHONSE KARR BAMBOO; Japanese name, SUOCHIKU.

Alphonse Karr bamboo was named for Jean Baptiste Alphonse Karr, a French journalist, novelist, and horticulturist of the 19th century. It is a large and attractive hedge bamboo much like the typical form in stature and foliage characters; however, the culms and branches are bright yellow irregularly striped with vivid green and the culm sheaths have whitish to yellowish stripes that remain when the darker, brownish-green parts fade to a pale brownish hue. Culm heights of 35 to 40 feet in Florida have been reported, but 25 to 30 feet is usual under most conditions. The new shoots appear in early midsummer. This cultivar perhaps can withstand a degree lower temperature than the typical form.

**Bambusa multiplex** cv. FERNLEAF Young (*B. nana*; *B. nana* var. *gracillima*; *B. nana* var. *disticha* Hort.; *Leleba floribunda*).

FERNLEAF HEDGE BAMBOO; Japanese name, HO-O-CHIKU.

Cultivar Fernleaf is a graceful, more or less dwarf form of the species that has been long in the nursery trade. In this country it has been sometimes known under such erroneous names as *Arundinaria nitida* or *Bambusa falcata*. Culms are 10 to 20 feet high and have hollow internodes with relatively thick walls. The fernleaf character of foliage results from the dwarf size of the entire plant but especially of the leaf-bearing branches or twigs. The twigs are shorter and the leaves are smaller but much more numerous on a twig than they are on the typical form. Leaves are  $\frac{5}{8}$  to  $1\frac{1}{2}$  inches long,  $\frac{1}{8}$  to  $\frac{3}{16}$  inch wide, closely 2-ranked, and usually 10 to 20 on a twig. There are no special color markings on the plant. In a relatively infertile or dry soil the foliage characters mentioned are commonly well retained and the culms may not exceed 11 feet in height. Under better soil and moisture conditions, however, they grow taller and the foliage often tends to lose its fernlike character. New culm



shoots appear in late spring or early summer. This bamboo withstands temperatures down to about 16° F., with little injury.

**Bambusa multiplex** cv. SILVERSTRIPE FERNLEAF Young (*B. nana* f. *albo-variegata*; *Leleba floribunda* f. *albo-variegata*).

SILVERSTRIPE FERNLEAF BAMBOO; Japanese name, FUIRIHO-O-CHIKU.

Cultivar Silverstripe Fernleaf, a rare variety, is similar to cv. Fernleaf except that it has white-striped leaves. It is believed to have arisen, however, from the cultivar Silverstripe, since fern-leaved branches occasionally have been observed in the latter cultivar.

**Bambusa multiplex** cv. STRIPESTEM FERNLEAF Young (*B. nana* f. *viridi-striata*; *Leleba floribunda* f. *viridi-striata*).

STRIPESTEM FERNLEAF BAMBOO; Japanese name, BENIHO-O-CHIKU.

Cultivar Stripestem Fernleaf is similar in all respects to cv. Fernleaf except that the culms at first are light reddish to yellowish and are irregularly striped with green.

**Bambusa multiplex** var. *riviereorum* Maire.

CHINESE GODDESS BAMBOO; Chinese name, KOON YAM CHUK.

Chinese goddess bamboo is a very distinct, dwarf, solid-stemmed, fern-leaved variety from southeastern China. In foliage characters it is nearly identical with cv. Fernleaf and cv. Stripestem Fernleaf. This beautiful bamboo appears to be perfectly stable in all its characters; it has not been known to change materially in stature or other respects with ordinary differences in soil or moisture. In comparison with cv. Fernleaf, the solid internodes of the culms of the Chinese goddess variety constitute a positive distinguishing character. It is slightly more cold resistant, however; it endures about 15° F., with minor injury.

**Bambusa multiplex** cv. SILVERSTRIPE Young (*B. nana* var. *variegata*; *B. nana* var. *argenteo-striata* Hort.; *B. argentea-striata* Hort.; *B. vittata-argentea* Hort.; *Leleba multiplex* f. *variegata*).

SILVERSTRIPE HEDGE BAMBOO; Japanese name, HOSHCHIKU.

The Silverstripe hedge bamboo apparently is the largest form of *B. multiplex* and the most widely grown in the Lower South and the Southwest. Heights up to 45 or more feet have been observed in an old planting, under exceptionally favorable conditions in central Florida, though ordinarily it rarely exceeds 35 to 40 feet. The plant differs in appearance from the typical form in that a few to many of its leaves are striped with white, the culm internodes usually bear one or two threadlike whitish stripes, and the culm sheaths have several broad brownish stripes alternating with green when fresh, and



the brown remains when the green fades. Rarely some of the fern-leaf type of foliage has been observed on a branch or two of a single culm. This cultivar endures somewhat lower temperature than does the typical form.

**Bambusa multiplex** cv. WILLOWY Young.

Cultivar Willowy is a medium-sized bamboo with slender culms. This cultivar apparently has not been recognized under a distinctive name in China or Japan, though allusion to a drooping form in China has been found in the literature. Culms grow to about 20 feet high, and the culm diameters do not exceed  $\frac{5}{8}$  to  $\frac{3}{4}$  inch near the base. Culms nearing maximum height tend strongly to droop or bend, even without the masses of foliage that cause excessive bending in other varieties. The lowest internodes are solid and higher ones thick walled, so that the drooping tendency does not develop in culms of lower height. The new shoots appear in summer. All parts of the plant of cv. Willowy are green, and the culm sheaths fade to a dull straw color. Branches and twigs are exceedingly slender. Leaves are narrow,  $1\frac{1}{2}$  to  $4\frac{1}{2}$  inches long by  $\frac{5}{16}$  to  $\frac{3}{8}$  inch wide. In cold resistance this bamboo about equals cultivars Silverstripe and Fernleaf.

**Bambusa oldhami** Munro (*Leleba oldhami*; *Sinocalamus oldhami*).

OLDHAM BAMBOO; Japanese name (in Formosa), MOROKUDAKE.

Oldham bamboo is a handsome, semihardy, giant bamboo, native to southern China and Formosa. *B. oldhami* was long known in southern California and Florida under the misidentification of *Dendrocalamus latiflorus*. It forms moderately open clumps. Culm heights up to 55 feet have been reported in Florida and even taller in the Panama Canal Zone; the maximum culm basal diameters attained were about  $3\frac{1}{4}$  inches. There are the usual fairly large primary branch, two smaller secondary branches, and a few smaller ones at each branching node of the culm. Leaves, seven to nine on a branch or twig, are 3 to 9 inches long and  $\frac{5}{8}$  to  $1\frac{1}{2}$  inches wide. New shoots appear in early or midautumn in California and Florida. The culm sheaths are much the same in shape as those of *B. beecheyana* except that they are much broader at the apex, with the base of the sheath blade greatly extended and equaling the apex of the sheath in width; rudimentary auricles are sometimes present. The sheaths are at first covered with short appressed hairs, but as the sheaths dry most of these fall off; the sheaths dry to a somewhat dull straw color, and the veins do not become prominent.

The culm walls are of moderate thickness, and the wood is not very hard. No important economic uses for the culms are yet known, but the plant is an outstanding ornamental of large size.

Oldham bamboo withstands a minimum temperature of about 20° F.

**Bambusa pervariabilis** McClure.

Chinese names, YAN CHUK, FA MEI CHUK, NAI CHUK.

*B. pervariabilis* is a medium-tall, slender bamboo closely related to *B. tuldooides*. It grows more stiffly erect than *B. tuldooides*, but resembles it in some other superficial characters. The culms are thicker walled, the wood is more durable, and the nodes are more prominent and more heavily branched than in *B. tuldooides*; and the internodes are very often white-striate and densely pubescent. Culms are up to 50 feet high and 2 inches in diameter at the base. The sheaths of culms and branches also are often very densely pubescent, but they vary greatly in this respect and also in shape. The name *pervariabilis* alludes to this variability. This valuable bamboo is less vigorous than *B. tuldooides*, and the production of new culms less prolific.

The culms are reported to be used extensively in China in heavy construction and for punting poles.

The cold endurance of *B. pervariabilis* has not been determined.

**Bambusa polymorpha** Munro.

*B. polymorpha* is a giant bamboo, native in Bengal and Burma. It was introduced from India in 1924 by the U.S. Department of Agriculture and is established at Vero Beach, Fla., and in Puerto Rico and the Panama Canal Zone. It forms an exceedingly dense clump of bluish waxy culms that attain heights in India of 75 to 90 feet, with basal diameters up to 6 inches; they bear masses of beautiful feathery foliage. The lower parts of culms in a mature clump are free of branches. Branches and twigs are long and slender. This species is one of the smallest and slenderest leaved—1½ to 7½ inches long and 5/16 to 7/16 inch wide—of the tropical clump bamboos yet introduced, except those of the fern-leaved forms of *B. multiplex*. In Florida the new shoots appear in autumn. The culm sheaths are distinctive in having very prominent auricles, profusely margined with long stiff bristles; the sheaths are exceedingly stiff and are densely covered with fine appressed stiff hairs, that are rather easily rubbed off, which leaves the dry sheath with a silvery-gray appearance.

Mature clumps of *B. polymorpha* are reported to have survived a minimum of about 28° F. in southern Florida, but younger ones elsewhere were killed to the ground at that temperature.

**Bambusa textilis** McClure.

Chinese name, WONG CHUK.

