Volume 1 Number 1

JOURNAL

OF THE

AMERICAN BAMBOO SOCIETY

ISSN 0197-3789

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FIRST PRINTING, MAR. 1980
SECOND PRINTING, NOV. 1980

STATEMENT OF ORGANIZATION AND PURPOSE

The American Bamboo Society was formed on Oct. 20, 1979, in Encinitas, California, to fill a vacuum in bamboo culture and research that has existed since the U.S.D.A. stopped large scale bamboo research in 1965.

The Bambusaceae is an unusually difficult plant group to study since, typically, the plants flower only after long periods of time and are difficult to tell apart in their vegetive state. The necessity of an organization devoted to maintaining good records of as many species as possible as well as maintaining a living collection of plants of documented origin becomes obvious.

Following the examples of the Lingnan University Garden in Canton and the Fuji Bamboo Garden in Japan, it is hoped that this organization can establish a garden of several hundred bamboo species and open up research in areas that have been, so far, neglected.

The primary objectives of the organization are as follows:

1. To provide a source of information on the identification, propagation, and utilization of bamboos. To disseminate and store this information, we intend to establish a journal, a library of references, and a herbarium.

2. To promote the utilization of a group of desirable species by development of stocks of plants for distribution to botanic gardens and eventual introduction to the general public.

3. To preserve and increase the number of bamboo species in the United States. To implement this, we propose to establish a bamboo quarantine greenhouse in the San Diego area to import selected species from foreign sources.

4. To plant and maintain a bamboo garden to display the characteristic beauty of mature plants and to provide a means for research in the propagation and culture of as large a number of species as possible.

Kenneth Brennecke: A SURVEY OF U.S.D.A. BAMBOO INTRODUCTIONS

Since 1898, the U.S.D.A. has been engaged in introducing new plant material from around the world to strengthen and establish crops of economic value in this country. Hundreds of introductions and re-introductions of bamboo were made based on the belief that this group of plants had a future here as a cash crop.

Although some species found their way to the general public, the plantations never materialized and the bulk of the introductions were left tended in experiment stations and arboretums until they met some fatal event. The list of material is truly impressive and the fate of these plants obscure. There is the possibility that a great number of these plants are alive and thriving somewhere in the United States. Also, since the list of unidentified species is so large, there may be species unknown to science growing and accessible.

The bamboo officially introduced by the U.S.D.A. from 1898 to 1975 follows (the 1970 record was not seen and therefore not included.) Attempts were made to clear up the more obvious nomenclatural problems. Plant identification numbers are included.

ARTHROSTYLIDIUM Ruprecht

capillifolium Griseb. 47123
longifolium (Fourn.) E. G. Camus 158803, 240702

ARUNDINARIA Michaux

agustifolia (Mitf.) H. de L. 129301
alpina Schum. 64555, 213455, 225735, 271521, 279487, 279488, 316511
anceps Mitf. 89699, 110334, 123426, 159288, 164129, 189231, 217431, 231049, 246398, 330922
amabilis McClure 110509, 134091, 161733, 161734, 198169
angulata (Munro) Porterfield 77012, 77254, 93225
basigibbosa McClure 139884
brevipaniculata Hand.-Mzt. 69384

ARUNDINARIA Michaux (cont.)

fortuni (Van Houtte) A. & C. Rivière 52672
gauntletti Hort. 92509
gigantea (Walt.) Chapm. 153802
graminea (Bean) Makino 42649, 159290, 164131, 189234
hindsii Munro 9057, 38914, 81725
hindsii Munro var. *graminea* Mitf. 9058, 75147, 89700
macrosperma Michx. 75148
nagashima (Marl.) Aschers. and Graebn. 75149
nepalensis Hort. 89703
pumila (Mitf.) E. G. Camus 41924, 52673, 75166
racemosa Munro 114414, 129303
schomburgii Bennett 182768
simonii (Carr.) A. & C. Rivière 3223, 7823, 9050, 11641, 42650, 75151, 142429, 148026, 153808, 153809
simonii (Carr.) A. & C. Rivière cv. *variegata* Hooker 38921, 75152
spathiflora Trin. 89706
tecta (Walt.) Muhl. 146301, 153803 - 153806
tecta (Walt.) Muhl. var. *decidua* Beadle 153807
vagans Gamble 159293, 164134, 189237, 231053
varabilis Makino 77253
viridi-striata (Regel) Makino 52670, 75161, 263985, 268116

BAMBUSA Retzius corr. Schreber

arundinacea Retzius 21317, 21837, 22487, 27490, 28369, 31643, 31761, 74486
aurea-striata Regel 38918, 42672
balcooa Roxb. 51361
bashirsuta McClure 128747
beecheyana Munro 114349, 128758, 128759, 143688 - 143693
boniopsis McClure 128754
dissimulator McClure 128748, 128750, 139890, 139892
dolichoclada Hayata 128732
eutuldoides McClure 128696, 139888
eutuldoides McClure var. *basistriata* McClure 128690
fecunda McClure 128730
flexuosa Munro 128692, 128737, 128752
gibba McClure 128718

BAMBUSA Retzius corr. Schreber (cont.)

glaucescens (Willd.) Sieb. ex Holtt. 42658, 73958, 100227, 101503, 124675, 124734, 128695, 128702, 128708, 128722, 128734, 128738, 128739, 128741, 128760, 404051
glaucescens (Willd.) Sieb. ex Holtt. cv. *alphonse karr* Young 9056, 42670, 73959, 124734
glaucescens (Willd.) Sieb. ex Holtt. cv. *fernleaf* Young 99289, 101502
jubbulporensis Hort. 67505
lapidea McClure 128685, 128701, 128705, 128726,

lapidea McClure 128685, 128701, 128705, 128726
longispiculata (Gamb. & Brand.) Bois. & Grignan. 40936, 81495, 89029, 94209, 117530, 178809
macroculmis A. & C. Rivière 62651, 79548, 93771
muriaki Hort. 68349
mutabilis McClure 128751
oliveriana Gamble 129598, 145884, 150187 - 150191
pervariabilis McClure 128700, 128723, 128724, 128744, 128762, 128766, 128767, 139893
polymorpha Munro 61373, 67506, 131469
rutila McClure 128714
senanensis Franch. & Sav. 23746, 24350, 42673
sinospinosa McClure 128684, 128736
spinosa Roxb. 128710
striata Lodd. 12757
textilis McClure 128698, 128704, 128715, 128721, 128761
textilis McClure var. *albo-striata* McClure 128691, 128742
textilis McClure var. *fusca* McClure 128746, 139889
textilis McClure var. *glabra* McClure 128725
textilis McClure var. *gracilis* McClure 128716, 128740, 128763, 128764
textilis McClure var. *maculata* McClure 128703, 128765
tulda Roxb. 19269, 21002, 44240, 48229, 54449, 67507, 74413, 128707, 221127
tuldoides Munro 110510, 128713, 128719, 128720, 128745
ventricosa McClure 128706, 132871

BAMBUSA Retzius corr. Schreber (cont.)

vittato-argentea Hort. 42671
vulgaris Schrad. 9055, 21349, 42668, 73635, 93573, 128712
vulgaris Schrad. cv. *vittata* A. & C. Rivière 70740, 142358

CEPHALOSTACHYUM Munro

burmanicum Parker & Parkinson 117531
capitatum Munro 55676
pergracile Munro 21943, 40887, 64808

CHIMONOBAMBUSA Makino

falcata (Nees) Nakai 45902, 110335, 116089, 123427, 159289,164130, 189232, 217432, 231050
marmorea (Mitf.) Makino 24654, 24655, 89710, 123429, 246399
quadrangularis (Fenzi) Makino 9049, 24657, 112744, 281753, 281754

CHUSQUEA Kunth

cumingii Nees 94772
quila (Poir.) Kunth 3355, 3740, 23867, 23868, 23869, 26310, 26311, 42388, 43269, 201454, 201455
quila (Poir.) Kunth cv. *bambusaeoides* (Raddi) Hackl. 23425
quila (Poir.) Kunth cv. *longiramea* Parodi 199745
quleou E. Desv. 242395, 337169
simpliciflora Munro 151065
valdiviensis E. Desv. 23864, 23865

DENDROCALAMUS Nees

asper (Schultes) Backer 133622, 139270, 139271
brandisii Munro 54429
giganteus Munro 45963, 51026, 140034, 210158, 220852, 326049
hamiltonii Nees & Arn. 38736, 39178, 40888, 43287, 48266, 53909, 64809, 74487, 226491
latiflorus Munro 76496, 128687, 128694, 128717, 128749, 199308, 258357

DENDROCALAMUS Nees (cont.)

longispathus Kurz 54045, 54311
membranaceus Munro 64810, 74229, 74488, 391435
merrillianus Elm. 124969, 135026
sikkimensis Gamble 54450, 55814, 56068, 56457
strictus (Roxb.) Nees 21548, 22819, 23476, 28607, 37223, 40889, 53610, 56532, 67508, 77061, 124504, 152569, 157523, 240894, 254923, 261440

DENDROCHLOA Parkinson

distans Parkinson 117532

DINOCHLOA Buse

scandens (Blume) O. Kuntze 124970

ELYTROSTACHYS McClure

typica McClure 146256

GIGANTOCHLOA Kurz ex Munro

aspera Hort. 71258, 99572
levis (Blanco) Merr. 128711
verticillata (Willd.) Munro 79568, 99573

GUADUA Kunth

agustifolia Kunth 37009, 42066, 132895, 152364, 209575, 247958
amplexifolia Presl. 132894
tagoara Kunth 247142

INDOCALAMUS Nakai

herklotsii McClure 128683, 139895
nanunicus (Hance) Nakai 128815, 139894
sinicus McClure 139896

LINGNANIA McClure

chungii McClure 139898
fimbriligulata McClure 128729, 128753

MELOCANNA Trinius

baccifera (Roxb.) Kurz 21347, 28781, 54430, 151344, 164567, 220149
humilis Kurz 73222

OCHLANDRA Thwaites

travancorica Benth. 190905, 198012

OXYTENANTHERA Munro

abyssinica (Rich.) Munro 42835, 278172, 279656, 368254
aliena McClure 139899

PHYLLOSTACHYS Siebold & Zuccarini

angusta McClure 23237
arcana McClure 77007
aurea A. & C. Rivière 3222, 7817, 9052, 29534, 38919, 42667, 55975, 70744, 75153, 159775
aureosulcata McClure 55713
bambusoides Sieb. & Zucc. 8428, 9044, 9046, 12180, 24760, 40842, 42664, 75154, 77003, 77255, 118926, 128775, 128787, 147718, 153736, 241488
bambusoides Sieb. & Zucc. cv. *allgold* McClure 38912, 39718, 89701
bambusoides Sieb. & Zucc. cv. *castillon* Marliac 9041, 42659, 75155, 128794, 149627
bambusoides Sieb. & Zucc. cv. *marliacea* H. de L. 9048, 38920, 42665, 77256, 89714
bambusoides Sieb. & Zucc. cv. *slender crookstem* McClure 146420
bambusoides Sieb. & Zucc. cv. *white crookstem* McClure 66785
bissetii McClure 143540
congesta Rendle 80149
decora McClure 128789
dulcis McClure 73452, 221247
elegans McClure 110511, 128778
flexuosa A. & C. Rivière 52686, 75156, 89715, 116965
glauca McClure 77011
makinoi Hayata 195284, 237990
meyeri McClure 116768

PHYLLOSTACHYS Siebold & Zuccarini (cont.)

nana Rendle 3228
nevinii Hance 76321
nidularia Munro 63696, 63697, 63757, 66786, 67399, 77005, 128769, 128772, 128779, 128812
nidularia Munro cv. *smoothsheath* McClure 128776
nigra (Lodd.) Munro 3407, 7822, 9042, 12179, 23240, 37555, 38913, 42663, 49222, 49505, 66784, 73960, 75159, 77259, 124928, 224206
nigra (Lodd.) Munro cv. *bory* (Mitf.) Makino 77258, 217928
nigra (Lodd.) Munro cv. *henon* Mitf. 9047, 12177, 24761, 42660, 66787, 75158, 82153, 92511, 93223
nigra (Lodd.) Munro cv. *madaradake* ? 9043
nigra (Lodd.) Munro f. *punctata* Nakai 89717
nuda McClure 103938, 215494
propinqua McClure 76649
pubescens Houz. de Leh. 3408, 7820, 8427, 9045, 12178, 24759, 42661, 47370, 51476 - 51478, 70878, 80034, 391434
pubescens Houz. de Leh. cv. *heterocycla* (Carr.) Houz. de Leh. 42662, 93224, 271429
purpurata McClure 128771
purpurata McClure cv. *solidstem* McClure 77006, 128791, 128800, 128805
purpurata McClure cv. *straightstem* McClure 77001, 116711, 128792, 128797
rubromarginata McClure 66902, 67398, 77000
violascens A. & C. Rivière 7824, 89719, 260422
viridi-glaucescens A. & C. Rivière 75160, 123432
viridis (Young) McClure 49357, 77257
viridis (Young) McClure cv. *houzeau* McClure 233849
viridis (Young) McClure cv. *robert young* McClure 89718
vivax McClure 82047, 372884