*B. textilis* is an exceptionally handsome, medium-tall bamboo from southern China. It forms a compact clump of thin-walled but tough

culms with long internodes. Heights up to 50 or more feet and basal diameters of 2 inches have been attained. The culms are erect and usually straight, with nodding tips, and are free of branches to a greater height than most bamboos; the nodes are not prominent. The branches, 6 to 10 at a node of the culm, differ less in size than do those of most other species of *Bambusa*. Foliage is distinctive and attractive; leaves on the primary branch are up to 8 inches long and 1 inch wide, while those on other branches and on twigs rarely exceed 6 inches by  $\frac{5}{8}$  inch.

In China the culms are split and used extensively in the weaving of mats, hats, and baskets and also for making rope. The culm characters indicate considerable potential value; the smaller culms, when fully mature, could be used for light fishing poles.

*B. textilis* is one of the most cold-hardy of the tropical, clump-type bamboos; it survived a temperature of 13° F. in central Florida with only slight leaf injury. It appears, however, to be susceptible to some other unfavorable conditions, as in a more northern locality, in which no lower temperatures were experienced during the period of observation, the plant has not thrived.

### ***Bambusa tulda* Roxb.**

*B. tulda* is a giant tropical bamboo, native to India. It was first introduced in 1907, by the U.S. Department of Agriculture. In India heights of 70 or more feet have been reported, and it has attained heights of at least 60 feet in central and southern Florida, with maximum culm basal diameter of about 3 inches. There are the usual 3 larger branches at a node of the culm, with 6 to 10 leaves on each. Leaves are often large—3 to 10 inches long and  $\frac{1}{2}$  to  $1\frac{1}{8}$  inches wide. The lower branches on large culms are leafless, much reduced in length, and almost thornlike. Culm sheaths at the lower nodes are broad and more or less arched at apex, with the blade narrower than the sheath apex but with a pair of prominent, unequal, crinkly or wavy auricles extending to edges of apex; sheaths usually are more or less brown-hairy on the outside.

The culms of large size are straight, thick walled, and the wood is fairly dense. In Puerto Rico split fishing rods have been made from them. The wood fiber is of only medium length, but if available in sufficient quantity the culms could be a source of material for paper pulp.

*B. tulda* is injured or killed at temperatures below 27° F.

A smaller thick-walled bamboo received as seeds under the name *B. tulda* by the Department in 1927 from India was recorded under P. I. 74413. It was distributed for many years under that name and number. Although the plant is closely related to *B. tulda* and its

culm sheaths strongly resemble those of that species, numerous differences, in addition to size, have been observed that indicate that it is probably a different but as yet undetermined species.

**Bambusa tuldoides** Munro (*B. pallescens*; *B. guadua*; *Leleba tuldoides*).

PUNTINGPOLE BAMBOO; Chinese names, CHAANG KO CHUK,  
NAI CHUK.

Puntingpole bamboo is a handsome semihardy bamboo, native to southern China. It was known in southern California and Florida for many years under the misidentification of *B. thourarsii*. Culms are slender, erect, straight, fairly thick walled, and up to 55 feet high and  $2\frac{1}{4}$  inches in diameter at the base. There are several ascending branches at each branching node of the culm—the usual larger primary, a secondary smaller pair, and a few twiglike branches. The dark-green oblong leaves, 5 to 12 on a branch or twig, may range from about  $2\frac{1}{2}$  to 5 inches long and  $\frac{5}{16}$  to  $\frac{5}{8}$  inch broad, or, on first-year culms, as much as 5 to 10 inches long and  $\frac{1}{2}$  to 1 inch broad.

In China the culms are used for many industrial purposes, such as punting poles for propelling small boats and for the weaving of heavy crates from the split culms. Largely because of its prolific production of culms, *B. tuldoides* is one of the most important economic bamboos in the region of Canton; however, in quality of wood it is distinctly inferior to the related *B. pervariabilis*.

The foliage endures temperatures down to 19° F.

**Bambusa ventricosa** McClure.

BUDDHA'S BELLY BAMBOO; BUDDHA BAMBOO.

Buddha bamboo is a semihardy bamboo from southern China. It is commonly cultivated there as a dwarfed potted or tub plant; however, it becomes a semigiant in the open under favorable conditions. When dwarfed, by tub culture or by sterile or dry soil in the open, and even in good soil with newly propagated plants, the internodes of the culms are shortened and swollen in a characteristic manner. This characteristic shape is the reason for its Chinese common name, translated as Buddha's belly bamboo. Under these conditions the height probably will not exceed 7 or 8 feet. In a favorable outdoor environment the distortion of the internodes tends to disappear, and the thick-walled culms have attained heights up to 55 feet, with maximum basal diameter of about  $2\frac{1}{4}$  inches, in southern Florida and Puerto Rico. New shoots appear in late summer or early autumn. On normal adult culms there are usually three larger branches and often two or more smaller ones at a node, but on dwarfed culms there



is sometimes only a single branch at a node. The leaves are  $1\frac{1}{2}$  to 5 inches long and  $\frac{5}{16}$  to  $\frac{5}{8}$  inch wide on dwarfed culms and 2 to 7 inches long on normal ones.

For indoor culture direct sunlight is necessary for a good part of the day and good light for the remainder. Buddha bamboo in Florida has withstood a temperature of  $17^{\circ}$  F. without damage, but at  $13^{\circ}$  it lost all leaves and the culms were injured severely or killed.

### **Bambusa vulgaris** Schrad.

*B. vulgaris* is one of the most widely grown of all bamboos in tropical and subtropical regions. Its popularity, no doubt, is partly because of its attractiveness and its large size—70 to 80 feet high and 4 to 5 inches in diameter at the base—but also because of the comparative ease of propagation and cultivation in most localities that are nearly or quite free from frost. Internodes are green at first, but later they turn yellow; in one form they become largely suffused with black. This species forms a much more open clump than others of the clump type, because the rhizomes from which the new culms develop often extend up to  $2\frac{1}{2}$  feet horizontally before turning upward. Branching is similar to that in most other species of *Bambusa*. Leaves are 4 to 9 inches long and  $\frac{1}{2}$  to  $1\frac{1}{8}$  inches wide. The sprouting season is late summer and early autumn in Florida, but the culms do not shed their sheaths and extend their branches until spring. The culm sheaths are highly characteristic; the apex of the sheath is very wide, with the center arching gently, and the ligules are of medium height, with finely notched, shortly ciliate margins. Sheaths are at first covered on the outside with short, appressed, stiff brown hairs, most of which gradually fall off; the sheaths dry to a pale brown. The sheath blades, on the lower sheaths especially, are much narrower than the apex of the sheath, but a pair of prominent fringed auricles at the base of each extend to the edges of the sheath; the inside of the sheath blade is at first densely brown-hairy, but much of this is lost on drying.

The wood of the culms is relatively soft and has rather low value for construction purposes, though it has been much used for furniture and many other household articles. The wood fibers are long, however, which makes this bamboo valuable in frost-free regions as a source of material for paper pulp.

Clumps have persisted for many years and grown to considerable size in protected situations in Florida as far north as Gainesville before being destroyed in a periodic freeze. This species suffers foliage injury at  $30^{\circ}$  F. and at  $28^{\circ}$  usually is killed to the ground.

A smaller, attractive variety of this bamboo, *B. vulgaris* cv. VITTATA McClure, having golden-yellow culms with a few slender bright-green stripes, is also found rarely in southern Florida. It resembles



the typical form in other respects except that it is reported to be even less cold resistant.

**Dendrocalamus asper** (Schult.) Backer (*Bambusa aspera*; *Gigantochloa aspera*; *Dendrocalamus flagellifer*; *Bambusa macroculmis*; *Dendrocalamus macroculmis*).

*D. asper* is a fairly cold-resistant, giant East Indian bamboo with edible shoots. It is reported that the culms sometimes grow to more than 100 feet tall and up to 8 inches in diameter at the base. Culms attained 60 feet or more in height in Puerto Rico, and also at the U.S. Plant Introduction Station near Miami, Fla. The culms are relatively thin walled (the largest ones are scarcely  $\frac{3}{4}$  inch thick), but they are usually straight or nearly so, even though inclined at an angle in the outer part of a clump. Leaves are exceedingly variable in size—from 5 inches long and  $\frac{3}{4}$  inch wide to as much as 18 inches long and 3 inches wide on young culms in Java. The new shoots appear in summer or early autumn in Florida. The lower culm sheaths are very short in relation to their width, narrowing abruptly to a narrow apex, with a high, fimbriate ligule; they are stiffly leathery, densely covered outside with stiff brown hairs, and usually dry to a dark or pale brown. The sheath blades are small, lance-shaped, reflexed, and rolled inward on the edges; auricles are rudimentary or lacking.

In Java *D. asper* is said to be grown more for its edible shoots than for its culms; the shoots are dug before they emerge from the ground, as they are then tender and are better tasting when cooked. Notwithstanding the relative thinness of the walls, the mature culms, because of their strength and durability, are preferred to other available woods for posts and scaffolding for houses in Java.

In Algiers this species is reported to have withstood many degrees of frost. Cold injury has not been reported from southern Florida, but its maximum cold endurance has not been determined. In Java it is planted at altitudes up to 6,000 feet.

**Dendrocalamus latiflorus** Munro (*Sinocalamus latiflorus*).

Cantonese name, TIM CHUK (sweet bamboo).

*D. latiflorus* is a large, handsome, tropical and subtropical bamboo, native to Formosa. Culms are thick walled, up to 50 or more feet high, and nearly 5 inches in diameter at the base. The leaves are rather large (6 to 10 inches long and 1 to 2 inches wide) and rounded at the base, with long-acuminate tips.

This bamboo is grown widely in the region of Canton, China, for its excellent edible shoots, which are robust, relatively solid, and unusually free of any unpleasant taste when raw. The shoots of *D. latiflorus* are rated more highly than are those of *Bambusa beechey-*

*ana*, another important edible bamboo cultivated largely in the same area. They appear in autumn in a region with cool winters.

The frost resistance of this bamboo is not yet known, since the first successful introduction was of recent date.

***Dendrocalamus strictus*** (Roxb.) Nees (*Bambusa stricta*).

CALCUTTA BAMBOO; "MALE" BAMBOO.

Calcutta bamboo is a tall, tropical bamboo, long in cultivation in India and eastward, with slender, thick-walled or rarely solid culms. In the Americas the culms grow to 60 or more feet high and have basal diameters of  $2\frac{1}{4}$  to  $2\frac{1}{2}$  inches; in tropical Asia they are reported sometimes to grow nearly 100 feet high. The different forms grown are highly variable in several characters besides thickness of culm walls, though the wood is always dense and hard when mature. There is much variability in the straightness of culm, especially in the slightly zigzag character at the nodes. The primary branch at each branching node is frequently much larger than any of the three to six smaller ones. The various forms of the species vary in the number of leaves on a branch or twig; there may be 5 to 7, 6 to 10, or 7 to 13 leaves. Leaves on adult culms average much larger in some forms than in others; the smallest are about 2 to 5 inches long and  $\frac{3}{8}$  to  $\frac{3}{4}$  inch wide and the largest, 3 to 10 inches long and  $\frac{5}{8}$  to  $1\frac{1}{4}$  inches wide. Sprouting of new shoots in Florida is in autumn, but the culms do not shed their sheaths and extend their branches until spring. Culm sheaths are leathery to rigid and more or less densely brown- or blackish-hairy or bristly and gradually or abruptly narrowing toward the apex. The sheath blades are as wide at the base as the apex of the sheath and usually inseparable. The ligules are low, truncate.

A bamboo long known in the trade as "Calcutta cane," formerly the preferred bamboo for the manufacture of split fishing rods, has until recently been supposed to belong to *Dendrocalamus strictus*; but there now seem to be good reasons for believing that it is an entirely different bamboo. The name "Calcutta bamboo," therefore, used in the heading probably is not appropriate; it is used here only because of the belief that has prevailed in the past and the lack of a current alternative. The name "male" bamboo in English is widely used in India. A Malay name, translated "stony bamboo," doubtless is in allusion to the hardness of the wood.

*D. strictus* is cultivated extensively in India in a manner to produce many small culms; these, it is understood, are used for making cudgels, which are used in great numbers. The culms are also considered a good material for paper pulp. The adaptability of these heavy culms for use in the natural form as fishing poles remains to be determined.

*D. strictus* can be grown successfully only in areas almost free from frost, as it is injured or killed at temperatures below 27° F.

A superior form of *Dendrocalamus strictus* with unusually straight and otherwise desirable culms, growing at the Federal Experiment Station at Mayaguez, Puerto Rico, has recently been recognized and has been recorded under P.I. 254923.

**Sinarundinaria nitida** (Mitf.) Nakai (*Arundinaria nitida*).

*S. nitida* is an exceptionally cold-resistant bamboo, native in Szechuan and Kansu Provinces, China, at altitudes up to 10,000 feet on the northern slopes of mountains. Culms have reached a height of 20 feet and a basal diameter exceeding  $\frac{3}{4}$  inch in England. They are slender and blackish purple. The brilliant-green leaves are small—2 to 3 inches long and up to  $\frac{1}{2}$  inch wide.

The slender culms were reported by the explorer Frank N. Meyer to be used in China by the local population in making baskets, sieves, and light fencing and even in house construction.

*S. nitida* is reported to endure more cold in England without injury than some of the hardy running bamboos. Being of nonrunning type, it will be of particular interest for testing as an ornamental in northern localities having rather mild winters.

### Other Clump-Type Bamboos in Cultivation

	Approximate height Feet
<i>Bambusa boniopsis</i> McClure .....	7
<i>dissimulator</i> McClure .....	45
<i>flexuosa</i> Munro. Branches thorny .....	50
<i>longispiculata</i> Gamble .....	45
<i>malingensis</i> McClure .....	25
<i>mutabilis</i> McClure .....	20
<i>rutila</i> McClure. Branches thorny .....	50
<i>Cephalostachyum pergracile</i> Munro .....	55
<i>Dendrocalamus giganteus</i> Munro .....	100
<i>membranaceus</i> Munro .....	75
<i>latiflorus</i> Munro .....	50
<i>Elytostachys typica</i> McClure. Vinelike climbing culms .....	50
<i>Gigantochloa apus</i> (Schult.) Kurz .....	65
<i>levis</i> (Blanco) Merr. ( <i>Bambusa levis</i> ) .....	50
<i>verticillata</i> (Willd.) Munro ( <i>Bambusa verticillata</i> ) .....	80
<i>Guadua amplexifolia</i> Kunth .....	60
<i>angustifolia</i> Kunth .....	100

	Approximate height Feet
<i>Melocanna baccifera</i> (Roxb.) Kurz ( <i>Bambusa baccifera</i> ; <i>Melocanna bambusoides</i> ). Clump habit very open.....	65
<i>Ochlandra travancorica</i> Gamble.....	20
<i>Schizostachyum funghomii</i> McClure.....	33
<i>Sinarundinaria murielae</i> (Gamble) Nakai. Semihardy.....	12
<i>Thamnocalamus aristatus</i> (Gamble) E. G. Camus.....	13

## Propagation of Clump-Type Bamboos

There are three common methods of propagating the clump-forming bamboos. Each is best done in the spring, and the last two, especially, should not be done until after the weather has become steadily warm. The three methods are:

*Division of the clump.*—A clump with culms of rather large diameter will require dividing by chopping or sawing, but a clump of very slender culms can often be divided with a sharp knife or a pair of pruning shears. A division may consist of one or more culms, with the rooty base; the culms usually should be cut back to 2 feet or less in height. Ideally, in a nursery operation, all clumps would be kept small, so that division with pruning shears usually would be possible. However, if large clumps are to be divided, a method of loosening the clump that has been successfully used in the clay soils at the Federal Experiment Station in Puerto Rico, at Mayaguez, may be used. In this method, after cutting back all culms, several holes are bored obliquely downward from the edge toward the center of the clump and sticks of dynamite placed at the bottoms of the holes are exploded simultaneously. This loosening of the clump greatly facilitates the division into units suitable for planting.

*Cuttings of the culm.*—This method will not be successful with all the clump bamboos, but it is with many, especially the genus *Bambusa*. It is useful especially when the culms are of rather large diameters. The culm is sawed into short sections, usually single-node sections with a small leafy branch at the node; the cuts are made about the middle of the internodes. The hollow ends of the section are filled with wet soil or sand and the cuttings planted horizontally, with the branch toward one side, 2 to 4 inches deep in very damp to wet soil (or sand), with part of the branch extending above the surface, in a very warm location. Rooting and sprouting from the bud at the node should start within 30 days.

*Layering the culm.*—This consists in cutting out an entire culm, usually of fairly large size and preferably not more than 3 years of

age, with its rooty base attached, and burying it about 6 inches deep in a trench in warm moist soil. One or two small leafy branches are left at each node and these are left projecting above the surface of the ground. With a clump bamboo adapted to this mode of propagation, sprouting and rooting at most of the nodes should begin within 4 to 6 weeks. After several months, when the roots are well developed, the soil is removed near the middle of each internode and the culm carefully sawed through at these points. Transplanting usually should be deferred for a few months longer, to allow for further root growth. This method has been in use for species of *Bambusa* and for *Dendrocalamus strictus*.

A fourth possible way of propagating some clump bamboos—a method not yet widely known and applicable only to certain species—consists of making a single cutting from the basal parts of large branches, including the enlarged base (which may already have root initials more or less developed). This method, in use among Chinese growers in the region of Canton, was first reported in 1925. More recently its use experimentally has been reported by the Federal Experiment Station, Mayaguez, Puerto Rico (9).<sup>6</sup>

## CULTURAL INFORMATION

Bamboo plants from the nursery may be transplanted to the field, preferably with a ball of earth, in the spring before sprouting time. The site for planting should be fairly fertile and well drained. Bamboo is not recommended for marginal land. When different species of hardy bamboos are grown they must be kept well apart—at least 40 to 50 feet—in order to avoid intermixing within a few years, as the rhizomes of many of them, after they become established, spread 10 to 25 feet a year in all directions if soil conditions are favorable. Plants of species of the the genus *Phyllostachys* that grow to giant size (50 to 70 feet high) should be spaced 12 to 15 feet apart each way and in an area not less than 60 to 75 feet across. Plants of running bamboos that grow 16 to 25 feet high may be spaced as close as 8 by 8 or 10 feet, in an area not less than 30 feet across. In certain of the running bamboos, such as *P. aurea* (fishpole bamboo), *P. nigra* (black bamboo), *Semiarundinaria fastuosa* (Narihira bamboo), and *Arundinaria simonii*, which may reach heights of 20 to 30 feet, the rhizomes are much less rampant in growth than many others and will produce culms of maximum sizes in somewhat smaller areas than the more rapid spreading species.

In general, the distance across the area allotted for any bamboo clump or grove should be at least a little greater than the expected

<sup>6</sup> Italic numbers in parentheses refer to Literature Cited, p. 74.



maximum height of culm. The rhizomes in mature plantings of the medium-sized and larger species of running bamboos usually will extend at least 15 to 25 feet beyond the limits of the grove, at depths of from a few inches to 4 feet, depending upon the texture of the soil and the age of the grove.

When transplanting has been properly done, new culms at least double the height of those of the first year may be expected in the second year. The rhizomes then begin spreading. Each succeeding season, under favorable conditions for growth, culms of increasingly greater height and diameter will be produced until the maximum is reached. For the largest bamboos under the best conditions for growth it will take at least 10 to 15 years for a grove to produce culms of full size. Lower growing species can be grown to mature size in a shorter time.