PSEUDOSASA Makino ex Nakai

japonica (Sieb. & Zucc.) Makino 7819, 42651,

PSEUDOSTACHYUM Munro

polymorphum Munro 226492

SASA Makino & Shibata

albo-marginata (Miquel.) Makino & Shibata 24656, 153737
amphitricha Koidz. 227488
argenteo-striata (Regel) E. G. Camus 42669, 73961
aureo-striata (Regel) E. G. Camus 7818, 73962
chrysantha (Mitf.) E. G. Camus 75162
disticha (Mitf.) E. G. Camus 7821, 75163, 89708, 101174, 110338, 123848
humilis (Mitf.) E. G. Camus 75164, 77260
ishizuchiana Makino 228039
kurilensis (Rupr.) Makino & Shibata 186514, 227543, 259466
pygmaea (Miquel.) Kurz 42653, 52674
tessellata (Munro) Makino & Shibata 38915, 75167, 77333
variegata (Sieb.) E. G. Camus 75168, 92508
veitchii (Carr.) Rehder 9053, 75169, 75170, 89705, 92510, 101076, 112670, 196436

SCHIZOSTACHYUM Nees

dumetorum (Hance) Munro 128728, 139903
funghomii McClure 110512, 128686, 139883, 158768
lima (Blanco) Merr. 128709
lumampao (Blanco) Merr. 74507, 124971, 135027
pseudolima McClure 128731

SEMIARUNDINARIA Makino

fastuosa (Marl.) Makino 42652, 52671, 73957, 75146, 112080
venusta McClure 139905

SHIBATAEA Makino

kumasasa (Zoll.) Makino 9051, 42666, 75157, 89716, 101175

SINARUNDINARIA Nakai

nitida Mitf. 75150, 89704, 110336, 129302, 159292, 164133, 189236, 217435, 231052, 237528, 244004, 246401, 261213, 265286

SINOBAMBUSA Makino

humilis McClure 128674, 139907
intermedia McClure 139908
laeta McClure 139909
rubroligula McClure 139911
tootsik (Makino) Makino 128673, 128677, 129304, 139910

THAMNOCALAMUS Munro

falconeri Hook. 92507, 114413, 123428, 126852, 189233, 217433
spathaceus (Franchet) Soderstrom 89702, 123430, 159291, 164132, 189235, 217434, 231051, 237527, 244003, 246400, 260373, 274268
spathiflorus (Trin.) Munro 110337, 114415, 123431

THYRSOSTACHYS Gamble

siamensis Gamble 67509

UNIDENTIFIED

A - Arundinaria
AR - Arthrostylidium
B - Bambusa
C - Cephalostachyum
CH - Chusquea
D - Dendrocalamus
DI - Dinochloa
I - Indosasa
IC - Indocalamus
P - Phyllostachys
S - Schizostachyum
SA - Sasa
SB - Sinobambusa
SE - Semiarundinaria
SI - Sinocalamus
SN - Sinarundinaria
T - Thamnocalamus

2903-2908, 5345, 5346, 9054, 9807, 14447, 20842, 21241, 21298, 22579, 23233-23236, 23238, 23239, 23241-23262, 29169, 29451-29453, 34408 (*CH*), 36131, 37129, 37556, 37679 (*P*), 38909-38911, 38916, 38917, 38922, 39154, 40851, 46205 (*P*), 49175 (*S*), 50648 (*S*), 54457 (*D*), 55582 (*P*), 55583 (*P*), 63691-63695, 63698, 63699, 63976, 64054-64056 (*B*), 66086, 66781, 66782 (*P*), 66783 (*P*), 66788, 66789, 66900 (*P*), 66901 (*P*), 70741 (*P*), 70877 (*P*), 73389 (*P*), 73453 (*P*), 74216 (*B*), 76471 (*D*), 76648 (*A*), 76698 (*B*), 77002, 77004 (*A*), 77008 (*A*), 77009 (*P*), 77010 (*A*), 77013 (*B*), 77014, 80872-80875 (*B*), 89707 (*A*), 89709, 89711-89713 (*B*), 101095 (*A*), 101173 (*T*),

UNIDENTIFIED (cont.)

110513, 116712 (*A*), 123847 (*A*), 123849 (*A*), 126493 (*C*), 128671 (*A*), 128672 (*A*), 128675 (*A*), 128676 (*A*), 128678 (*I*), 128679 (*A*), 128680 (*A*), 128688 (*SI*), 128689 (*SI*), 128693 (*SI*), 128697 (*SI*), 128699 (*SI*), 128727 (*SI*), 128733 (*B*), 128735 (*B*), 128743 (*B*), 128755 (*B*), 128760 (*SI*), 128757 (*B*), 128768 (*P*), 128770 (*P*), 128773 (*P*), 128774 (*P*), 128777 (*P*), 128780-128786 (*P*), 128788 (*P*), 128790 (*P*), 128791 (*P*), 128793 (*P*), 128795 (*P*), 128796 (*P*), 128798 (*P*), 128799 (*P*), 128801-128804 (*P*), 128806-128810 (*P*), 128811 (*A*), 128813 (*P*), 128814 (*A*), 128816 (*SI*), 133256 (*S*), 135028 (*S*), 135471 (*S*), 139269, 139870-139882 (*A*), 139885-139887 (*A*), 139891 (*B*), 139897 (*IC*), 139900-139902 (*P*), 139904 (*SA*), 139906 (*SE*), 139912 (*SB*), 139913 (*SB*), 143541 (*SN*), 146721 (*AR*), 153735 (*P*), 182767 (*A*), 210339 (*B*), 210340 (*SA*), 213561 (*DI*), 226297 (*SA*), 240615 (*A*), 241895 (*A*), 266713 (*A*), 302783 (*AR*)

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McClure, F. A. 1957. Bamboos of the Genus Phyllostachys Under Cultivation in the United States. United States Department of Agriculture, Handbook No. 114.

United States Department of Agriculture. Plant Inventory, Vol. 1-177, 1898-1969 and Vol. 179-184, 1971-1975.

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The expense and quarantine time necessary to import bamboo encourages the A.B.S. to seek the help of its friends and members in acquiring species domestically, if possible.

In an attempt to fulfill the objective of establishing a garden and making a large living collection accessible to the public and the academic community, we are publishing a list of bamboo later in the journal that is now directly accessible for study.

The A.B.S. encourages its readers to compare the list of available bamboo with the previous one of the U.S.D.A. introductions and to help locate plants that are not yet listed as available. - Ed.

Kenneth Brennecke: PROPAGATION OF BAMBOO BY VEGETIVE FRACTIONS (1)

GENERAL CONSIDERATIONS.

Of the many techniques for the propagation of bamboo by vegetive fractions, all are dependent for their success on not violating (to any great degree) a few basic principles.

First, the balance between plant transpiration and water uptake should be maintained.

From the moment the propagating material is taken from the parent plant, it experiences some water stress. If the propagule has roots that are still intact, the root hairs will have been damaged unless sufficient soil was taken to protect them. Even when protected, enough root volume cannot usually be taken to sustain the amount of leaves the propagule has. Since each leaf loses moisture to the air, it is a common practice to drastically reduce or completely remove the propagule's leaves.

This gives the fraction the ability to conserve its water and supply its (greatly reduced) needs even with no roots. Since the propagule is now less able to supply itself, it must be protected from low ambient humidity and excessive exposure to sun and wind until adventurous roots, root hairs, and root volume increase.

When the propagule is sufficiently healthy and taken correctly, the roots can re-establish themselves in as little as four to six weeks.

The growth of shoots and leaves does not necessarily indicate a root system capable of supporting the extra foliage under increased water stress, nor does the lack of new shoots indicate the root system has been idle.

Because the leaves are the primary source of food for the roots, it is desirable to leave as many leaves as possible on the propagule. (1) However, one must guard against the greatly increased threat of dessicating the fraction. Wind breaks, high humidity environments (greenhouses or intermittent misting apparatus), sun screens, and spraying the leaves with an antitranspirent (such as POLYTRAP), are common ploys.

Experience will soon show how much foliage can be maintained by the roots available. Good rules of thumb are - if there are no roots, there should be no leaves. Minor disturbances of the root system (clump divisions of smaller species, for instance) may need no leaves removed. In this case, it is instructive to see how many leaves the plant sheds of its own accord. Typically, foliage is reduced by at least fifty percent for larger species with good root complements. It is safer to denude the plant of leaves if there are any doubts as to the root system's ability to support the propagule in the nurse environment. The propagule will take longer to establish itself but there is far less risk of losing the plant altogether.

If at all possible, anti-transpiration measures should be taken before or immediately after the vegetive fraction is removed from the parent plant. A delay of a few minutes can sometimes dessicate the fraction enough to kill it or greatly retard its establishment.

Second, the propagule must be taken at the right season for the desired result.

Each bamboo species has one grand period of growth of the culms per year. The initiation of this growth period is different for each species and also depends on the climate. Generally, the hardy running bamboos (Arundinaria, Pleioblastus, and Phyllostachys) will begin shooting between March and May while the tropical forms (Bambusa, Dendrocalamus, and Schiziostachym) will begin between May and August. Chimonobambusa and Semiarundinaria do not fall neatly into these broad categories. The best time to take propagules is one or two months prior to the beginning of the first emergence of the new shoots. The propagule then enters a natural period of growth and stands an excellent chance of establishing itself. There is also some evidence that bamboos have a maximum carbohydrate level the month or six weeks prior to shooting. (2) If taken when the most food is available, the propagules may be taken smaller with success. When limited material for propagation is available, more plants can ultimately be produced.

Sometimes when smaller plants are desired, it is the usual practice to take the vegetive fractions after the grand period of culm growth. The food supply is limited and the culms correspondingly smaller. (3) The attrition rate is usually greater too.

Third, the age of the propagating material should optimize propagule success.

Studies by Lin (4), McClure (5), and others have pointed out that in most cases the best results have been with material that is between one and two or sometimes between two and three years old depending on the species. Presumably, this is because the fractions from plant parts less than one year old have not developed any food reserves while older plant parts have either become too woody or have lost their ability to break buds and form new plant parts.

Fourth, the fraction should be removed cleanly from the mother plant.

Fragmenting the propagule increases the surface area exposed to bacteria and fungi. If time permits or the propagating tissue is soft, sterilizing the freshly cut surfaces and sealing them will increase the success rate. (6)

Fifth, the drainage in the propagating bed should be good.

A rich loose soil mix will greatly help in the formation of new and/or more extensive roots. Stable litter from horses with some loam mixed in or the "Cornell mix" of one half vermiculite and one half peat moss have given good results.

Sixth, each propagule type has a minimum size that can survive in a given environment.

Bottom heat and greenhouses will allow smaller fractions to be taken, but after a certain point for any given species, propagation methods become exotic.

to be continued

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(1) McClure attributes better success rates with leaves to the continued movement of water in the plant. However, since the leaf consumes only a small percent of the food it produces, leaving even one or two leaves on the fraction would be a great boost to the root system in the establishment of the propagule. See p. 6, McClure, F. A., 1938. Notes on Bamboo Culture with special reference to southern China. Hong Kong Naturalist, Vol. 9, (1&2), p. 4-19.

(2) See p. 12, Adamson, White, DeRigo, and Hawley, 1978. Bamboo Production Research at Savannah, Georgia, 1956-77. Agricultural Research Service, U.S.D.A..

(3) See p. 17-18, Fairchild, D. G., 1903. Japanese Bamboos and their Introduction into America. Bureau of Plant Industry, Bulletin No. 43, United States Department of Agriculture.

(4) Lin, W. C., 1962. Studies on the Propagation by Level Cuttings of Various Bamboos (1). Bulletin of Taiwan Forestry Research Institute, Vol. 80, p. 1-39.

----------, 1964. Studies on the Propagation by Level Cuttings of Various Bamboos (2). Bulletin of Taiwan Forestry Research Institute, Vol. 105, p. 1-52.

(5) See p. 211-212, 226, 232, and 237, McClure, F. A., 1966. The Bamboos, a Fresh Perspective. Harvard Univ. Press

(6) Ibid, p. 225. I quote McClure, "In later trials we found that sterilizing the freshly cut surface at each end of the rhizome with a 10-percent aqueous solution of Chlorox for 5 minutes and then, after they were dry, sealing the ends with melted paraffin reduced the losses from rotting and from disease to a negligible percentage, and also increased the period during which the rhizomes continued to produce new plants."

THE A. B. S. BAMBOO COLLECTION

The following list of bamboo is actually held or committed to the public gardens the A. B. S. is establishing. The preliminary plantings can be found at the Quail Botanical Gardens, 230 Quail Gardens Drive, Encinitas, Calif., 92024. Presently, about ten species have been planted in the 3/4 acre area.

ARUNDINARIA

argenteo-striata (Regel) E. G. Camus
chino (Fr. & Sav.) Makino
pumila (Mitf.) E. G. Camus
simonii (Carr.) A. & C. Riv.
viridi-striata (Regel) Makino

BAMBUSA

beecheyana Munro
glaucescens (Willd.) Sieb. ex Holtt. cv. *alphonse karr* Young
glaucescens (Willd.) Sieb. ex Holtt. cv. *fernleaf* Young
glaucescens (Willd.) Sieb. ex Holtt. cv. *rivierorum* Maire
glaucescens (Willd.) Sieb. ex Holtt. cv. *silverstripe* Young
oldhamii Munro
textilis McClure
tulda Roxb.
tuldoides Munro
ventricosa McClure
vulgaris Schrad. ex Wendl.
vulgaris Schrad. ex Wendl. cv. *vittata* McClure

CHIMONOBAMBUSA

falcata (Nees) Nakai
marmorea (Mitf.) Mak.
quadrangularis (Fenzi) Mak.

CHUSQUEA

coronalis Soder. & Cald.