Cultivation of a new bamboo grove is necessary for 2 or 3 years. Some crop plants may be grown between the rows for the first year or two, or a cover crop may be planted. After this, the cutting of grass and weeds (which should be left to decay on the ground) usually will be all that is required until the shade of the bamboo becomes sufficient to check other growth. Care must be taken not to injure the running rhizomes in cultivation. For small areas irrigation should, if possible, be practiced in any prolonged dry period, especially if the drought occurs just before or during the sprouting season and if vigorous growth is desired. Fertilizer may consist of well-rotted manure applied in the late winter, supplemented a few weeks later with a nitrogen fertilizer such as ammonium nitrate, nitrate of soda, or cottonseed meal. In the absence of manure, a complete commercial fertilizer (formula 7-6-5, 6-6-6, or 5-7-5) may be applied early in spring, with plenty of dead leaves; the need for leaves will be supplied in part by the bamboo. Applications of fertilizer may start with 600 to 800 pounds per acre and for a giant bamboo should gradually be increased to about 1 ton as more and larger culms are produced.

The sprouting period for most of the hardy bamboos usually is during April and May, though in the gulf region, particularly if the early spring is warm and moist, some species may begin to send up shoots in March. When the spring is cold or dry, sprouting is much retarded or may even be almost suppressed. In many seasons, small shoots may continue to appear at intervals until autumn. All live-stock eat the young tips of the shoots greedily if allowed access to a bamboo grove and should therefore be excluded during the spring sprouting period. A bamboo grove should be protected from fire, as relatively little heat will kill the culms.

## HARVESTING AND PREPARING BAMBOO FOR MARKET

As mentioned earlier, bamboo culms in general and those of the hardy running kinds in particular, whether large or small, differ from other woody plants in that they attain their full diameter when only a few inches high and make their entire growth in height within about 5 to 8 weeks. However, the wood of the culms during the first 2 years is comparatively soft—the fiber cells being at first very thin walled and filled with sap. During the third year the wood completes its hardening, through the thickening of the walls of the microscopic cells, so that by the end of the third season, and not before, the wood has acquired its maximum strength and durability. Therefore, the culms should not be cut before that time for any purpose for which strength and durability are important. Giant bamboo culms usually live 5 to 12 years and sometimes much longer.

It is especially important that American-grown bamboo shipped to commercial users or handlers be uniform in quality. The Department has received complaints from users of bamboo on the lack of strength and durability of some of the bamboo obtained from American sources. This seems definitely to indicate immaturity of the wood. Therefore, bamboo should not be cut until it is 3 years old to avoid reason for this dissatisfaction; otherwise, a prejudice against domestic bamboo may be built up that will be difficult to overcome.

To avoid error or difficulty in judging the time to cut bamboo culms, the grower must know the age of all culms, or at least all under 3 years old, in his grove. This will require that the new culms that grow each spring be marked during the season to show the year in which they came up. They are easily recognized throughout the first season by their fresh bright appearance, but after that it becomes difficult, and, finally, impossible to distinguish the culms of different ages by their appearance.

New bamboo culms can be marked in any of several ways. One way is to rub the thin waxy film from a small area of culm surface with a piece of coarse cloth and then, with India ink and a camel's-hair brush, paint on the figures for that year (for example, 61 or simply 1). A white oil paint, applied with a 1/2-inch brush, instead of the India ink, also has been used with satisfactory results by an experienced grower of bamboo in the gulf region. The ink or paint marks should last at least 3 or 4 years under ordinary conditions. Another way is to stamp the figure lightly into the surface tissue by means of a small steel die and a hammer. This gives a permanent mark; the impression need not be so deep as to do real injury to the culm. If the mark is made at the same level on all culms it can easily

be found. As it can be quickly made, some growers may prefer this method.

In thinning a bamboo grove the aim should be to prevent crowding of the culms and also excessive shade but at the same time to avoid letting in enough sunlight to burn the surface of the culms. In a mature grove of giant bamboo the culms probably are best spaced 4 to 5 feet apart on the average. All culms to be removed should be cut with a saw, horizontally, and very close to the ground.

Precise information on the methods used in the Orient in the curing and other preparation of bamboo culms for the market is not available. However, certain facts are known and from these and reported experiences in this country the following suggestions, which have particular reference to bamboos of the genus *Phyllostachys*, are made.

### Removal of Branches

A convenient method of removing the branches is to cut into the lower side of the pair of branches, close to their base, with a stroke of a hacksaw with about 24 teeth to the inch. Then snap the branches off, either by a slight jerk in the opposite direction or by means of a light tap with the back of the saw frame to the upper side of the branches. The depth of the cut with the saw should be about  $\frac{1}{3}$  the thickness of the thicker branch—not deep enough to scar the culm.

### Straightening or Bending of Culms

*Straightening with heat.*—If a fresh culm, or pole, requires straightening in any part this can be done rather quickly by the suitable application of heat and pressure. Heating may be done (1) over charcoal fire, (2) by means of a carefully applied blowtorch or Bunson burner to a temperature that does not cause scorching, or (3) with steam. The heating with steam for 10 to 15 minutes, if facilities are available and especially if much straightening is to be done, is undoubtedly the best. A bend, whether short or long, must be heated and straightened throughout a large part of the area to give satisfactory results. A special wooden straightening tool is used in the Orient. It is employed in much the same way as the "hickey" is used in bending electrical conduit. While the bamboo culm is still hot, the waxy coating on the surface should be wiped off thoroughly with a coarse cloth before it hardens. This gives the culm a pleasing and uniform yellowish color. After the culm is straightened, and cleaned the cooling can be hastened by applying cold wet cloths; however, this will rarely be necessary.

*Straightening without heat.*—Two other, but slower, methods of straightening bamboo poles also have been used more or less successfully. One is the old and widely known practice with the native

bamboo of suspending the freshly cut curved pole by the tip in the shade and attaching a sufficient weight to the lower end to straighten the curve. The process may require 2 to 4 months—the time required depends largely on the dryness of the situation. The second method consists essentially in laying the green pole on or against a flat surface and reducing any curves by suitably applied continuous pressures during the period necessary for thorough drying and “setting” in the straightened form. This may be done on a floor, a board, or even against the side of a timber. Binding the pole to a line of nails driven at 16-inch intervals into such a surface and also forcing the pole into contact with the surface wherever it may curve from it has given good results. Poles that have dried have been straightened by this method after being thoroughly soaked in water.

### **Drying, or Curing**

Drying, or curing, of bamboo culms should take place in a shaded, dry, well-ventilated place. Thorough drying usually will require several months; the time will be determined largely by the humidity and temperature of the air. The culms should be laid horizontally on a rack, with the supports for the culms at intervals of a few feet to avoid bending. In quantity drying, the culms may be placed with butts and tips alternating and tied in bundles to prevent the development of new curves.

Culm sections of large diameter that are to be used in making split fishing rods will need to cure for a considerably longer period. It may be possible to shorten the time required, however, by splitting the sections into halves.

### **An Oriental Method of Surface Finishing**

In the Orient bamboo culms are made uniform in appearance by scouring by hand with wet sand and exposing them on all sides, in a nearly vertical position, to direct sunlight for a limited period. During the exposure the culms are gradually turned—about one-third of the way at a time—in order to obtain even coloring from the sun. The length of time of exposure required will vary with the intensity of the sunlight; a total of 12 hours or more in each position is sometimes needed. Protection from rain and dew is provided. Where heating for straightening purposes is not being done, this oriental method may sometimes be used.

### **BAMBOO PESTS**

Bamboo in general is singularly free from destructive or highly injurious pests. The organisms that do from time to time attack bam-

boo and cause damage in different ways are of several types: Fungi, which usually affect the new growth, including annual new twigs and leaves; insects and mites that attack the new growth and other insects that bore into stored bamboo and sometimes into articles made from it; nematodes, or minute eelworms, which sometimes infect the roots; and rabbits, which when abundant at sprouting time may destroy many young shoots by gnawing into them and eating part of the succulent interior. A few owners of mature bamboo groves have written of the congregating of great numbers of grackles, cowbirds, or starlings in their groves at night in some seasons, which was disliked by some but not by others. Of the several groups of harmful organisms, only the fungi contain any members considered seriously destructive; of the two known important diseases, one—bamboo smut—has not as yet become established in this country or in the Western Hemisphere so far as known. Bamboo scales assume serious importance only when, because of neglect, infestation of the plants becomes heavy. Some further information concerning the few diseases and insect enemies of bamboo is given in the following.

## Bamboo Diseases

### Bamboo Smut

Bamboo smut (*Ustilago shiraiana* P. Henn.) is a parasitic fungus related to the smuts of corn, wheat, oats, and several other kinds of grasses. It was accidentally introduced in plants of the genus *Phyllostachys* obtained from Japan in 1909. A few months later it was discovered, and the affected plants as far as recognized were all destroyed except two that were grown for a time in one of the pathological greenhouses of the Department for study of the disease. The disease reappeared at two points in the field about 6 years later. All infected plants again were immediately destroyed by spraying with oil and burning, and there has been no further outbreak of bamboo smut in the United States since that time. The smut is not known to occur on bamboos other than those of the genus *Phyllostachys*.

The smut occurs only on new growth of the bamboo—new twigs and leaves. The twigs first appear somewhat swollen, and growth is checked. Later the sootlike spore masses, or fruiting bodies, break through. The effect produced cannot be mistaken for any other disease. No evidence has been obtained here that the disease is spread by the spores, though with other diseases that would be expected. The way the disease showed itself on plants kept under observation in quarantine for several years suggested that the mycelium of the fungus lives perennially in the rhizome of the bamboo, and reports from Japan indicated that this is the case. Eradication is the only



remedy, and it must be complete. It is not enough to cut down the culms and destroy them, but all rhizomes must be dug and burned.