DENDROCALAMUS

asper (Schult.) Backer
strictus (Roxb.) Nees

PHYLLOSTACHYS

angusta McClure
aurea A. & C. Riv.
aureosulcata McClure
bambusoides Sieb. & Zucc.
bambusoides Sieb. & Zucc. cv. *allgold* McClure
bambusoides Sieb. & Zucc. cv. *slender crookstem* McClure
bissetii McClure
dulcis McClure
flexuosa A. & C. Riv.
meyeri McClure
nidularia Munro
nigra (Lodd.) Munro
nigra (Lodd.) Munro cv. *bory* (Mitf.) Mak.
nigra (Lodd.) Munro cv. *henon* Mitf.
nigra (Lodd.) Munro f. *punctata* Nakai
pubescens Houz. de Leh.
rubromarginata McClure
viridis (Young) McClure
viridis (Young) McClure cv. *robert young* McClure
vivax McClure

PSEUDOSASA

japonica (Sieb. & Zucc.) Mak.
japonica (Sieb. & Zucc.) Mak. cv. *tsutsumiana* Mak.

SASA

chrysantha (Mitf.) E. G. Camus
humilis (Mitf.) E. G. Camus
palmata (Marl.) Nakai cv. *nebulosa* Suzuki
tessellata (Munro) Mak. & Shib.
variegata (Sieb.) E. G. Camus
veitchii (Carr.) Rehder

SEMIARUNDINARIA

fastuosa (Marl.) Mak.

SHIBATAEA

kumasasa (Zoll.) Nakai

SINARUNDINARIA

nitida (Mitf.) Nakai

SINOBAMBUSA

kunishii (Hay.) Nakai
tootsik (Mak.) Nakai

THAMNOCALAMUS

spathaceus (Fran.) Soder.

YUSHANIA

aztecorum McClure & E. W. Smith

LETTER TO THE EDITOR

An appeal to bamboo fanciers

The beauty of bamboo and the place it takes up in the art of the Far East, its general hardiness and ease of growth are attracting more and more growers. In France, like in other countries, collections of bamboo, in some cases very large ones, have been built up.

A wide range of bamboos was brought into Europe during the colonial period by fanciers of this exotic plant which came from different parts of China, Japan, or India. Many species and varieties still exist in Europe, and, as it is easy to spread them by division, this diversity has been maintained until now. It is certain that interesting varieties can be found in gardens, as we have observed in France, often without their owners realizing how rare some plants are in our countries.

It seems of primary importance to make an inventory of bamboos in private and public collections, to spread them, for this heritage is all the more precious as it is quite difficult to import new species.

The setting up of 'plant conservatories' of bamboos which would be open to the public and which would allow for a better scientific study could even be considered.

The identification of bamboos causes serious difficulty for many species. It would therefore be interesting to know the regretfully few botanists who are interested in bamboo and, perhaps, inspire new members to their ranks.

Britain has one collection at Kew and another very large one which , although private, is well known to specialists. Belgium has collections and probably other countries. The most remarkable French bamboo garden, at Prafrance, has been open to the public for many years.

In order to make a complete survey of bamboo gardens, to exchange lists of available bamboo species and varieties, as well as information on bamboos, cultural experiences, even offsets or young plants, we would like collectors and specialists to get in touch with us.

Jacques Yovane

Commission bambous
Société nationale d'horticulture de France
84 rue de Grenelle
75007 Paris (France)

JOURNAL OF THE AMERICAN BAMBOO SOCIETY

INFORMATION TO CONTRIBUTORS

The *Journal* invites for review original papers in bamboo taxonomy, utilization, culture; and classification. Papers must not have been previously published nor submitted elsewhere for publication. Announcements of new results or discussions of published papers may be submitted as *Letters to the Editor* (1000 words or less, no abstracts).

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

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

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

Plate size for the printed portion of the page is 20.3 cm. by 12.8 cm. including upper headline and lower page number. Reduction is 15 percent so make figures and captions large enough to be legible when reduced. Lettering should be uniform. Each figure should have the author's name and number of the figure on the back. Captions should be on a separate piece of paper (not on the figures) and figures should be consecutively numbered in Arabic numerials.

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1. Membership dues for the American Bamboo Society is $8.00 per year and runs through the calendar year. This includes the *Journal* issues for that year. A person who joins late in the year will receive the past issues of the *Journal* for that year.

2. Back issues for the previous years will be $3.50 each for members, $5.00 each for nonmembers.

3. Nonmember and institution rates are $20.00 per year.

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Address subscriptions and general business to the President

Richard Haubrich

Journal communications to be addressed to the Editor

Kenneth Brennecke

1101 San Leon Court, Solana Beach, California 92075

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1101 San Leon Ct.
Solana Beach, Calif. 92075
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VOLUME 1 NUMBER 2

THE

JOURNAL

OF THE

AMERICAN BAMBOO SOCIETY

MAY 1980

ISSN 0197-3789

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Contents

FIRST PRINTING, JULY 1980
SECOND PRINTING, NOV. 1980

CLONE REGISTRATION

The A.B.S. is beginning a long term project of registering bamboo seedling populations. If you have grown a bamboo from seed and

(1) know the species,
(2) know the germination date (within one month),
(3) are willing to make propagules of the clones' available to other workers at a future date,
(4) will inform the A.B.S. of subsequent changes in the clone (death; flowering, periodic or gregarious; mutations, somatic or sexual; etc...)
(5) will register seedlings from previously registered plants,

then write the A.B.S. and please provide the following information:

(1) your name, address, and phone,
(2) species, date of germination, number of seedlings, where the seedlings are growing if different from your address,

and if known also supply:

(1) date seed gathered,
(2) date seed sown,
(3) length of time parent plant was flowering, whether it recovered vegetive vigor or died, and how long it took,
(4) whether fruits were plentiful or rare,
(5) how much seed was sown,
(6) germination rate and the number of albino germinations,
(7) the percent which appear superior, more vigorous or other, please explain,
(8) were seedlings, seeds, or other plant parts treated with mutative agents/radiation and what were the results?

You will be assigned a unique number for each seedling. Please maintain the number on the seedling as it matures and on all propagules from that seedling. The A.B.S. will publish the species registered (each Nov. issue) and will direct interested researchers to you. Please keep good records as many of these plants will do nothing significant for thirty to sixty years or more. Address your letters to CLONE REGISTRATION, care of the Editor.

TANSO ISHIHARA

It is with deep regret we report the untimely death of Tanso Ishihara, which took place in Japan on May 16, 1980. While taking an evening stroll, he slipped from the roadway and fell to his death. He was fifty-one.

Tanso was educated at Iwate University where he studied ecology and horticulture. He continued his work at the Horticultural Research Station at Akitsu, Shizuoka Prefecture and later spent five years studying the art of landscape design under Professor Shige Mori whom he assisted during the landscaping of the Nitobe Gardens located at the University of British Colombia campus in Vancouver, Canada.

Tanso's most recent work has been in connection with the Hakone Gardens in Saratoga in the San Francisco area. His achievements include the design and landscaping of major portions of the garden, the founding of the Hakone Gardens Japanese Cultural Society, and the planning of the Far Eastern Bamboo Garden within Hakone Gardens.

His published work includes an article in the California Horticultural Journal (Oct. 1974) on Hakone Gardens and a book which he coauthored with Gloria Wickham titled *Hakone Gardens* (Dec. 1974).

The deepest sympathy of the Society is extended to his wife Teru and his children Arlene and Howard in their bereavement.

Kenneth Brennecke: PROPAGATION OF BAMBOO BY VEGETIVE FRACTIONS (1)

PROPAGATION FROM ABOVE GROUND PARTS.

All bamboos can be propagated by a division of the rhizome system. How such divisions are made depends on the species and the factors presented in the previous article. (1) However, not all bamboos are restricted to being propagated only by underground parts. Hundreds of plants have active meristematic tissue located in buds at the base of the culm branch complements. Propagation methods attempt to exploit this by coaxing these buds into forming new roots and shoots. Shoots can be both above ground (culms) and below ground (rhizomes). Propagation succeeds when a new rhizome is established. Some species may be large or vigorous enough to permit the use of the branch complements from the branch nodes.

Porterfield, in his work with *Phyllostachys nigra*, defines three zones of the culm. (2) "The culm at its base is divided clearly into three regions: (1) the uppermost part, which is the erect culm portion with hollow internodes, rising above the ground level; (2) the culm base with very short internodes, which is swollen and solid, being the subterranean continuation of the culm and developing numerous fleshy roots; and (3) the 'Stiel' or bridge, a tough solid neck connecting the culm base to the node of the rhizome, short-noded but with no appendages other than sheaths." These zones can be found in more or less developed forms in all bamboos. Only material from Zone 1 will be considered now. This is done to avoid the possible inclusion of the genus *Phyllostachys* in this discussion.

Among the bamboos which can be propagated using above ground culm parts are those in the genera *Bambusa (Guadua), Dendrocalamus, Gigantochloa, Cephalostachyum, Oxytenanthera, Otatea, Schizostachyum, Lingnania,* and *Melocana*. Generally, they tend to be clump forming tropical bamboos. (3) Most studies to date have attempted to determine (for a given species) the best part of the culm to take and/or the best age of the material. Many trials did not attempt to control temperature, humidity, or soil fungi and bacteria. Due to the size of some culm fractions it would have been impossible to do so without great cost both in terms of money and man power.

Before discussing the many ways of taking vegetive fractions from these bamboos, mention should be made of the possibility of in situ propagation and/or stimulation of the Zone 1 meristematic tissues. There are two methods of promise. The first is layering and the second is to induce the culm to form more developed root and shoot structures without the use of a medium around the nodes.

With the first method either (1) a suitable medium (soil, sphagnum moss, etc...) is placed around the nodes and held in place with plastic wrappers or funnel shaped cups and kept moist or (2) a culm is bent to the ground, staked, and the nodes buried. Side branches are usually trimmed to within a few inches of the culm. Keeping the nodes and base of the branch complements unexposed to the light is probably important but there has been no discussion of this in the literature seen. White (4) and McClure (5) both agree that the yields are low and the effort comparatively great with layering.

The second method takes advantage of the plant's own response to situations which threaten its survival. Rotting rhizomes (ie. dead rhizome buds), death or dysfunction of cambium tissue or physical damage to the culm have on occasion forced the upper culm nodes to form adventitious roots and stimulated shoot development from the nodal buds. Cobin (6) reported seeing *Bambusa textilis* culm nodes forming adventitious roots while the base of the culms were in poor draining soil. McClure expands the concept by pointing out that such rhizomes probably no longer have viable rhizome buds. He gives several examples with different species of spontaneous production of rooted plants at the branch nodes (*Bambusa tulda, B. arundinacea, B. multiplex, B. multiplex var. riviereorum, Guadua angustifolia*).(7) Therefore, with suitable stresses placed on the culm base or rhizome, it may be possible to produce small rooted propagules in quantity. Rapid dissemination of some species with attendant reductions in the costs would be one desirable result.

The most obvious fraction to be taken of above ground parts is the entire culm. This is usually cut at or near ground level in such a way as to include basal root buds and exclude the rhizome. The top several feet are discarded, the idea being that it is too small to produce plants. The culm then has its branches cut back or greatly reduced and the culm is buried horizontally in the ground. For some species, this is the method of choice. McClure reports on ten species; *Bambusa polymorpha, B. textilis, B. tulda, B. tuldoides, B. ventricosa, Cephalostachyum pergracile, Dendrocalamus strictus,*

Gigantochloa apus, Guadua angustifolia (*Bambusa guadua*), *Sinocalamus oldhami* (*Bambusa oldhami*). (8) The results vary widely. A more detailed account of part of the results is also available. (9) Other guidelines are given by White. (10) However, he recommends the retention of a functional piece of rhizome. Side by side trials to determine whether the removal of the rhizome is important does not appear to have, as yet, been carried out.

to be continued

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(1) Brennecke, K. , 1980. Propagation of Bamboo by Vegetive Fractions. Journal of the American Bamboo Society, Vol. 1, p. 12-15.

(2) Porterfield, W. M., 1935. The Relation of Shoot Roots to Shoot Elongation in the Bamboo *Phyllostachys nigra*. American Journal of Botany, Vol. 22, p. 878-879.

(3) *Arundinaria amabilis* has also been propagated solely by above ground parts. See p. 241, McClure, F. A., 1966. The Bamboos, a Fresh Perspective. Harvard Univ. Press.

(4) White, D. G., 1948. Bamboo Culture and Utilization in Puerto Rico. Puerto Rico Federal Experiment Station Circular No. 29, p. 13.

(5) See footnote 3 reference, p. 250-255.

(6) Cobin, M., 1947. Notes on the Propagation of the Sympodial or Clump Type of Bamboos. Florida State Horticultural Society, Proceddings, Vol. 60, p. 181-184.

(7) See footnote 3 reference, P. 245-250.

(8) Ibid, p. 232-234.

(9) McClure, F. A., and W. C. Kennard, 1955. Propagation of Bamboo by Whole-Culm Cuttings. American Society of Horticultural Science, Proceedings, Vol. 65, p. 283-288.

(10) See footnote 4 reference, p. 7-10.

Richard Haubrich: THE AMERICAN BAMBOOS: PART I,

SPECIES CULTIVATED IN THE U. S.

Although bamboos are native to every continent except Europe, most of the described species come from tropical and subtropical Asia. Thus, in the minds of most people, bamboos are associated with oriental culture and landscapes, since both the plants and the products produced from them are of great importance to the people of the East. Yet many bamboos are also native to the Americas and out of about 1000 species that have been described almost 300 are from the New World. Only one species is native to the United States; the others occur in every country from Mexico to the tip of South America.

The bamboos of the New World have not been used as extensively as those in Asia. The Japanese, for example, value bamboo as an ornamental plant in their gardens, as a food, and as a versatile building material for the manufacture of things as diverse as houses and objects of art. In the Americas *Bambusa guadua* Humboldt & Bonpland and related large tropicals have been used in Colombia and Ecuador for housing construction. But American bamboos are not often used as food and from my personal experiences in Mexico and Costa Rica I found that native bamboos are almost never used as ornamentals.

Between 1898 and 1975 the U.S.D.A. officially introduced 12 recognized species of New World bamboos (Brennecke, 1980). In addition there were several unidentified introductions belonging to the genera *Chusquea* and *Arthrostylidium*. Today only two of these species survive as living plants, so that along with one native U. S. species and one species of *Chusquea* introduced by M. A. Machris, we have four species of American bamboos in cultivation in the U. S. In this article, I will describe these four species, and in a later article, Part II, I will describe some additional species that have just recently been introduced from Costa Rica.

Arundinaria gigantea (Walter) Muhlenberg

The only species of bamboo native to the United States was first described by Walter in 1788 as *Arundo gigantea*; it is now regarded as the type species for *Arundinaria*. All other species of the genus *Arundinaria* are from the Old World. *A. gigantea* is quite different from all the other American species; it is a

running bamboo (monopodial rhizomes) whereas all the others are clumping (sympodial rhizomes).

Gilly (1943) gives the distribution of *A. gigantea* based on herbarium specimens. The range covers the area south of a line running from Delaware west through southern Indiana and Illinois, then south-west through eastern Oklahoma and Texas. Known locally as canebrake, southern cane or switch cane, extensive, almost impenetrable stands occured in the past especially along the muddy banks of streams and rivers. Today many of the stands have been destroyed as land has been cleared and drained. There are no recent studies which determine just how much of the native bamboo remains.

Some authors have regarded *A. gigantea* as two or even three distinct species. McClure (1973) however, treats it as a single polymorphic species consisting of the three subspecies, *gigantea*, *tecta*, and *macrosperma*. Subspecies *gigantea* and *tecta* differ from one another in certain morphological characteristics. For example, subspecies *gigantea* has rhizomes without air canals, culms that are spaced separately from each other and leaves that are pubescent only on their lower (abaxial) side. Subspecies *tecta* has rhizomes with air canals, some culms spaced separately and others clumped together, and leaves pubescent on both sides. Subspecies *macrosperma* (probably a hybrid) exhibits a combination of characteristics somewhere between those of the other two.

Although *tecta* has often been regarded as "small cane" with culms less than 2 meters (6 ft.) tall, McClure (1973) states that there is no difference in the height of culms of the three subspecies. He attributes the observed height differences to variations in soil and climate.

A. gigantea typically grows to about 5 m. (16 ft.) high with some culms reaching 8 m. (25 ft.). Culm diameters are up to about 3 cm. (1 1/4 inches) and the leaves are up to 30 cm. (1 ft.) long by 3 cm. (1 1/4 inches) wide. The plants are not generally cultivated in the U. S. Lawson (1966) states that *A. gigantea* (he calls it *A. macrosperma*) grows to 6 m. (20 ft.) under cultivation in England, and that *A. tecta* grows to 2 m. (6 ft.). He calls the later second rate as a garden bamboo because of its "shrubby" appearance looking "sad and tattered during winter."

A. gigantea deserves a place in our gardens if for no other reason than that it is the only native bamboo species in our country. The English have found it worthy of cultivation for over 100 years.

Bambusa guadua Humboldt & Bonpland

Bambusa is a large genus of American and Asiatic tropical bamboos. In the Americas there are about 30 species; all of these have been assigned to the subgenus *Guadua*, by McClure (1973).

B. guadua was first described in 1808; Humboldt and Bonpland state that it grew in vast forests of nearly pure stands several leagues in extent in Colombia. Today most of these areas have been cleared for cattle farms.

The plant is a giant growing up to 30 m. (100 ft.) in height and attaining diameters greater than 15 cm. (6 in.). The rhizomes are clumping but the growth habit is open with culms separated by up to 1 m. (3 ft.) so that one can stroll through a stand like through a grove of trees. Small branches growing around the base of the culms typically bear thorns. The wood near the base of culms is quite thick, about 3 cm. (1 1/4 inches) on large plants. A distinctive feature of *B. guadua* which makes it stand out from other bamboos even at a distance is the rather broad whitish band circling each node. This along with massive culms and relatively short internodes, which have a smaller diameter than the nodes, gives the plant an exotic appearance unlike any other species I have seen.

B. guadua has been used for many different construction purposes in South America including building entire houses and even as electric power poles. The wood is described as mechanically strong and workable as well as durable, being resistant to rot and insect attack (McClure 1966).

In the U. S. I know of only one small stand of *B. guadua* consisting of no more than about 10 culms located at the U.S.D.A. Subtropical Horticulture Research Unit in Coral Gables, Fla. In February of 1980 I cut one culm from this stand and brought back culm and branch cuttings to California for propagation. None of the cuttings rooted, however.

In June of 1980 I saw two stands of *B. guadua* at the Centro Agronomico Tropical de Investigacion y Eseñanza near Turrialba, Costa Rica. In the first stand Bill Teague was able to find small culms (perhaps seedlings) which he dug for taking back to the U. S. In the second stand, which was growing in an area cleared of other plants, I measured diameters of 16 cm. (6 1/2 inches) and estimated heights of 25 m. (80 ft.). It is truly an impressive species. I hope that the small propagules that we brought back can be established in California. The species should do well in areas that rarely experience temperatures below -3° C. (27° F).

Chusquea coronalis Soderstrom & Calderón

The genus *Chusquea* first described by Kunth in 1822 is a distinctive group of bamboos that occur throughout the American continent from Mexico to Argentina. Distinguishing characteristics are solid culms and multiple buds at the culm nodes. McClure (1973) lists 96 species; there are probably many yet to be described. Five species have been introduced by the U.S.D.A. over the years, but none of these are known to have survived in the U. S.

Lawson (1968) states that *C. culeou* Desvaux is in cultivation in many areas in Europe and that it is considered the hardiest of any bamboo in the collection of the Royal Botanic Gardens in Edinburgh. *C. cumingii* Nees, a native of Chile, is reported to be growing in at least one collection of bamboos in France.

Aside from the above two species the only other *Chusquea* known to be in cultivation is *C. coronalis* which is grown in the U. S. In 1962 Mr. M. A. Machris while on a visit to Guatemala City noticed a bamboo in flower on the grounds of his hotel. He collected seed and brought them back to California where they grew into a beautiful and unique ornamental bamboo. The species remained unnamed until 1978 when it was described by Soderstrom and Calderón (1978) from flowering specimens collected in Costa Rica by R. W. Pohl. Soderstrom and Calderón decided that the Machris plants as well as other specimens collected from Mexico to Costa Rica all belong to the same species.

I have seen *C. coronalis* in its native habitat at a place near the type location in Costa Rica growing on a steep hillside alongside a stream where it is mixed and shaded by taller plants. *C. coronalis* differs slightly from the plants cultivated in California. The leaves are larger and there are no root thorns (small protuberances around the lower 2 or 3 nodes) on the wild plants.

The California *C. coronalis* has very small leaves, typically no more than 3 cm. (1 1/4 inches) long by 1/2 cm. (3/32 inches) wide. The culms grow in a rather close clump up to over 7 m. (23 ft.) high in mature plants with culm diameters to about 2 cm. (3/4 inches). Most plants that I have seen are, however, less than 3 m. (10 ft.) high. The leaves grow from many tiny branchlets (up to 40 or 50) that surround each node. The tops of culms arch over, hang down, and taper to a very small diameter near their ends. The plants may be seen at sev-

eral southern California botanic gardens including the Los Angeles Arboretum, the Huntington, and U.C.L.A. in the Los Angeles area and Quail in the San Diego area.

In its native habitat, *C. coronalis* grows at elevations between 600 and 1800 m. (2000 to 6000 ft.) making it a tropical member of its genus. It is not known how much frost the species will tolerate. Potted plants in my yard were unaffected by overnight temperature down to -3° C. (27° F.). A plant at the Huntington Botanic Garden lost a large part of its leaves during winter perhaps as a result of below freezing temperatures.

Propagation of *C. coronalis* can be done by division of the clump. I have divided two potted plants in May before new shoots appeared. Most of the small fractions with single culms and rhizomes less than 5 cm. (2 in.) across died. Larger propagules usually with 2 or 3 culms survived. I have also tried to propagate culm cuttings, but so far none have rooted.

Otatea aztecorum (McClure & Smith) Calderón & Soderstrom

The species is known by the common name, Mexican Weeping Bamboo. It was introduced some years ago by the U.S.D.A. as *Arthrostylidium longifolium* (Fourn.) Camus. McClure (1973) found that Camus actually had described two different species under the above name. McClure therefore described the plant calling it *Yushania aztecorum*, a name that lasted until Calderón and Soderstrom (1980) assigned it to a new genus, *Otatea*.

The only other species of *Otatea* is *O. acuminata* (Munro) Calderón & Soderstrom. In reading Munro (1868) I cannot find anything in the description of the vegetative parts of *O. acuminata* that distinguishes it from *O. aztecorum*. I have seen cultivated plants growing in Costa Rica that resemble *O. aztecorum* except for perhaps narrower leaves and a more open clump; they may be *O. acuminata*.

O. aztecorum forms a somewhat open clump with culms spaced from 10 to 50 cm. (4 to 18 inches). The mature culms may reach 6 m. (20 ft.) in height with a diameter of 4 cm. (1 1/2 inches). The leaves are very narrow measuring less that 3 mm. (1/8 inch) in width by about 15 cm. (6 inches) in length. The characteristic weeping appearance of the plants is due to the profusion of leaves which bend the culms over at their ends so that one sees only masses of leaves. *O. aztecorum* is reported to grow at elevations up to 2700 m. (9000 ft.) in Mexico. It

seems to endure light frost and I know of plants that have survived overnight lows of -8° C. (18° F.) with no visable damage.

O. aztecorum is a beautiful ornamental. Unfortunately, it is in short supply; there are at present no adequate commercial sources. Propagation methods are not well established. The method commonly used is division of the clump during the spring months of April or May before new culms begin to shoot. Small potted plants often give better results when divided than large plants in the ground. The potted plants tend to produce many small culms each of which is a potential new plant after division. Plants in the ground tend to produce a small number of large culms which are more difficult to divide and no more reliable as propagules than the smaller ones. I have heard reports that culm cuttings will root, but I have tried a few with no success.

CONCLUSIONS

We have been slow to make use of the many diverse species of American bamboos. Only three have been successfully introduced and only one of these is commercially available. Yet all three are ornamentally superior plants.

In Central and South America population pressure is clearing the land of its native vegetation at an alarming rate. There are predictions that in 20 years virtually all the tropical rain forests in the world will have disappeared. I hope that some of the great variety of tropical species can be saved before their habitats and perhaps the plants themselves are gone forever.

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Erratum

In Vol. 1 No. 1 (Feb. 1980) on page 6 line 11 from the bottom replace *agustifolia* with *angustifolia*.

JOURNAL OF THE AMERICAN BAMBOO SOCIETY

INFORMATION TO CONTRIBUTORS

The *Journal* invites for review original papers in bamboo taxonomy, utilization, culture, and classification. Papers must not have been previously published nor submitted elsewhere for publication. Announcements of new results or discussions of published papers may be submitted as *Letters to the Editor* (1000 words or less, no abstracts).

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

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Richard Haubrich

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Kenneth Brennecke

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VOLUME 1 NUMBER 3

THE

JOURNAL

OF THE

AMERICAN BAMBOO SOCIETY

AUG 1980

ISSN 0197-3789

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Contents

George A. White*: **Importation of Bamboo Vegetative Propagules into the United States**

Vegetative propagules of bamboo are prohibited entry into the United States except for experimental or scientific purposes by the U.S. Department of Agriculture or by research institutions that qualify for quarantine permits. The long-standing basis for this restriction is to guard against introduction of dangerous plant diseases, including bamboo smut (caused by *Ustilago shiraiana*). The quarantine restriction does not apply to mature, dry culms that are used to make various products.

Since there is interest in bamboos for ornamental and germplasm purposes, some importations are made through the USDA's Plant Introduction Office. These materials are then subjected to a greenhouse quarantine period of about 18 to 30 months. Careful and periodic examination for presence of possible injurious and exotic organisms is made through two or more active growth periods. The quarantine facility is part of the U.S. Plant Introduction Station, Germplasm Resources Laboratory, Glen Dale, Maryland.

There are many species of bamboo in the United States. Over a period of many years, several species (especially of the genus *Phyllostachys*) were introduced by the USDA for experimental purposes as possible sources of paper pulp and as ornamentals. Some large tropical clump types were included. A few nurseries offer a limited number of species for sale. Still other species are maintained by arboreta, botanical gardens, and by hobbyists.

The following suggestions are made to persons wishing to import bamboo for propagation:

1. Be sure that the desired species or cultivar is not in the United States. The American Bamboo Society may be able to assist in this determination.
2. Determine a) if you can qualify for a quarantine permit or b) if a permit-holding research institution will handle the importation for you. Adequate greenhouse facilities with special screening and limited access for the entire quarantine period and periodic inspection by quarantine officials are required.
3. If the material of interest is not in the United States and you need assistance, write the USDA Plant Introduction Officer.
   a. Clearly identify the material wanted by scientific and cultivar names and give the name and address of possible foreign sources.
   b. State why the particular bamboo is of interest. Be as specific as possible because importation through the Plant Introduction Office depends on Departmental interest as well as your own.