Bamboo plants for many years have not been allowed entry into the United States except under strict quarantine regulations, and it seems unlikely that there will be further trouble from smut.

### Bamboo Rust

More than a dozen species of rust fungi have been reported on bamboos in different parts of the world, but so far only one, *Puccinia phyllostachydis* Kusano (*P. melanocephala* Syd.), is known to be present in this country. Most rusts are destructive and are controlled with difficulty, but *P. phyllostachydis*, which is only known to attack species of the genus *Phyllostachys*, does not often cause serious damage. It is somewhat common on bamboos of this group almost wherever grown in the United States. The disease attacks the new leaves; numerous brown powdery spots appear on the under surface with corresponding yellow discolorations on the upper side. When badly affected the leaves shrivel and dry up. The powdery material on the under surface of the leaves forms the summer spores (uredospores), or reproductive bodies of the fungus. A pathologist of the Department also found the winter spores (teleutospores) on dead fallen leaves. The effect of the rust is to check growth by injury to the leaves, many of which may be shed prematurely.

There is no known treatment for the control of bamboo rust when once established. However, when new plants are propagated, they should be carefully examined before replanting or shipping and any rust-infected leaves removed. A nursery plot for the propagation of *Phyllostachys* plants should be located at a considerable distance from any area of infected plants that may be in the vicinity. Control of bamboo rust by application of fungicides has not been studied, but it is known that *Puccinia* species attacking cereals can be fairly well controlled by dusting with elemental sulfur or spraying with zineb at intervals of a week or less.

Studies on control of cereal rust with eradivative fungicides are in progress and several compounds have been effective, but all are phytotoxic to cereals in some degree.

### Melanconium Culm Disease

A disease that causes the death of medium-sized and large culms of large species of the genus *Phyllostachys* has been observed occasionally for many years at the United States Plant Introduction Station near Savannah, Ga., and at other points in the South. What seems to be the causal organism appears to be identical with the imperfect fungus *Melanconium bambusae* Turc., reported earlier as the cause of a similar disease in Italy. The disease usually, or at

least often, does not reveal its presence or its effects until the new culm has reached nearly its full height. The internodes near the ground turn purplish black or sometimes brown. The discoloration, not sharply defined, begins at the base of the internode and gradually extends around and upward to the next node. The culm eventually dies and the leaves dry up. The immature wood of the culm is found to be permeated with mycelial threads. These constitute the vegetative parts of the fungus. It seems doubtful that this type of fungus attacks healthy plant tissue, and it is thought that affected culms probably have been previously weakened in some way. Invasion of the fungus has been reported where the soft wood of the young culm has been bruised or injured by cuts.

### Insect Pests of Living Bamboo <sup>7</sup>

The principal insects that infest living bamboo in the United States are of the sucking type.<sup>8</sup> They feed by extracting juices from the leaves and stems. The most important ones are scales. They, however, assume serious importance only when, because of neglect, infestation of the plants becomes heavy. Other insects of minor importance are the long-tailed mealybug, aphids, a leaf-rolling caterpillar, and a roundheaded prionid beetle. Also certain mites attack bamboo.

#### Bamboo Scales

##### *Asterolecanium bambusae* (Bdv.)

The bamboo scale *Asterolecanium bambusae* (Bdv.) is the most common and injurious pest of growing bamboo. It was introduced from the Orient and attacks the clump-type *Bambusa vulgaris* and related species, as well as several of the hardy running bamboos. The adult female has an oval, moderately convex body; is slightly less than one-eighth inch long and half as wide. The scale is smooth, glossy, semitransparent, and colorless or tinged with green or yellow. The posterior is drawn out into a small blunt point. The marginal fringe consists of a double series of short, pinkish, glossy filaments which appear in pairs.

The insect is found at many places in California, in the Southern States, particularly in Florida, and is intercepted at quarantine stations. In California, it is of little economic importance.

<sup>7</sup> The sections on insect pests were prepared by R. A. St. George, entomologist, Division of Forest Insect Research, Forest Service, Beltsville Forest Insect Laboratory, Agriculture Research Center, Beltsville, Md.

<sup>8</sup> Some of the distribution and host records concerning sucking insects and mites found on bamboo were taken from a paper prepared by Miss Gertrude Myers, "Insects and Mites Recorded from Bamboo in the United States, with Records of Their Distribution and Food Plants in Foreign Countries." U.S. Dept. Agr. Insect Pest Survey Spec. Sup. 2, 10 pp. Feb. 1947.

**Asterolecanium miliaris robustum** Green

*A. miliaris robustum* Green is closely related to *A. bambusae*. In Florida, it has been found on species of *Bambusa*. The female scale is long and narrow—about one-fifth of an inch long and one-third as wide. It is moderately convex, glossy, and varies from semitransparent and colorless to translucent and tinged with yellow or green. The posterior end is drawn out into a blunt point, and the marginal fringe is short and imperfect. It infests both sides of the leaves.

A closely related scale, *A. miliaris miliaris* (Bdv.), has been found on species of *Bambusa* and on *Dendrocalamus strictus* in Florida, as well as in the Tropics. A species of another genus, *Aclerda arundinariae* McConnell, has been found on *Arundinaria tecta* in South Carolina.

**Antonina crawi** Ckll.

The cottony bamboo scale, *Antonina crawi* Ckll., attacks the new twigs; it makes the bamboo unsightly and sometimes stunts its growth. It infests bamboos of the genus *Phyllostachys*, particularly the black bamboo, *P. nigra*, and the common fishpole bamboo, *P. aurea*, as well as *Pseudosasa japonica*.

The adult females are one-eighth to nearly one-fourth inch in length and are completely covered with a thick, white cottony coat, which makes them very conspicuous. During May and June they collect in rather large masses in the leaf axils, where they deposit their eggs. Shortly after the young crawlers hatch they make their way to the leaves and tender new growth, where they settle down and feed. This scale has been found on bamboos in California, the Southern States, and as far north as New Jersey.

**Kuwanaspis pseudoleucaspis** (Kuw.) (*Leucaspis bambusae* Kuw.)

A Japanese scale, *Kuwanaspis pseudoleucaspis* (Kuw.), is found on bamboo of the genus *Phyllostachys* in the United States. The female is about one-eighth inch long, slender, and is nearly parallel sided. It is convex, rather thick, and usually straight but sometimes curved. Its color varies from white to light gray and its skin has a brownish cast at one end. This scale has been found at Riverton, N.J., and in different parts of Florida.

**Other Scale Insects**

Other scale insects on bamboo in this country are *Chaetococcus bambusae* (Mask.) on *Bambusa arundinacea* and *B. tulda*; *Kuwanaspis howardi* (Cooley) on *Phyllostachys nigra* cv. Henon at San Antonio, Tex.; *Odonaspis penicillata* Green on *Bambusa multiplex* in New Orleans, La., in 1910, and subsequently in Georgia, Alabama, Mississippi, Louisiana, and California; and *O. secretus* (Ckll.) on *Pseudosasa japonica* in Riverton, N.J.

### Control of Scale Insects

Where the control of scale insects is deemed advisable, the most heavily infested canes should be cut and burned and the more lightly infested ones should be sprayed in the spring when the young crawlers are present. A white-oil emulsion diluted to 1 to 2 percent oil and fortified with 1½ pints of 50 percent malathion emulsifiable solution per 100 gallons of spray should be used for spraying. It should be repeated weekly about three times to kill all the crawlers as they hatch.

### Long-Tailed Mealybug

The long-tailed mealybug, *Pseudococcus adonidum* (L.), attacks many plants, including bamboo, and is common on ornamentals. The female adult is oval and about one-eighth inch long. Its body is grayish to light yellow and covered with a fine powdery, waxlike whitish secretion. This species is distinguished by the unusually long filaments, or tassels, about its body. Those around the margin are often equal in length to half the width of the body. The four posterior tassels give the insect the appearance of having a long tail, and the middle pair are often longer than the body. This species is widely distributed in this country and probably was introduced from Australia.

Control of this mealybug is made difficult by its waxy protective covering. Water applied under strong pressure to heavily infested culms will remove some of them. A 5 percent DDT water emulsion, repeated a few days later, will give complete control on bamboo without any noticeable burn, according to Morrill and Otanes (5). In tests by others the water dispersible form of DDT proved to be ineffective. Malathion, applied at the rate of 4 pounds of the 25 percent wettable powder per 100 gallons of water and repeated two or three times at 7- to 10-day intervals, is also effective and safe to handle. Since ants are largely responsible for the dissemination of mealybugs, it is important to control ants. This is done by the use of chlordane in the form of a spray or dust (7).

### Bamboo Aphids

The bamboo aphid, or the adult bamboo plant louse, *Myzocallis arundicolens* Clarke, has been found on *Pseudosasa japonica* and on species of *Sasa* and *Bambusa*. It is about one-tenth inch long and pale yellow, with some light-brown and dusky markings. The young nymphs show little or no markings. The insect attacks the underside of the leaf blades, often in large colonies. It causes considerable damage by weakening the plants. The excess sugar-water excreted by the insect is a favored medium on which a sooty mold develops; this gives the leaves a smutty appearance and makes them unsightly.

This aphid is reported from the central and southern parts of California.

Another species of *Myzocallis*, *M. arundinariae* Essig, has been reported on undetermined species of *Arundinaria* and *Bambusa* in California. The aphid *Anuraphis arundinariae* Tissot has been found on *Arundinaria tecta* at Gainesville, Fla., and another aphid, *Dryopeia morrisoni* Baker, has been found on an undetermined species of *Phyllostachys* in Maryland.