* USDA Plant Introduction Officer, Germplasm Resources Laboratory, PGGI, Agricultural Research Center, ARSEA, U.S. Department of Agriculture, Beltsville, Maryland 20705.

c. The requestor must be willing to pay for the costs of the material and of shipping it to the Plant Germplasm Quarantine Center. Also, realize that the material may not survive the transit, or quarantine period, or might have to be destroyed if exotic pests are detected.
d. The USDA will usually exercise its option of sending a portion of the propagules after release from quarantine to the National Arboretum, to the bamboo germplasm collection in Georgia, or to other locations for research and germplasm preservtion. Information about quarantine-released bamboos introduced through the USDA is usually documented and a PI (Plant Introduction) number is assigned to each accession.
e. Since facilities and personnel to handle bamboo importations are limited, relatively few requests for importations will be approved.

Bamboos as a whole are not particularly easy to propagate and maintain in greenhouses where space and environmental controls are limited. Suggestions for greenhouse care during the quarantine period for various species and/or cultivars are welcomed.

In summary, your best bet is to utilize bamboos that are already in the United States. Otherwise, state a good case for importation of desired and specifically identified bamboo propagules if to be handled through the auspices of the Plant Introduction Office.

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Bamboo Quarantine 7CFR, Part 319.34. 1918. Animal and Plant Health Inspection Service, USDA.

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A description of *Ustalago shiraiana* may be found in Hino, Iwao, 1961. Icones Fungorum Bambusicolorum Japonicorum. Fuji Bamboo Gardens. p. 288. - Ed.

Richard Haubrich*: **The American Bamboos: Part II**
Natives of Costa Rica

Introduction

Last May, Bill Teague and I flew to Costa Rica to hunt native bamboos, our aim to introduce living plants of some of the many Central American species into the United States. We chose Costa Rica for several reasons. First, in a relatively small area, there are a large number of species, probably 20 or more. Second, it is easy to reach, has fairly good roads and a stable government. The final and most important reason is that an American botanist, Dr. Richard Pohl of Iowa State University, has been studying the grasses (including bamboos) of Costa Rica for the past several years (Pohl, 1976); we were fortunate in being able to obtain his help in our collection efforts. For seven days we accompanied Dr. Pohl and a graduate student, Lynn Clark, on their field examination of bamboos throughout Costa Rica.

Costa Rica, with an area one-eighth the size of California, lies between Nicaragua and Panamá at about 10 degrees north latitude. Most of the 2 million population live on the central plateau, the meseta central, at elevations between 1000 and 1500 m. where the climate is moderate. Several volcanos and a mountain range rise above the plateau, reaching up to 3800 m. On both sides of the central area, coastal lowlands stretch to the Pacific and the Caribbean. Here the climate is hot and often humid. To the north in Guanacaste province it is dryer and the rolling hills are covered with grasses and brush with few trees.

The following is a description of my observations of the bamboos of Costa Rica, listed by genus and species. Almost all the species observed were collected as living plants and returned to the United States. Most locations are given relative to San José, the capitol city, located in the center of the country, and the Interamerican Highway, which I call Route 1, northwest of San José, and Route 2, southeast of that city. I am indebted to Dr. Pohl for showing us the locations and for identifying all of the native species.

Natives

Arthrostylidium Ruprecht

The genus contains about 20 species that range from the Caribbean Islands to Brazil and Venezuela. Most species climb or hang from trees.

We observed only one occurrence of *Arthrostylidium*, an unidentified species, growing about 20 m. off Route 2, 33 km. southeast of San José, at an elevation of about 2000 m. The plants had delicate, vine-like culms that clambered up trees and hung down, with total culm lengths up to over 5 m., and culm diameters less than 5

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

mm. We found and dug small plants that looked like seedlings at the base of the larger ones.

Bambusa Schreber, **Subgenus Guadua** (Kunth) Nees

The genus covers a large number of Asiatic and American species. The later, comprising about 30 species, all belong to the subgenus *Guadua*. They are generally large, erect bamboos that grow at lower elevations. Many species have thorns as do the two species that we observed in Costa Rica.

B. paniculata (Munro) Hackel

This is perhaps the most common species of bamboo at elevations below 1000 m. in Costa Rica; we saw it growing in several different locations. The culms, up to 8 m. tall by 3.5 cm. in diameter, are thick walled or even solid near the base and thinner walled up above. The narrow leaves are about 17 cm. long by 1 cm. wide. Not very abundant thorns about 1.5 cm. long occur mostly in the axils of branches arising from the culms. The clumps are generally open with culms spaced up to 2 meters apart. We dug a 3 cm. diameter culm and its attached rhizome which was 1 m. long by 2 cm. in diameter. It looked more like the rhizome of a running bamboo than that of a clumper. However, after removing the sheaths, one could see no buds on the numerous rhizome nodes which were spaced only 2 or 3 cm. apart. Apparently, this is a long-necked rhizome which generates culms only at its distal end.

We found *B. paniculata* to the south in Puntarenas province alongside Route 2 near Buenos Aires and again 20 km. farther south. Both stands grow among trees and tall shrubs on the steep slopes above small streams at elevations of about 300 m. In the north we found plants in Guanacaste province at a location 3 km. east of Route 1 from a point 50 km. north of Liberia. Here, at an elevation of 200 m. under relatively dry conditions the plants grow in thickets of small shrubs and vines in an area that has few trees. Plants that flowered 2 years ago are now dead but have produced a new generation of seedlings. We gathered plants from the first two sites and seedlings from the last.

B. sp.

We found an unidentified native *Bambusa* at a site about 1 km. east of Upala in the northwest part of Alajuela province at an elevation below 100 m. in a rain forest next to an area cleared for farming. The species has thin-walled culms that are up to 4 m. tall by 3 cm. in diameter. The branch arrangement and the presence of thorns identifies it as a *Bambusa*. It differs from *B. paniculata* by the appearance of whitish bands around each node and by its broader leaves that are up to 3 cm. wide.

Chusquea Kunth

This is the largest genus of American bamboos with over 90 described species. The plants generally form dense clumps of solid culms. Each mid-culm node typically has a single large branch and numerous small branchlets. In Costa Rica we saw seven different species and collected living plants of six.

C. coronalis Soderstrom and Calderón

We saw the species growing in only one location, about 5 km. from Empalme along Route 12 in San José province. Here at an elevation of 1200 m. a small stream leads back from the road to a waterfall forming a steep sloped little canyon. The slopes are covered with an assortment of trees, shrubs and vines including an unidentified bamboo of the genus *Rhipidocladum.*

The species flowered in 1976 and was described (Soderstrom and Calderón, 1978b) from specimens collected by Dr. Pohl only a few km. from the present site. The plants here having culms up to 3 or 4 m. in length and 1 cm. in diameter may well be seedlings from the 1976 flowering. The leaves which measure up to 5 cm. long by 1 cm. wide are smaller than those of any other bamboo that I saw in Costa Rica but somewhat larger than the leaves of the *C. coronalis* cultivated in California. I could find no root thorns on the Costa Rican plants although they are common on the California plants.

C. longifolia Swallen

The species is common in Costa Rica at elevations above 2000 m. We saw it growing along Route 6 between San José and Volcán Irazú, as well as along the road to the summit of Irazú, at an elevation of 2900 m. in fields alongside a species of live oak. At the later location we were able to find small culms near to the road that were easy to dig.

A rather large coarse bamboo, *C. longifolia*, has culms which grow in tight clumps up to about 10 m. tall with diameters to 3 cm. The masses of large, dark green leaves which measure up to 20 cm. long by 3 cm. wide cause the ends of culms to arch over strongly, completely obscuring the center of the plant.

C. pittieri (Hackel) McClure

This is the largest and most impressive of the *Chusqueas* in Costa Rica with culms commonly more than 10 m. in height and base diameters from 3 to 5 cm. becoming very slender in their upper parts so that they arch over almost touching the ground, or, in some cases, hang down over the sides of cliffs to levels far below the point where the culms emerge from the ground. Total culm length may thus reach 15 or even 20 m. One characteristic of the species are the stiff root thorns which encircle the lower nodes protruding a cm. or two out from the culm.

We found the species growing on steep slopes along roads and along the banks of streams. At one location, along Route 6 between San José and Volcán Irazú, at about 2000 m. where plants grow on the steep slope of a stream bank, we dug culms about 2 cm. in diameter and 6 m. high. Other stands of the species were observed a few kilometers north of Heredia.

C. scabra Soderstrom & Calderón

We saw a large stand of this species clambering through several trees about 10 km. north of Heredia in a field off a back road that goes due north from the city. The brownish appearance at a distance of 200 m. from the road indicated that the entire stand was in flower.

The rough feeling (scabrous) culms are 1 1/2 to 2 cm. in diameter and quite long. Extending up through the branches, they hang down over the outside of the trees as thin vines extending almost to the ground so that the total culm length may reach 15 to 20 m. Lower culm nodes produce a principle branch as large as the culm. These in turn produce large branches so that a single culm gives rise to a multitude of vines that extend throughout a large tree. In addition to the numerous normal branches, one often sees many thread-like, leafless branchlets that are a form of "witches broom" caused by a fungus (Soderstrom & Calderón, 1978a).

Although the flowers were numerous and in all stages of development from newly emerging to old and dried, I could find no seed. The local people said that seedlings are often seen near bamboo that has flowered, but we could find no seedlings at this location. We collected no living plants of this species since we could find none that were not in flower.

C. simpliciflorum Munro

We saw this species only at the site near Upala. The small thin culms which are 2 or 3 m. long by only a few mm. in diameter are not self supporting but lean on other plants. The peculiar thing about the species is that it spreads by slender rhizones up to 1 m. long that are often above ground.

C. tonduzii Hackel

The species grows in abundance along Route 2 southeast of San José at elevations between 2000 and 3000 m. At one location 68 km. from San José at 2650 m. we found plants growing in a sphagnum moss bog. Even though the 2 to 3 m. tall culms are somewhat smaller than in other locations, they showed the ability of the species to grow in standing water. About 1 km. from Empalme along Route 12 we collected small plants about 20 to 50 cm. high that looked like recent seedlings.

C. sp.

Along Route 2 about 80 km. southwest of San José at elevations between 2700 and 3100 m. we observed a beautiful *Chusquea* which differs from the other species of the genus by having long slender leaves, about 15 cm. long by 5 mm. wide. As we drove to elevations above 2700 m. we found masses of this species in flower. Large areas of the hillside along the road are colored brown due to the abundant flowers that have replaced most of the green leaves. Because the species has not previously been observed in flower in Costa Rica, it has not been identified. I searched diligently through many flowers looking for seed but I could not find even one. We found some plants that were not flowering and dug specimens of these.

Elytrostachys McClure

The genus consists of two species that grow in wet lowlands from Honduras to Venezuela. One of these is native to Costa Rica.

E. clavigera McClure

The species appears to be rather common at lower elevations in Costa Rica; we collected it at two widely separated locations. The culms which are up to 10 m.

long by 4 cm. in diameter and extremely thin walled are self-supporting below and lean on other plants above. The species is distingusihed by extremely long (up to 4 cm.) hairs (oral setae) which grow from the top of the culm sheath. The leaves are about 13 cm. long by 2 cm. wide in mature plants, much larger in seedlings.

In the southeastern province of Puntarenas we found *E. clavigera* growing along the banks of a small stream near Route 2 about 15 km. south of Buenos Aires at an elevation of 300 m. We collected several seedlings growing near and beneath the mature plants. In the northwest we found *E. clavigera* in Alajuela provence at the Upala site. We collected seedlings growing among the old plants that had flowered and were dying.

Rhipidocladum McClure

The genus contains 11 species that grow from Mexico to Brazil and northeastern Argentina. The culms are usually self-supporting below and leaning or pendulous above. Members of this genus (as well as *Merostachys*) are characterized by branches which arise at different levels from the culm node leaving a triangular space between them. Three species were collected in Costa Rica.

R. pittieri (Hackel) McClure

The species grows in the vicinity of San José. A small plant was collected for us by Dr. Pohl.

R. racemiflorum (Steudel) McClure

We found the species growing along the Rio Tenorio where it crosses the road to Upala 25 km. north of Route 1 in Guanacaste province. The culms are not more than 1 cm. in diameter at the base, but reach a total length of over 10 m. Toward their upper end, the culms taper down to only a few mm. in diameter and hang down vinelike from trees. The leaves which are 7 cm. long by 5 mm. wide are arranged around each node on short small branchlets somewhat like a *Chusquea*. We were able to dig small plants that looked like seedlings.

R. sp.

We found this unidentified species growing a the same site as *Chusquea coronalis* in San José province. The plants resemble *R. racimiflorum*, but the culms are somewhat smaller. The characteristic triangle between the base of branchlets identifies this as either a species of *Rhipidocladum* or *Merostachys*.

Swallenochloa McClure

McClure (1973) described the genus and included in it a group of *Chusqueas* that are native to the high mountains of Central and South America. Soderstrom and Calderón (1978a) list 7 species; three are natives of Costa Rica. *Swallenochloa* differs from *Chusquea* in having culms that are not solid; the central core consists of pith that is usually broken up by openings. The branching patterns of the two genera differ in that *Chusquea* has a large central dominant branch flanked by many small branchlets while *Swallenochloa* has only 5 to 7 almost equal branches. *Swallenochloa*

often grows above the treeline in the mountainous areas of Central and South America called páramos. The climate is cool, damp and clowdy while the soil is acidic and permanently saturated.

S. longiligulata Soderstrom & Calderón

The species grows over a wide range of elevation in Costa Rica, from 1400 m. to 3200 m. We saw plants all along Route 2 between 30 and 80 km. southeast of San José at elevations between 2000 and 3000 m. We collected plants at 77 km. southeast of San José at about 2900 m. which were growing next to *Chusquea sp.* We also saw *S. longiligulata* in the vicinity of the summit of Volcán Poás at 2700 m. where it grows in large thickets of trees and shrubs.

S. longiligulata has culms up to 10 m. long by 2 or 3 cm. in diameter which generally arch over and lean on other plants with their slender ends hanging down like vines. The species is distinguished from other bamboos by its exceptionally long leaf ligule. Most bamboos have a ligule (the extension of the sheath parallel to its blade) that is at most a few mm. long. In *S. longiligulata* the ligule is often from 1 to 3 cm. long making the species easy to identify even at a distance.

S. subtessellata (Hitchc.) McClure

This is a common species above timberline on the páramos of Costa Rica. We found it growing alongside Route 2 about 80 km. southeast of San José at elevations above 3000 m.

The plants are typical of the genus; the culm grows stiffly erect up to 2 or 3 m. tall and 1 cm. in diameter. We found several culms that were in flower with no evidence of plants dying. Although we could find no seed, there were small seedlings in one area that looked like they were a year or more old.

S. vulcanalis Soderstrom & Calderón

The species looks very much like *S. subtessellata* except that it is somewhat taller. We found plants up to 4 m. tall growing at an elevation of 3200 m. about 2 km. from the summit of Volcán Irazú located 22 km. east of San José. We also saw the species on Volcán Poás 35 km. northwest of San José. Here the clumps are growing at an elevation of 2500 m. about 2 km. from the summit. The culms are up to 5 or 6 m. in height and 3 cm. in diameter. Two clumps out of a total of about 15 were in flower but no seed could be found. We collected small plants from both locations.

S. sp.

On our return trip from San Isidro de General to San José, we stopped at a hotel called La Gorgina which is located 95 km. southeast of San José on Route 2. Across the highway from the hotel we saw a bamboo growing on an embankment above the road. The plants are easily recognized as a *Swallenochloa* but are significantly different from the three described species. With strongly arching culms that are up to 7 m. long by 2 cm. in diameter, the plants look somewhat like *S. longiligulata* but have no long leaf ligules. We collected several culms with attached rhizomes.

Non-natives

Many bamboo species have been introduced into Costa Rica for ornamental or commercial purposes. Those most commonly used as ornamentals are *Phyllostachys aurea* A. & C. Riv. and *Bambusa vulgaris* Schrad. ex Wendl. cv. Vittata McClure; they are seen throughout the country planted in city and country yards, parks, around motels, etc... Far less often we saw a few other species used as ornamentals including *Gigantochloa apus*, *Bambusa guadua* and various Asiatic *Bambusas* that I could not identify. Not once did we see native bamboo that had been planted.

More than 20 species of non-native bamboos are growing at the Tropical Agricultural Research and Training Center (CATIE) located just east of Turrialba about 50 km. east of San José. Here at an elevation of about 500 m. a variety of tropical plants are grown and tested for their possible use and benefit to the small farmers of Costa Rica. The bamboos are mostly giant tropicals that grow in large mature clumps. There appears to be little interest in the bamboo at present for no one at the Center could identify the species or provide a list. However, we were given a guide to show us the plants and we were allowed to take divisions of whatever we wanted.

In all we obtained 5 different species. Two are American natives: *Bambusa guadua* Humb. & Bonpl. from Ecuador and Peru, and a species that looks very much like *Otatea aztecorum* (McClure & Smith) Cald. & Soder. The other three species are probably Asiatic: a large leafed bamboo, identified as *Gigantochloa apus* (Bl. ex Schult.) Kurz., some seedlings growing under a flowering *Bambusa*, and a running bamboo that most likely is a *Sinobambusa* or *Semiarundinaria*.

Conclusions

Plants dug in the field were placed in plastic bags and carried back to our base of operations in San José. Each plant brought into the U.S. must be free of all soil and pests. Since many of the larger plants collected carried infected material especially in the rhizomes and roots, most of them had to be discarded or severely trimmed. On the last day in Costa Rica we did the final cleaning and trimming of our material. The crevices in rhizomes were scrubbed with a tooth brush to remove all traces of soil and every discolored plant part was removed as a suspected infection. Most of the material ended up with little or no roots and only a few plants had any leaves.

We returned to the U.S. on a Friday afternoon. The plants were held over the weekend by the U.S.D.A. Plant Protection and Quarantine. After being released on Monday, they were carried to the quarantine greenhouse at the Huntington Botanic Garden and potted by Bill Teague. Those plants that survive must remain in quarantine for two years.

As of this writing many of the species collected have died, and only two (*Chusquea longifolia* and *C. pittieri*) from elevations above 2000 m. survive. Certainly great care is required in collecting, transporting, and maintaining plants from the high mountain regions. I believe that it is especially important to dig propagules with large pieces of rhizome. It would require collecting a large amount of material in order to

obtain some that is free of pests. Also it would probably help if the plants are kept cool in transit and while growing in the greenhouse until they are well established.

I feel our trip was successful since at least 6 or 7 native Costa Rican species have been introduced and are alive. We have also gained experience so that in the future we may be able to obtain those species that were lost this time.

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Erratum

In Vol. 1, No. 1 (Feb. 1980) on page 2 line 10 from the bottom, replace *agustifolia* with *angustifolia.*

Fig. 1 *Chusquea longifolium*, the slender end of a culm hanging down. Photo by Bill Teague.

Fig. 2 *Swallenochloa vulcanalis* growing near the summit of Volcán Irazú. Photo by Bill Teague.

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Richard Haubrich

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Kenneth Brennecke

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VOLUME 1 NUMBER 4

THE

JOURNAL

OF THE

AMERICAN BAMBOO SOCIETY

NOV 1980

ISSN 0197-3789

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Contents

Robert D. Fabel-Ward*: **Report on the Flowering and Fruiting of *Arundinaria angustifolia* (Mit.) Houz. de Leh.**

The Beginnings

The Spring and Summer of 1980 will be the fourth season for *Arundinaria angustifolia* to flower. The flowering habit was first observed in 1977 just one year after being released to the collector in 1976 by the USDA. The original stock was obtained from Hillier and Sons of Winchester, England.

The 1980 season will see about 75% of the stand in flower. The following is a history of the flowering and seed production:

1) In 1977 less than 10%, 30 seeds collected;
2) In 1978 about 15%, 98 seeds collected;
3) In 1979 more than 50%, 120 seeds collected;
4) In 1980 about 75%, 241 seeds collected as of June 30th.

At the time of this writing four variegated seedlings and twenty-two albino seedlings have appeared in 1980. Two forms of leaf variegation have appeared: pure white stripes and cream and white blurs. All albino seedlings will of course die as soon as the seed nutrients are used up . All seeds in 1980 were allowed to drop onto the soil and germinate and were collected when 1-2 leaves appeared.

Six variegated seedlings appeared in 1979, however, after one month's growth these died suddenly.

With the increased flowering each season, this bamboo has not shown loss of growth or vigor. Many of the culms that produced inflorescences in 1980 are the same ones that did so in 1977 through 1979.

The Development of the Inflorescence

Usually in December of each year the inflorescence can be observed and will continue to develop through January and February without regard to weather conditions. By the end of February the inflorescence is noticable from a range of ten feet. By March 15th the three stamens appear from the florets, and these continue to develop until the end of June at which time new foliage begins to hide the green to brown seeds. This is probably why the flowering of many bamboos of this type goes unnoticed.

It is at the beginning of April that the fast developing seeds become a dominant feature because of their weight and because the birds go after them. As the

* Horticulturalist, 54 Belmont Dr., Little Rock, Arkansas 72204.

temperature increases in June and July the inflorescences and seeds disappear.

Some of the lateral fruit develop, but very few terminal florets have enough nutrition to develop into ripe fruit. Because of this, the inflorescence produces from 1-4 ripe seeds at most. It does not matter how much water is used by the plant. Moisture will not increase seed production, but dry situations will reduce it.

The seeds can be collected as they turn a light to dark brown color. Many seeds that are green can also be collected and if placed in good potting soil will germinate within two weeks.

Effects of Local Weather Conditions

In 1979, Little Rock, Ark. had over 50 inches of rain and high humidity so that several branches that were located on new culms produced seeds that germinated while still attached to the inflorescence.

History

It is difficult to find histories of bamboo flowering and it is even more difficult to assimilate the information on the histories because there seems to be a general lack of agreement on plant nomenclature.

Arundinaria angustifolia has gone through such a metamorphosis that one wonders if *A. angustifolia* is one and the same as Himeshima-dake of the Japanese authors. The history of *A. angustifolia* can best be described as confusing and possibly incomplete since different authors used several names in published reports from the same institution. They are blessed with a common denominator - a good local name.

Isuke Tsuboi (1916) in his monograph on bamboos uses the name *A. chino* Makino var. *argento-striata* Makino forma *elegantissima* Makino and assigns the Japanese name Himeshima-dake; Tsuboi goes on to say that Himeshima-dake is a variety of Medake (Kawatake) or *A. simonii*. A communication from H. G. Hillier states that this bamboo will sport variegated leaves but can't be trusted to remain a true variegated type. The writer couldn't find any literature that tells whether Tsuboi's plant is a a true variegated form or just a sport. Many reports state that sport variegations are known to come and go with the passing of time.

Two Comparisons

A case can be made for both possibilities that *Sasa chrysantha* is a true variegated bamboo or that it is a sport. According to Freeman-Mitford (1896) this bamboo has yellow variegated leaves, however the author has never seen this; the leaves on all of his clumps are solid green.

Further studies might reveal that spontaneous variegations are caused by fungal and viral invasions. A stand of *Phyllostachys nigra* cv. Henon produced hundreds of variegated leaves this year. Seven different colors were observed under microscopic tests at the University of Arkansas at Little Rock (results to be released later this year), but the bamboo has replaced all these leaves early this summer and not

one variegated leaf can be found.

Dr. Kochiro Ueda (1960) working at the Kyoto University Experimental Forest Station mentions a *Pleioblastus angustifolius* Nakai and lists the Japanese name Himeshima-dake in a list of bamboos indigenous or cultivated in Japan. In another report from Kyoto University, Isa and Hashimoto (1964) list *Pleioblastus chino* Makino forma *angustifolius* Muroi with the same common name, Himeshima-dake.

From 1960 to 1964 and at the same institution several authors used different technical names for the same plant Himeshima-dake. They all agreed on the local common name.

Finally an article by David McClintock (1979) of Kent, England, writing in the Plantsman, states that although sevearl bamboo species have flowered in England, he could find no reports that *A. angustifolia* has done so.

Conclusion

There is still more research needed to check with other collectors of this bamboo to see if their stands have flowered and file this information in the A.B.S. records.

It is my personal opinion that Tsuboi probably had a variegated plant that lost its ability to variegate as time passed. As we can see from the history here quoted other authors using the same local name do not hint at variegation.

In my 15 years of bamboo study I have seen what I've labeled false variegations because of the aforementioned reasons. Caution should be used to have the plant under study for several years before going to press. I'm still looking for a variegated form of *Sasa chrysantha*.

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Clone Registration 1980

The following plants were all raised from seed between 1976 and 1980. Some of the earlier seedlings cannot be accurately dated to within two months. Most however are completely documented and details of their batch germination rate, percent of albinos, etc... are available. For those readers who desire propagules of these clones for life cycle work and other studies, please submit your request to the Editor. There will be about a two year wait before there will be enough material available to be sent out. For those readers who have raised bamboos from seed, we urge you to register your plants and provide us with updated information on the status of your plants occasionally as well as making the clones available to other workers. Please include the ABS number and the species with your request. Also tell us what work you have planned.

Bambusa tulda Roxb.	ABS3-A-001 to ABS3-A-012
Dendrocalamus strictus (Roxb.) Nees	ABS4-A-001
Phyllostachys aurea A. & C. Riv.	ABS6-A-001 to ABS6-A-005
Phyllostachys pubescens Houz. de Leh.	ABS1-A-001 to ABS1-A-004
Phyllostachys vivax McClure	ABS2-A-001
Pseudosasa japonica Makino ex Nakai	ABS5-A-001
Sasa tessellata (Munro) Makino & Shibata	ABS7-H-001 to ABS7-H-006

Erratum

In Vol. 1, No. 3 (Aug. 1980) on page 2 line 2 from the bottom, replace *Ustalago* with *Ustilago.*

Richard Haubrich*: **Handbook of Bamboos Cultivated in the United States**
Part I: The genus *Phyllostachys*

Introduction

The purpose of this Handbook is to give a description of each species of bamboo which is presently cultivated somewhere in the U. S. The descriptions are made as complete as possible so that the reader can determine the identity of a particular bamboo plant using vegetative characteristics only.

Section 1 is a review of the basic description of bamboos in general. Section 2 treats the plants of the genus *Phyllostachys.* Section 3 explains each of the entries in Table 1, which summarizes those characteristics of each species important to identification. In Section 4 there is a detailed description of each species plus notes on origin, uses, hardiness and the present locations of growing plants. Details of locations mentioned in the text follow Section 4.

The description of each species is based primarily on the work of McClure (1957). I have added two cultivars to McClure's original list, *P. bambusoides* Cv. Marliacea and *P. nigra* f. *punctata.* I have replaced McClure's key with Table 1. The twenty-five figures are all reproduced from McClure (1957).

1. The Growth Habit of Bamboo

Bamboos are woody stemmed members of the grass family, Gramineae, which belong to the subfamily Bambusoideae. All members of the subfamily can be distinguished from the other grasses by foliage leaf blades which are attached to their branchlets by slender leaf stalks or petioles. Other grasses like corn and sugar cane have leaves without petioles.