Aphids are controlled by spraying with malathion, as mentioned previously for other sucking insects.

### Leaf-Rolling Caterpillar

The leaf-rolling caterpillar, *Crocidophora pustuliferalis* Lederer, rendered useless as much as 25 percent of the leaves on the culms of *Arundinaria tecta* and of an undetermined species of *Semiarundinaria* at the U.S. Plant Introduction Station near Savannah, Ga. Such injury can be prevented by spraying the foliage with DDT, before the leaves are rolled, at the rate of 2 pounds of the wettable powder per 100 gallons of water.

### Roundheaded Prionid Beetle

The roundheaded prionid beetle larva, or grub, occasionally damages the rhizomes of bamboo of the genus *Phyllostachys*. It first feeds on the exterior surface and then bores into and subsequently mines the rhizomes. Such injury has been observed in bamboo groves located in the vicinity of Savannah, Ga. To control these beetles the infested rhizomes, which are revealed by the wilting young culms, must be dug up and destroyed.

### Common Bamboo Mite<sup>9</sup>

The common bamboo mite, *Schizotetranychus celarius* (Banks), resembles somewhat the red spiders of the genus *Tetranychus* and makes small white webs on bamboo leaves. It chiefly infests bamboos of the genus *Phyllostachys*, but it is also found to some extent on several related genera, including *Pseudosasa*. No serious injury has been noted either in this country or Japan, its native home.

This mite is confined to the leaf sheaths for a period of 8 to 10 months and is not found on the stems near the ground or in rhizomes or other parts of the plant below ground. It migrates in May and June. It is found in Florida and in California.

For control, the sheaths should be sprayed with aramite at the rate of 2 pounds of the 15 percent wettable powder per 100 gallons of water. For control in propagation, the rhizomes of the preceding year's

<sup>9</sup> Mites, although not true insects, are close relatives of them and, therefore, are considered in this discussion.



growth should be lifted in November or December, when the plants are dormant, and those pieces that contain live eyes or buds should be selected. These should be treated by immersing them for 10 minutes in hot water at 122° F. and then either heeled in sand previously sterilized by heating to 167° for 1 hour or in sawdust, where they should be kept cool until planting time in the spring.

### Bamboo Sheath Mite<sup>10</sup>

The bamboo sheath mite, *Steneotarsonemus phyllophorus* (Ewing), causes injury by adhering and feeding on the stalk of the terminal leaf of any of the *Phyllostachys* bamboos. It is flattened, reddish, and minute. It lives by sucking the juices from the tender growing parts. During dry periods or when cultural conditions are poor it aborts the leaves, checks the growth, and kills the terminal buds of the branchlets. Apparently no damage is caused when conditions prevail that promote vigorous growth and when the plants receive proper care. The mite migrates from the latter part of April through June in Florida. It is not widely distributed in this country.

For eradication of this mite in an established planting, it is necessary to cut, gather, and burn all leaf-bearing bamboo, preferably in early spring, before migration of the mite begins.

The mite can be controlled in bamboo propagation by dipping rhizome cuttings or small young plants suspected of infestation in hot water at 122° F. for 5 minutes.

### Insect Pests of Harvested Bamboo<sup>11</sup>

The principal enemies of harvested bamboo are species of bostrychid beetles belonging to the genus *Dinoderus*. In Puerto Rico and to a lesser extent in this country, *D. minutus* (F.) causes the most damage. Others of lesser importance are the lyctus powder-post beetles, *Lyctus* spp., and the roundheaded bamboo borer, *Chlorophorus annularis* (F.).

#### Bamboo Powder-Post Beetles

The bamboo powder-post beetle, *Dinoderus minutus*, attacks most species of bamboo (6). Since *Bambusa vulgaris* contains the most starch of any species tested, it is more attractive to the beetle than are the eleven other tropical bamboos tested. This beetle is only about one-eighth inch long and one-third as wide. It is hard shelled and has a parallel-sided body, which is amber brown to black. It occurs to some extent in Florida and Louisiana, but it is quite abundant in the Caribbean area. It is frequently found in infested bamboo

<sup>10</sup> See footnote 9, p. 61.

<sup>11</sup> See footnote 7, p. 58.

products at ports of entry. Sometimes these products contain live insects and reach the interior of the country. They usually come from the Orient, particularly China, Japan, and India.

The adult beetle usually enters the fresh-cut wood at breaks in the surface or at a culm-sheath scar, by making a circular hole in the surface and tunneling into the culm. The female beetle deposits her white translucent, elongate eggs in the softer, pithy tissue of the culm, the inner three-fourths of which contains starch, the insect's principal food.

According to Plank (6) infestation frequently occurs within 24 hours after the culms are cut if placed in a building for drying and storage. However, if dead, dying, or fresh-cut culms are left upright in clumps in the field with foliage intact for curing, they are rarely attacked. The culms are kept off the ground by inserting a wooden prop in the base, with a nail driven through the prop to prevent it from breaking through the nodal partition above. During the drying period the starch is slowly depleted from the culms, which makes them much less attractive to the beetles.

This beetle appears to have no definite generations in Puerto Rico. Most eggs are laid between May and August. The average life cycle requires 51 days (eggs 3-7, larvae 41, pupae 4). Some beetles begin to oviposit 17 days after emergence and lay as many as 100 eggs in 41 days. The beetles emerge through small circular holes that they make in the surface of the rind.

Application of 5 percent DDT in kerosene, brushed on freshly harvested culms, reduced internodal infestation by *Dinoderus* by 94 percent for 2½ months, without injury to the wood or to personnel.

Application of 5 percent DDT in diesel fuel oil, applied as a 10-minute dip, reduced infestation 98 percent for 3 months, 91 percent for 12 months, and was still toxic at the end of 3 years. Where splitting occurs during seasoning, a second treatment should be made at the end of 2½ to 3 months. Wettable DDT powders can be used where oils adversely affect the gluing of products made from bamboo.

The beetle has few known parasites or predators, and they have little effect upon its populations.

### **Lyctus Powder-Post Beetles**

One group of insects that is found associated with the dried bamboo is that of the lyctus powder-post beetles. Three species are known to attack bamboo. They are *L. planicollis* Lec., *Trogosylon aequale* (Wollaston), and *L. caribeanus* Lesne. The first-mentioned species occurs not only over the entire country but is cosmopolitan; the second one is established in Florida and in the southwestern United States; and the last one occurs in the Caribbean area.

The winged adult beetles of all three species are small (three-sixteenths of an inch in length), slender, somewhat flattened, and reddish brown to nearly black. They seek starch present in the wood and deposit their eggs in the pores. The starch is stored in the softer pithy wood in the inner three-fourths of the cross section of the culm; the outer rind does not contain any starch and is not attacked.

The eggs hatch in about a week, and the larvae begin to mine the starch-containing wood, gradually reducing it to a flourlike, or powdery, consistency. Species, quantity of starch present, favorable temperatures, and high humidity determine the length of the life cycle, which varies from 3 to 9 months. The optimum moisture requirement is from 12 to 15 percent.

Measures taken to reduce the starch content of the wood help to prevent attack by the lyctus beetles, as well as by species of *Dinoderus*, since it seeks wood high in starch content. With low starch content, relatively few eggs are deposited, the larvae develop slowly, and small beetle populations result.

The most effective control is obtained by chemically treating the wood, before it becomes attacked, with a chlorinated hydrocarbon insecticide such as DDT, as mentioned for *Dinoderus*. For treating furniture, it may prove to be more desirable to use a refined kerosene, such as ultrasene or deobase, instead of ordinary kerosene or fuel oil. The refined product is safer to handle—it has a relatively high flash point—, has little odor, and is a much cleaner material to apply to the surface of wood.

Five percent DDT, two percent chlordane, or one-half percent dieldrin or lindane have proven effective in preventing attack, especially when the product is dipped in the solution for 3 minutes. Further information concerning prevention and control of lyctus infestations is given in an article by Johnston, Smith, and St. George (2) and in U.S. Department of Agriculture Leaflet 358 (8).

## UTILIZATION OF BAMBOO

In China, India, Japan, and other Eastern countries the uses of bamboo are probably more diverse than those of any other plant. Many of these uses have developed because of the scarcity of other materials and the economic pressure to utilize abundant and inexpensive bamboo resources. Inasmuch as modern materials and manufacturing techniques have made available many products that could otherwise be made from bamboo it is likely that this crop will be used to a much lesser extent in this country than in other countries. However, the eminent suitability of bamboo for certain purposes has been demonstrated by its utilization in other countries. The following is limited to a discussion of practical uses of bamboo in this country and the research on utilization of bamboo in industry.

## Farm and Home Uses

The traditional use with which bamboo is usually associated in this country is that of fishing poles. A large part of the bamboo now used for this and other purposes is imported. However, this does not preclude the entry into trade of domestically produced poles from fully matured culms that are properly cured.

One of the most largely used bamboos for fishing poles in the import trade has been *Phyllostachys aurea* ("fishpole bamboo"). This species is suitable for production in this country and, in addition, *P. bambusoides*, its cultivar Slender Crookstem, and *P. meyeri*, when of suitable size, may be grown for this purpose. *P. aureosulcata*, *P. congesta*, *P. flexuosa*, *P. nigra* cv. Henon, *P. nuda*, and other species of *Phyllostachys*, although having less strength than the former group, can also be used for fishing poles.

Bamboo poles are used for rug poles and can also serve many useful purposes on the farm, such as in nut harvesting and for fruit-tree props, clothesline props, and lightweight fences. Due to its light weight, strength, and durability, bamboo is well adapted for use as plant stakes and trellises for crops such as beans and tomatoes. If support is desired for plants that will not cling readily to a smooth pole, short branches may be left on the culms or pruned so that projections of desired length remain on the stake.