1.1. The Culms

Like all grasses the bamboos have stems or culms which are segmented by joints called nodes. Bamboo nodes are always solid but between the nodes, the internodes of the culm are usually hollow. A group of culms growing near one another are usually connected together underground by segmented stems called rhizomes to form a single plant. The roots grow from the nodes of the rhizomes.

The rhizomes serve as a storehouse of food for the bamboo plant allowing new culms to grow very rapidly. Each culm grows to its full height in a grand period of growth which usually takes no longer than 2 or 3 months. Thereafter, even though it may live for up to 10 years, the culm does not increase in height or diameter. A plant with small rhizomes can produce only small culms. Under favorable conditions the rhizomes will increase in size and produce larger culms each year until

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

the limit for that particular species is reached. The oldest culms are thus often the smallest and the youngest the largest.

1.2. The Rhizomes

There are two basic types of bamboos, the clumpers and the runners. The culms of a clumping species grow close to one another usually no more than a foot apart, while the culms of a runner are often spaced far apart, up to 10 ft. or more. The spacing of the culms is characteristic of each species and depends on the nature of the rhizomes.

McClure first used the terms sympodial and monopodial to describe clumpers and runners. Sympodial refers to the branching habit of clumping rhizomes; each rhizome typically branches into a pair of rhizomes, each of which branches into a pair again. Monopodial refers to the running rhizome which consists of a main axis from which branches arise one at a time. Later (McClure, 1966) the above two terms were abandoned in favor of pachymorph and leptomorph; the first refers to the short, thick shape of the clumping rhizome while the later describes the long, slender shape of a running rhizome. Both pairs of terms describe some of the features of the two rhizome types but I prefer to use the words clumper and runner.

A running bamboo has the capability of spreading rapidly. It can also get nourishment from the ground at some distance from its culms. Under favorable growing conditions the runner planted as an ornamental can become a problem, growing into a lawn, a flower bed or a neighbor's yard. The clumpers are more well behaved as they can only spread slowly from the edge of the clump. In most cases the clump diameter will be no greater than about 10 or 15 ft. after many years.

In most genera of bamboos all of the species are either clumpers or runners. Most clumpers are tropical or subtropical plants that are damaged by temperatures below about 15° F, while most runners can withstand colder temperatures. There are exceptions - the two most hardy species grown in the U.S. *Thamnocalamus spathaceous* (Fran.) Soder. and *Sinarundinaria nitida* (Mitf.) Nakai are clumping bamboos.

1.3. The Branches

Almost all bamboos have one or more branches that grow from the culm nodes. In many species the lower nodes of large culms remain branchless. The number of branches, their relative size and their arangement on the culm node is an important charcteristic for the identifiction of the genus and sometimes of the species.

1.4. The Leaves

The bamboo leaf complement consists of two parts, the sheath and the blade. The sheath wraps around the stem to which it is attached at the sheath base. The opposite or distal end of the sheath developes into the blade which is often flat and bent away from the sheath and stem. Bamboos have two distinct kinds of leaves, culm leaves and foliage leaves.

Culm leaves are attached at the base of their sheaths directly to culm nodes at the sheath scar (see Figure 1). The culm leaf sheath, which is usually large compared to the blade, serves to protect the new culms as they emerge during the grand period of growth. After the culm grows to its full height the culm leaf dries and often falls off. Figure 5 shows the upper part of a culm leaf sheath and blade. On the upper end of the sheath on both sides of the blade are two auricles. The bristle-like hairs which extend from the margins of the auricles are called oral setae. Extending up from the central margin of the sheath is the ligule. The auricles and oral setae may be lacking on some species (see Figure 18). Culm leaf blades are larger toward the upper end of the culm. Near the upper tip the leaves are similar to foliage leaves; the blades remain green and persist long after the lower culm leaves have fallen off. The culm leaf sheath is often simply called the culm sheath or the sheath.

Foliage leaves grow from branchlets. The blades are generally large compared to the sheaths which wrap tightly around the stems often overlapping the sheath above it. The foliage leaf blade is commonly called simply the leaf. Foliage leaves have ligules and often auricles and oral setae. The foliage leaf blade is always attached to its sheath by a stem or petiole in contrast to the culm leaf blade which is often without a petiole. Foliage leaves drop off after about one year but not until new leaves have grown to replace them so that the bamboos are generally green year round.

The leaves that grow from main branches tend to resemble culm leaves while those at the ends of culms and branches are somewhere between the two types. To identify species one should look at culm leaves that grow near the middle of large culms and at foliage leaves that grow from branchlets.

1.5. The Flowers

The flowering of bamboo plants occurs at irregular, often long intervals. Each species has its individual pattern; it may flower continuously, yearly, every few years, or at long intervals up to over 100 years. The flowers may be only a few, cover one or a few culms or cover all culms of the species growing in a wide area. With heavy flowering vegetative growth comes to a virtual standstill that may last from a few months to many years, after which the plant may slowly recover its vegetative growth or it may die. Each flower does not produce a seed and often plants will produce a massive quantity of flowers and little or no fruit.

The history of the flowering of *Phyllostachys* is given by Adamson et al. (1978) for plants grown at the United States Barbour Lathrop Plant Introduction Garden at Savannah, Georgia (hereafter called the Garden). Eighteen different accessions representing 10 different species flowered between 1951 and 1977. Of these, 8 accessions died, 8 recovered and two were still flowering in 1977. During this time all of the accessions of *P. nidularia* flowered while some accessions of *P. bambusoides* flowered and some did not.

Because of the rarity of flowering in most bamboos, one must often rely on the vegetative characteristics to distinguish species. When a plant does flower it often lacks the vegetative parts such as culm leaves which are critical for identification. In

some cases most of the foliage leaves fall off of flowering plants.

2. The Genus *Phyllostachys* Siebold & Zuccarini

The most useful of all the bamboos, the genus *Phyllostachys* has supplied a source of wood, paper pulp and food in China and Japan for centuries. In the United States the largest effort at introducing members of the genus and conducting research on their cultivation has been made by the U. S. Department of Agriculture. Over the years 24 species and 11 cultivars have been established and grown at the Garden. Worldwide the genus contains at least 30 species of which 24 have been established in the U.S. All of the later are probably natives of China; several have been cultivated in Japan for hundreds of years.

2.1. Characteristics of the Genus

There are two distinguishing characteristics of *Phyllostachys* by which members of the genus can be easily recognized. The first is the distinct groove which gives the culm and branch internodes a cross section that is roughly D-shaped. The groove appears above nodes that have either a bud or branches and runs parallel to the length of the culm from the bud or branches up to the next node (see Figure 1). The groove is lacking above nodes which have no bud or branches. The second characteristic is that each node typically bears two branches, one usually larger than the other. Sometimes a very small third branch develops between the larger ones and rarely there are three branches with the central one dominant. Lower culm nodes may have no branches or only one.

In addition to the above there are several other characteristics common to the species of the genus. All are running bamboos with rhizomes which are long and typically more slender than the culms growing from them. The culms usually grow well apart, but under some conditions they can form a rather tight clump. The culms of most species are hollow. The rhizomes like the culms also have swollen nodes and grooved internodes which are generally only an inch or two long. Every node has a bud except for a few at the base of the rhizome where it is attached to another rhizome. Although each bud may develop into a culm or a new rhizome, the great majority remain dormant. Each rhizome node also bears a row of roots that emerge from the nodal ridge above the sheath scar.

The culm leaves drop off soon after the new shoots reach their full height, except near the base of the culm where a few sheaths may persist. The foliage leaf blades are longer than wide with a ratio of length to width from about 4 to 10. The leaves are lance-shaped i.e. wider near the base than near the tip, to linear lance-shaped, parallel sides except at the base and tip. All species tend to have some hair on each side of the midrib at the base on the underside of the leaf blade. The blades show a clear pattern of transverse veinlets which together with the longitudinal veins produce a design of small rectangles called tessellations. The tessellations are most easily seen by holding the leaf between a light source and the eye and looking at it with a 10 power magnifier.

2.2. Growth and Propagation

The growth of new culms takes place in spring generally between March and May. The exact time of shooting varies with the species and also with temperature and other environmental conditions. Generally most shoots appear within a period of a few weeks, but occasionally some will grow later during the summer. In Southern California a few shoots may appear at any time of the year.

The *Phyllostachys* species can be propagated from plant division, rhizome cuttings and seeds. Unlike many of the tropical bamboos, culm and branch cuttings cannot be used for propagation. Both division and rhizome cutting should be done before shooting occurs in spring. Most authorities recommend February as the time to propagate *Phyllostachys*, but successful results have also been obtained from November through January in Southern California.

Plant division is the fastest method of obtaining mature plants. From one to three culms with attached rhizomes about a foot long makes a manageable size propagule. It is best to use small culms which can be cut down to two or three feet in length and still retain some leaves.

Rhizome cuttings can be used to obtain large numbers of plants. The rhizomes are dug and cut into lengths between 4 in. and several feet. The material should not be over two years old and each cutting should have several healthy looking buds at the rhizome nodes. Since some of the buds may not break dormancy, long pieces of rhizomes have more chance of producing a plant than short ones.

Bamboo seed is generally not available for any given species because of the rarity of flowering. Still, there is likely to be at least one *Phyllostachys* species in flower in the U.S. at all times. Although many plants produce few seed, others produce hundreds to thousands. Since germination rates range from about 20 to 90%, one should with proper care be able to get 50% germination and about 25% survival. Seedlings take about one year longer than rhizomes and two years longer than divisions to produce a comparable size plant. An advantage of seed is that it produces a number of different clones some of which may turn out to be desireable varieties of the species.

2.3. Culture and Control

All of the *Phyllostachys* species do best when grown in full sunlight with the possible exception of *P. nigra* which does well in partial shade. The plants should have an adequate supply of water year round but especially in spring when the new culms are developing. A well drained sandy soil is better than heavy clay. The plants will respond to a balanced fertilizer that is high in nitrogen such as might be used on a grass lawn.

All of the species make attractive specimen plants when grown in pots. A well treated plant will outgrow its pot in one or two years after which it should either be moved to a larger pot or trimmed back in size.

The species of *Phyllostachys* are adapted to temperate climates and will tolerate a wide range of temperatures. The plants tolerate hot temperatures growing

throughout the southeastern U.S. as well as the desert regions of Nevada and Arizona. They also grow well and reach large sizes in tropical climates such as the low elevation coastal plane of Costa Rica.

Some members of the genus are the hardiest of the large bamboos. As a general rule they all appear to tolerate temperatures down to about 0^{o} F while some of the species can withstand temperatures a good deal colder. The damage done by cold, however, depends on more than temperature and species. Other conditions such as the general health of the plant, soil moisture, snow cover, wind and the temporal variation of temperature play an important role. Stages of cold damage from slight to severe are: slight leave damage, severe leaf damage in which all the leaves drop off, slight culm damage, culms killed to the ground, the entire plant killed outright.

Since many of the species had not been grown extensively outside of the Garden, McClure's information on hardiness was necessarily incomplete. I have used results from a recent study of hardiness made by James Smith. The comments on the cold tolerance of each species in Section 4 below are based primarily on Mr. Smith's observations. Column 27 of Table 1 lists the typical killing temperature in degrees F for some of the species.

Although all bamboos of the genus are capable of spreading by way of their underground rhizomes, there is great variation in the amount of invasiveness that occurs. Plants growing in the shade or in poor soil may never run at all but remain in a tight clump. Cool climates also slow the tendency to run; Lawson (1968) states that in England *P. aurea* is "slow moving," while in Southern California this species is capable of spreading rapidly with new culms emerging 15 ft. from the mother stand.

In large, open areas bamboos can be allowed to run free. Control is accomplished by simply cutting or kicking off the young shoots that appear in unwanted places. For plants grown in confined areas, near lawns, near other plants or along property lines, it may be desireable to surround the bamboo with an underground barrier of concrete or sheet metal that extends a few inches above ground and from two to four feet below. Two feet is probably sufficient for most *Phyllostachys* species, but a deep soil may induce an occasional rhizome to dip under the barrier so that a four foot depth is more certain.

2.4. Uses

All species of the genus make attractive ornamentals both in the ground and in pots. The culms can be spaced by appropriate cutting to produce an open grove or tight clumps.

Phyllostachys is the most useful bamboo for making a wide variety of products in Japan and other temperate regions of Asia. It is a potentially useful genus in the U.S. due to the large size of some species and its cold hardiness.

Many bamboo species produce shoots which are edible when still young and tender in the spring. The shoots of all the *Phyllostachys* species are good to eat and some are edible even when raw although others are bitter until cooked. The larger

species are most often used as food since smaller species require many shoots to produce an adequate amount for a meal.

The shoots are dug just as they emerge from the ground since once they are exposed to the light they become more bitter. To obtain a larger shoot pile dirt up around it and allow it to grow before emerging into the light. There is a limit to the size, however, because the base of the shoot becomes increasingly woody with time. To harvest the shoots dig down to the narrowed base and cut it just above where it joins the rhizome. Remove and discard the lower tough basal part and the sheaths. The remaining lower tougher part should be sliced across the grain in pieces not thicker than an eighth of an inch. The upper more tender parts can be sliced thicker and served raw if they do not taste bitter. To cook the shoots boil them for 20 minutes adding salt near the end of the boiling period. If the raw shoots are very bitter then change the water after the first 10 minutes of boiling.

3. Species Characteristics

Although it is a simple matter to distinguish the genus *Phyllostachys* from other bamboos, it is sometimes difficult to tell one species from another. Small plants especially tend to look alike whereas the mature stand is much more distinctive. Even the later may be similar enough in appearance to require a fresh culm leaf to identify the species.