Bamboo may be used for building various types of shade houses for plants or animals. Culms may be used entire or split for this purpose. It is desirable to alternate the pieces with respect to taper so that an area of uniform dimensions will be produced. As nails and screws cause excessive splitting in most bamboos of the Orient, it usually will be necessary to drill holes if this type of fastening is used. A more rapid method is to use galvanized wire for fastening the culms to their support.

Research was conducted by the Engineering Experiment Station at Clemson, S.C., on the use of bamboo as reinforcement in concrete (1). Several conclusions presented in the report of this study were as follows:

The load capacity of bamboo reinforced concrete beams increased with increasing percentages of the bamboo reinforcement up to an optimum value.

This optimum value occurs when the cross-sectional area of the longitudinal bamboo was from 3 to 4 percent of the cross-sectional area of the concrete in the member.

The load required to cause the failure of concrete beams reinforced with bamboo was from four to five times greater than that required for concrete members having equal dimensions and with no reinforcement.

Concrete beams with longitudinal bamboo reinforcement may be designed to carry safely loads from two to three times greater than that expected from concrete members having the same dimensions and no reinforcement.

The findings of the Clemson research also indicate that it is important to use mature, well-seasoned culms for reinforcement of concrete.

The foliage and young shoots of certain bamboo species serve as forage for livestock. In the United States in regions where the native switchcane (*Arundinaria tecta*) occurs naturally it has been shown to have excellent grazing value. From studies conducted by agencies of the U.S. Forest Service and North Carolina State College it was concluded that under conditions of very favorable growth (specifically in a test area in Washington County, N.C.) switchcane ranks among the highest yielding native ranges in the United States. Stock producers in localities still containing sizable areas of switchcane may therefore well consider using this for forage.

Bamboo may be used for soil-erosion control and road and stream-bank stabilization. Although few erosion-control studies have been made with the temperate bamboo species in the United States, tropical bamboos have been investigated in Puerto Rico and found to be well suited for this purpose. It is possible that certain well-adapted bamboo species of the temperate zone will find similar use in continental United States.

Bamboos have been suggested for use in the construction of strong, easily constructed windbreaks and snow fences.

### Ornamental Uses

Living bamboos, because of their diversity in habits of growth, appearance, and stature, are adapted to many ornamental uses. The variation in size among species makes possible a range of usage from ground cover and low-growing shrubs to tall plantings offering some features of shade trees combined with the density of shrubs.

The selection and description of bamboos for ornamental purposes have been presented in detailed form in a series of papers (10). Figure 12 shows several (*Arundinaria graminea*, *A. chrysantha*, *A. pumila*, and *Shibataea kumasaca*) low-growing ornamental species of the running type. Other low-growing ones are: *Arundinaria angustifolia*, *A. humilis*, *A. variegata*, *A. viridi-striata*, *Sasa disticha*, *S. palmata*, *S. tessellata*, and *S. veitchii*. Figure 13 shows three medium-height species. Other medium-height species are *Phyllostachys nigra*, with black culms, *P. bambusoides* cv. Allgold, and *P. bambusoides* cv. Castillon. *P. viridis* cv. Robert Young is of use as a tall ornamental. These are attractive because of unusual coloration of the culms. Two other running bamboos, with plain-green culms, that ultimately may exceed 50 feet in height and that have exceptionally graceful foliage are *P. nigra* cv. Henon and *P. pubescens*. *P. pubescens*, which is the



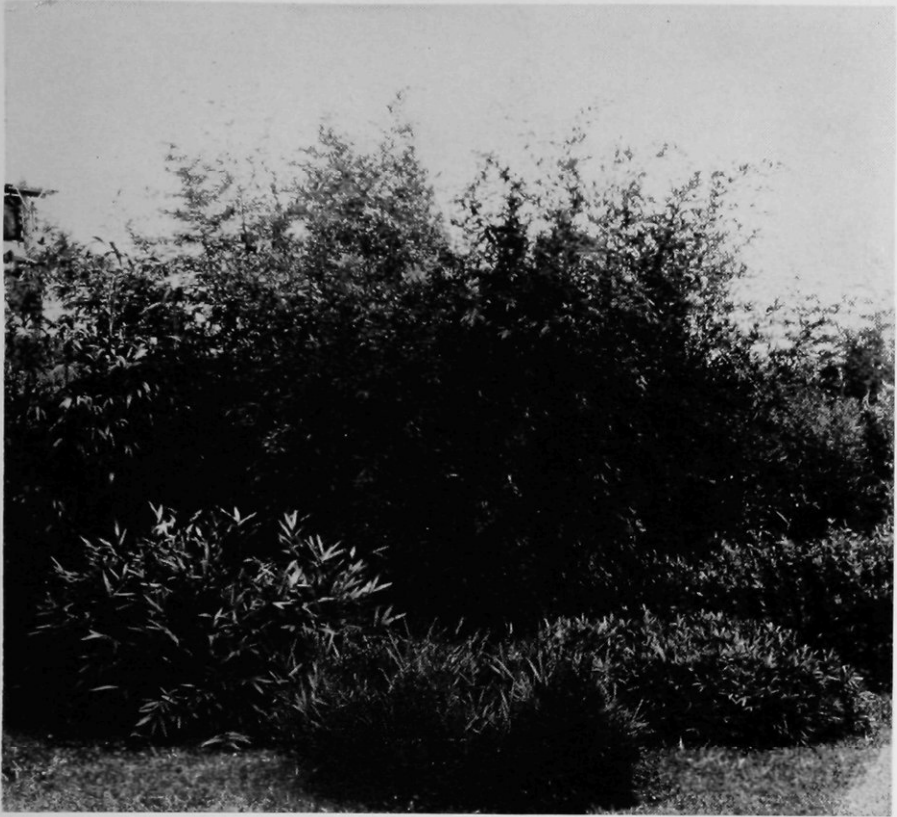


FIGURE 12.—A group of several hardy running bamboos grown in clumps with roots confined, near Washington, D.C. In foreground: *Arundinaria graminea*. Center: *A. chrysantha* (left) and *A. pumila* (right). Background: *Pseudosasa japonica* (left), *Phyllostachys nigra* cv. Henon (center tall clump), and *Shibataea kumasaca* (right).

largest of the hardy bamboos, is one of the smallest leaved species of *Phyllostachys*. All these running bamboos can be kept at lower levels of growth by cutting tops back completely in the early spring every 2 or 3 years. This treatment will result in forcing more new culms, but they will be of much smaller size.

An interesting type of hedge may be made with bamboo. The clump bamboo species, where climatically adapted, are better suited for hedges than the running forms since they spread very slowly. *Bambusa multiplex* and its varieties are frequently planted as hedges along the gulf and southern Atlantic coasts and in California where minimal winter temperatures remain above 17° F. (fig. 14). Where winter temperatures fall below 17° F. and do not go below 5°, the running species should be used. Several desirable running species for this use are *Phyllostachys meyeri* (fig. 15), *P. nigra*, *P. purpurata*, and *Semiarundinaria fastuosa*. Following are some useful details on establishing a bamboo hedge from running species.

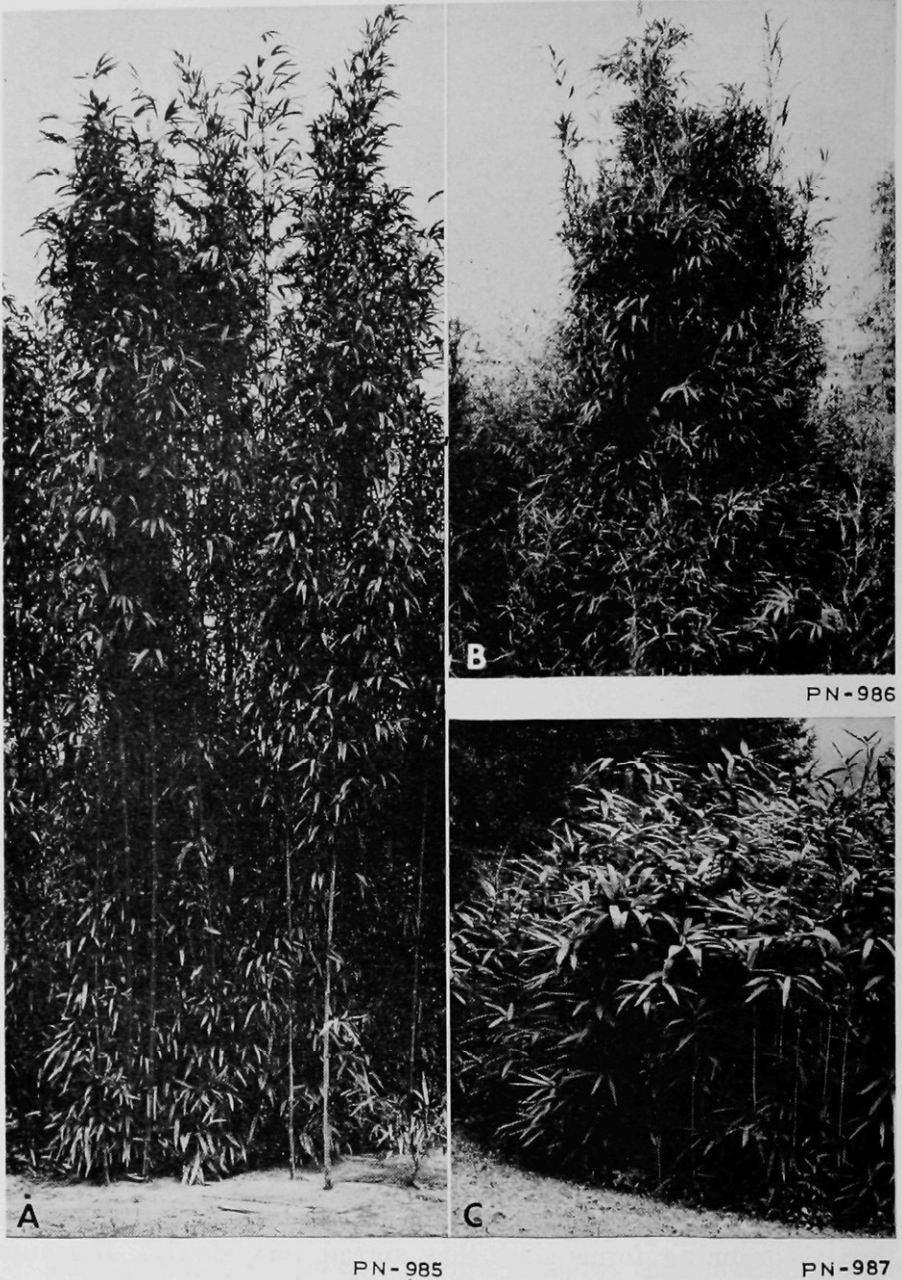


FIGURE 13.—Three medium-height bamboo species: A, *Semiarundinaria fastuosa*; B, *Arundinaria simonii*; and C, *Pseudosasa japonica*.

If rhizome cuttings are to be used they may be planted in either of two positions:

1. Cuttings placed vertically 6 to 8 inches apart in two or three rows in a trench about 18 inches wide. (Rhizomes planted in this manner usually give a quick growth of culms and a delayed growth of rhizomes.)



FIGURE 14.—Clipped hedge (3 feet high) of *Bambusa multiplex* cv. Fernleaf, in central Florida.



FIGURE 15.—Hedge of a running bamboo, *Phyllostachys meyeri*.

2. Cuttings laid horizontally in rows paralleling the sides of the trench. (Rhizomes planted this way tend to produce a large proportion of new rhizomes whose direction of growth is along the axis of the hedge.)

One- or two-year-old plants of running or clump bamboo species may be used for the establishment of a hedge within the limitations of climatic conditions given on page 67.

When the hedge is established the tops should not be pruned before the new culms have reached nearly their full height. The kind and amount of attention will depend upon the species used.

Since the running bamboos spread laterally by means of underground rhizomes, it is particularly important to provide relatively large areas for their growth or barriers to restrict their spread. If

the planting is to be immediately adjacent to extensive lawn areas, it is relatively easy to remove the unwanted shoots when they appear in the spring as the shoots are still soft and easily cut or broken off. As the planting increases in age sprouts will appear in greater number and at greater distances from the original plants. The distance of rhizome spread beyond the maintained borders of a planting may be only a few feet for low-growing or intermediate-sized species and as much as 25 to 50 feet for larger species.

Artificial barriers such as sheet metal or concrete may be provided to restrict the spread of ornamental species. Figure 12 shows several species grown in circular galvanized sheet metal barriers (without bottoms) 5 feet in diameter sunk 26 inches in the ground. In light soils the rhizomes of some bamboos may grow under such a barrier and come up on the outside. Thus, it may be desirable to extend the barrier considerably deeper—the depth depending upon soil type and species grown. More durable, though more expensive, barriers may be made from concrete or asbestos board. The points of connection in sheet metal or asbestos board should be folded or bolted together tightly so that rhizomes will not grow through the opening.

## Food

The young sprouts, or shoots, of the hardy Chinese and Japanese bamboos of the genus *Phyllostachys* are practically all edible. The sprouts of all are produced in the spring; those of one or two species appear in March but most in April or May. The season is usually 3 to 4 weeks. The sprouts are crisp in texture and are usually without pronounced flavor, though the species vary somewhat in both texture and flavor. Some, such as those of the Moso bamboo (*P. pubescens*) and the Henon bamboo (*P. nigra* cv. Henon), are somewhat bitter or acid, but when this flavor is objectionable it may be removed by boiling in two waters. In the shoots of many of the tropical and subtropical edible bamboos (of the genus *Bambusa* and others) the bitterness is much more pronounced than in those of the hardy running type. When growing some of the tropical or subtropical bamboos for food the bases of the clumps must be mounded up annually with soil to exclude sunlight as nearly as possible from the young shoots until they are dug. This is reported to be universal practice in southeastern China in the commercial production of shoots of the Beechey bamboo (*Bambusa beecheyana* Munro), one of the important edible bamboos of that region.

A typical sprout of *Phyllostachys* or other running bamboo properly dug will have a small rooted, woody basal portion, increasing



sharply in diameter upward for a short distance from the slender part attached to the underground rhizome. Shoots should be dug when the tips are just emerging from the surface of the soil or very soon thereafter, since tissues at the base become increasingly woody as the shoots elongate after emergence. Digging should be done with care to prevent bruising. The base of the shoot should be exposed and severed with a sharp narrow spade or other appropriate tool at the slender woody base where it is joined to the rhizome.

To prepare the shoots for cooking, the sheath covering is first cut through lengthwise with a sharp paring knife. Usually all sheaths are removed, but the tender ones at the tip may be left on if desired. If there is a grayish layer (due to age) next to the lower nodes (joints), this must be pared off. The tough basal part of a sprout must be discarded; above this, where still not too fibrous, the sprout should be cut across the grain and not thicker than an eighth of an inch. The more tender middle and upper parts may be sliced thicker or may be cut into various shapes according to the recipe in which the material is to be used (fig. 16).



FIGURE 16.—Sprouts of an edible bamboo (*Phyllostachys bambusoides*) in different stages of preparation. At right is shown a sprout in its natural state, with enveloping sheaths. To the left of it at the back is a sprout with all sheaths removed. Next to this is a piece of another sprout split lengthwise to show the inside structure. At the right front is lower part of a sprout sliced thinly. At left are the middle and upper parts of sprouts cut into various shapes.



Bamboo sprouts as thus prepared are used with excellent results as an ingredient in many ordinary dishes consisting of various vegetables with or without meat. They also may be served alone, drained, with butter melted over them, after boiling for about 20 minutes; salt is added near the end of boiling period. If the fresh sprouts are unpleasantly bitter to the taste, there should be a change of water after the first 10 minutes of cooking. Also the tenderest parts of non-acrid shoots can be used raw in mixed salads.

At present canned bamboo shoots used in the commercial food-distributing industries are almost entirely imported. However, shoots have been sold from several domestic bamboo groves, and occasional reports are received that much larger quantities of shoots could have been sold if the supply had been larger.

## **Furniture, Interior Decoration, and Other Manufactured Items**

Furniture and various types of shades and screens made from bamboo are used in the United States in considerable quantities. Most of these items are imported and for those manufactured in this country much of the raw material is imported. In Florida, however, vases of various types and other articles are now manufactured from locally grown bamboo, including *Bambusa vulgaris*. It is possible that if a sufficient quantity of domestic bamboo were available it would find a market in this industry. Other items that may be manufactured from bamboo are: Archery bows (laminated), handles for tools and sports articles, masts for sailboats and radio antennae, picture frames and other novelties, wood-wind musical instruments—e.g., the shepherd's pipe—ski poles and vaulting poles, and split fishing rods.

Bamboo culm sheaths of medium to large size of several species of *Phyllostachys* have numerous important everyday uses in the Orient, such as wrappings for portions of fresh or cooked meat and other foods and the making of workers' hats and clogs or sandals. None of these are likely to be adopted in this country, but there is another use—the making of a tool called the baren (pronounced bah'ren), used by wood-cut artists in the Orient and also here. This use came to attention during the early 1940's, when wood-cut artists in the United States were unable to obtain the needed material from Japan or China and inquired of the Department as to possible sources of American-grown culm sheaths. Sheaths of *Phyllostachys bambusoides* and one or two closely related species were found to be adapted for the making of barens.

## Paper Pulp

Paper has been made from bamboo for hundreds of years in China. Other countries are currently manufacturing paper from bamboo on a commercial scale. For example, in 1956 it was reported (3) that the annual production of bamboo pulp in India for papermaking amounts to about 250,000 tons (air-dry). As early as 1910 it was reported that a large Japanese papermill, after much experimentation, was establishing a pulp mill in Formosa; and in 1926, bamboo wrapping paper was being produced in French Indo-China.

With the increasing per capita consumption of paper and the increasing population of the United States it is estimated that a shortage of raw materials for paper may develop in 20 to 25 years. Thirty million tons of paper and paper products are consumed annually in the United States. Much of certain paper products currently used is imported. For example, in 1955, 6.5 million tons of newsprint were consumed in the United States, and of this 5.2 million tons were imported.

Indications are that pulp production per acre per year from bamboo will exceed that from either pine or hardwoods by several times. To determine the feasibility of growing bamboo on a commercial scale the New Crops Research Branch of the Department of Agriculture has initiated several large-scale experiments. These experiments are designed to determine the most desirable species, cultural requirements, and harvesting methods. It will be several years before the bamboos in these plantings will reach sufficient size to begin harvesting.

The Department does not recommend that large-scale bamboo growing be undertaken at this time in the expectation of making a profit. There is as yet no large market for the product and no experience on which to base estimates of production costs or of future selling prices. The Department recommends that at present the growing of bamboos by individuals be undertaken only by persons who expect to use the product themselves or to supply a known demand. It also recommends that plantings be made on a small experimental scale in order to gain firsthand acquaintance with the characteristics and habits of this plant. Plantings should not be made in poor soils or in swampy locations. Growth will be slow at best and maximum culm development will never be achieved in such soils.

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