Table 1 lists the important chararcteristics which help distinguish one species from another. Most entries contain a number for a given characteristic which is 0, 1, or 2 indicating that the chracteristic is lacking, moderately developed or well developed. The entries for cultivars are left blank when they are the same as the typical form. The details for each characteristic are described below.

The reader should be aware that all of the chracteristics are quite variable and that even the variability is variable. This variability has not been quantitatively documented and perhaps it is too complicated to be worth the effort. McClure in his descriptions repeatedly used the phrase "more or less", which I have tried to avoid since I have found all bamboos to be more or less variable in most of their characteristics.

The descriptions are for mature plants and may or may not hold for small plants. Plants which have grown under stress or in extreme environments will look quite different and probably not match many of the described characteristics. Aside from some distinctively colored or hairy culms, the culm leaf is the most valuable diagnostic for each species. These are usually available in a fresh state only for a few weeks in spring. I have reproduced McClure's (1957) drawings of the upper end of the culm leaf for each species in Figures 2 to 25. The drawings are of leaves taken from the middle part of the culm.

To identify a bamboo, scan through the table checking the characteristics which match your plant. Follow up by refering to the detailed descriptions in Section 4 of the most likely candidates and compare the culm leaves with the figures.

3.1. The Culms

Columns 1 through 12 of Table 1 list characteristics of the culms based on material no more than one year old. The culms tend to change color with age especially when they are exposed to sunlight so that a green culm often turns yellow after a few years. Both the white powder and hairs on the culm tend to fall off with time, sometimes disappearing soon after sheath fall.

Column 1 of Table 1 gives the maximum height in feet reached by the culms based on McClure (1957) except for a few of the largest which are taken from Young and Haun (1961). Since the maximum height depends on climate and soil conditions, it generally will not be obtained under less than ideal conditions. In England for example, Lawson (1966) gives 20 ft. as the maximum height of *P. bambusoides*. *P. nigra* generally grows no higher than 15 ft. in Southern California, but exceeds 30 ft. in the northern part of the state.

Column 2 of Table 1 gives the maximum culm diameter in inches measured at the base.

Column 3 of Table 1 is 0, 1, or 2 for culms that are usually straight, curved, or very curved. The culms of some species grow stiffly erect while in others they tend to arch more or less strongly. Since small culms often do not behave like the larger ones, one needs to observe a mature stand to use this characteristic. External forces may cause culms to bend, such as exposure to more light on one side.

Column 4 of Table 1 is 0, 1, or 2 for culms which are not zigzag, slightly zigzag, and zigzag. The zigzag characteristic is a tendancy for some of the culms to bend back and forth at the nodes. The characteristic is especially marked in *P. flexuosa* and Cvs. Slender Crookstem and White Crookstem of *P. bambusoides*. Not every culm of these species exhibits the characteristic, and sometimes only a small percentage are not straight so that a small plant with few culms may not have a single culm that is zigzag.

Culm internodes are generally short near the base. They become gradually longer reaching a maximum length at mid-culm and then become shorter again towards the tip. Columns 5 and 6 of Table 1 give the length in inches of the first and fifth internode counting from the base. The lengths were measured by McClure for each species on culms of maximum size growing in the Garden. The maximum internode length of each species is given in Section 4.

Column 7 of Table 1 indicates the color of the culm internodes by a 0 for green, 1 for green with brown or black spots, 2 for yellow with green stripes, and 3 for green with a yellow groove. The dark spots develop sometime during the first year, usually after the culm is a few months old. For details of colors see the individual species descriptions in Section 4.

Column 8 of Table 1 is 0, 1, or 2 for culm internodes which are without hair, with some hair, or covered with hair. Internodes with no hairs are smooth to the touch, while those with some hair are slightly rough feeling due to the presence of the minute stiff hairs. The only 2 in column 8 is *P. pubescens* whose culms are covered with velvety hairs. The hairs fall off with time and may be missing from

older culms.

At sheath fall the culm internodes of some species are covered with a layer of white powder which is generally loose and easily rubbed off. Column 9 of Table 1 contains a 0, 1, or 2 for no white powder, some white powder which may be limited to immediately beneath the nodes, and much white powder.

Column 10 of Table 1 is 0, 1, or 2 for culm internodes which are not ribbed, somewhat ribbed, or pronouncedly ribbed. The ribbing consists of parallel ridges or grooves that run vertically the length of the internode. They are much smaller and less pronounced than the main groove that occurs above branches and buds on all the *Phyllostachys* species.

Each node of a bamboo culm consists of 2 rings that encircle the culm (see Figure 1). The lower ring is the sheath scar, the place where the culm leaf sheath was originally attached to the culm. The upper ring is a swelling of the culm called the nodal ridge. Column 11 of Table 1 gives the relative prominence of the nodal ridge on a scale of 0 to 3. A 0 indicates that the nodal ridge is barely perceptable or lacking entirely, a condition that occurs only at nodes lacking branches. Column 12 gives the relative prominence and thickness of the sheath scars on a scale of 0 to 2.

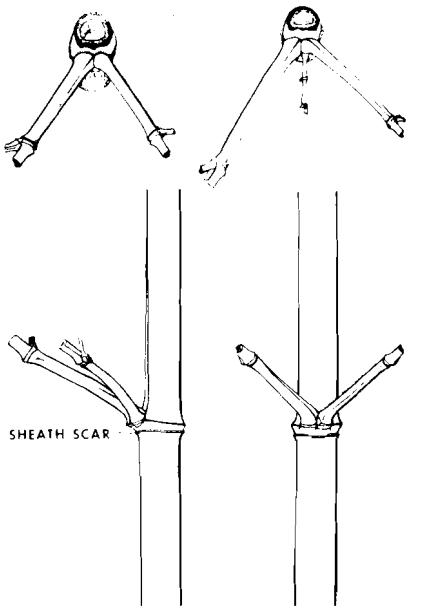

Figure 1. A midculm node with adjacent internodes of *Phyllostachys elegans* which is typical of the genus in the following features: The branch-bearing nodes are marked by a nodal ridge which lies just above the sheath scar; the internodes are flattened by grooves which run above the point where the branches join the culm; and the branches typically occur in pairs at each node with sometimes a third branch between the other two. (Based on P.I. No. 128778)

3.2. The Culm Leaves

Since culm leaves vary with their position on the culm, one should use those from the middle of the culm. Also the leaves from small culms may differ considerably from those on large culms. It is therefore best not to use sheaths from culms less than 1/2 in. in diameter.

Column 13 of Table 1 is 0, 1, or 2 for culm leaf sheaths that are unspotted, somewhat spotted, or very spotted. The spots range in size from small dots to large blotches that cover most of the sheath. Column 14 of Table 1 is 0, 1, or 2 for little, some, or much hair on the culm leaf sheath. The hair occurs on the back, or on the side and bottom margins of the sheath.

The auricles and oral setae of the culm leaf are an important indicator of species. Generally the two occur together in *Phyllostachys* - auricles commonly have oral setae and oral setae usually do not occur without auricles. Column 15 of Table 1 is 0, 1, or 2 for auricles that are small or lacking, somewhat developed, or well developed. Small culms of a species may exhibit the exact opposite of large culms in the development of the culm leaf auricles.

The culm leaf ligule is equal in importance to the auricles in distinguishing species. The ligule development is mostly dependent on its height, the dimension along the length of the culm. Tall ligules stick out between the culm leaf blade and the culm. Column 16 of Table 1 is 0, 1, or 2 for ligules that are short, medium or tall.

The upper margin of the ligule is often curved, usually up in the middle to form a convex line. Column 17 of Table 1 is 0, 1, or 2 for a margin that is straight, convex, or strongly convex.

Column 18 of table 1 is 0, 1, or 2 for a ligule margin fringed with minute hairs, moderately long hairs, or bristles.

Because the culm leaf blade varies considerably with its height on the culm, the table descriptions are very approximate. Column 19 is 0, 1, or 2 for blades that are long and narrow, medium, or short and wide.

Column 20 of Table 1 is 0, 1, or 2 if the culm leaf blade is typically pressed close to the culm, curved back, or bent strongly back and down.

Column 21 of Table 1 is 0, 1, or 2 for blades that remain flat like *P. decora* (Figure 9), blades that become wavy or slightly crinkled like *P. viridis* (Figure 25), or blades that become very crinkled like *P. vivax* (Figure 26).

3.3. The Foliage Leaves

Although foliage leaves have the same component parts as culm leaves, they are far less reliable as an indicator of species due to their greater variability. Column 22 of Table 1 is 0, 1, or 2 for foliage leaf auricles and oral setae which are usually small or lacking; moderately developed, or sometimes strongly developed and sometimes not; or usually strongly developed. Column 23 of Table 1 is 0, 1, or 2 for a foliage leaf ligule which is short, medium or tall.

The foliage leaf blade is not a very reliable indicator of the *Phyllostachys* species especially on smaller plants where blade size varies enormously. The blade shape is about the same for most species with a length that is from 5 to 7 times the width. Only *P. elegans* is shaped somewhat wider with a length to width ratio close to 4. Columns 24 and 25 of Table 1 give typical length and widths in inches of the blades on large culms.

All *Phyllostachys* foliage leaf blades usually have some hairs on the underside on each side of the midrib near its base. Some of the species tend to have additional hair usually on the underside of the blade. New blades should be examined since the hairs have a tendency to fall off. Column 26 of Table 1 is 0, 1, or 2 for leaves that have no hair, a little hair, or some hair (in addition to that on the underside near the base).

4. The Species

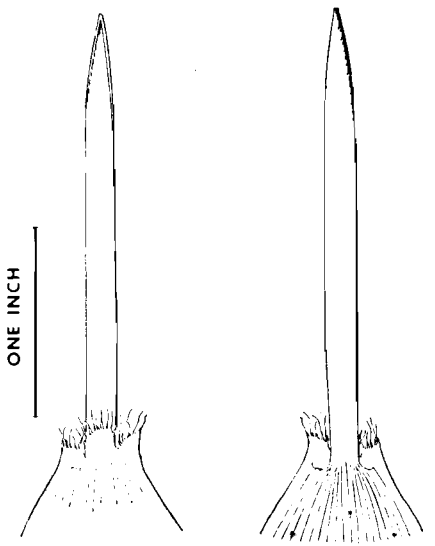

Figure 2. *Phyllostachys angusta* (P.I. No. 23237). Inner (left) and outer (right) views of the upper end of a culm leaf, showing the blade and the fringed ligule.

P. angusta **McClure**
Stone bamboo

P. angusta is called stone bamboo by the Chinese because of the hard, strong wood of its culms which are used to make fine bamboo furniture. It was first introduced in 1907 from material obtained at Tang-si, Chekiang Province, China.

The species is not widely distributed in the U.S. It has proven to be less hardy than *P. aureosulcata*, *P. dulcis*, and *P. nuda* at Glen Dale, MD., and it is killed by temperatures slightly below 0° F.

Culms to 22 feet tall by 1 1/4 in. in diameter, fairly straight, erect; internodes to 8 in. long, green, hairless, with only a little white powder mostly below the nodes at sheath fall, not ribbed; nodal ridges slightly more prominent than the sheath scars; sheath scars hairless, thin, moderately flared.

Culm leaf sheaths very pale in color, striped cream and lavender when fresh, sparsely strewn with small brown dots, hairless; auricles and oral setae lacking; ligules tall, narrow, pale greenish yellow, the apex straight to somewhat convex, the margin toothed or lobed and prominently fringed with pale bristles; blades narrow, lance-shaped to strap-shaped, spreading away from the culm, not crinkled.

Foliage leaves rarely show auricles or oral setae; ligules well developed, protruding; blades hairless, up to 6 1/4 by 3/4 in., commonly 4 1/2 in. long by 11/16 in. wide.

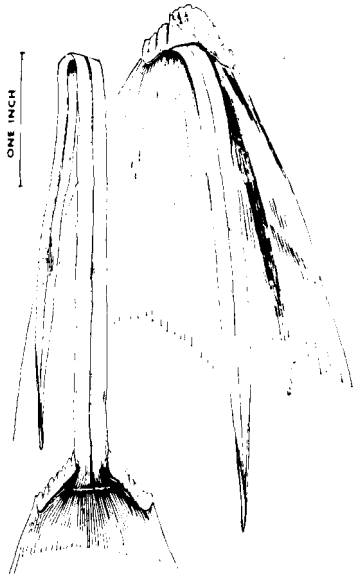

Figure 3. *Phyllostachys arcana* (P.I. No. 77007). Upper end of a culm leaf, showing the blade and ligule.

P. arcana McClure

The species was first brought to the U.S. in 1926 by McClure from Chiu-hwa-shan, Anhwei Province in eastern China. The split culms are used in China for weaving matting and for making lanterns. *P. arcana* resembles *P. nuda* differing from

it by having a strongly arched ligule that extends down the sides of the culm leaf sheath. *P. arcana* is also unique in having dormant buds at the lower culm nodes that are partially covered by the nodal ridges. Since the only mature stands of *P. arcana* are at the Garden, its hardiness is unknown.

Culms to 27 ft. high and 1 1/4 in. in diameter, sinuous, curved near the base or erect; internodes up to 14 in. long, sometimes spotted black with age, green, with abundant, loose white powder at sheath fall, hairless, usually perceptibly ribbed; nodal ridges prominent, narrow; sheath scars hairless, thick, strongly flared.

Culm leaf sheaths grayish or lavender beige with prominent green veins outlined in lavender, sparsely spotted with small brownish-purple dots, with noticeable white powder at first, rough to smooth; auricles and oral setae lacking; ligules tall, strongly convex at the apex, the margin with or without tiny hairs, extending down the sides of the sheath, especially on sheaths from lower and middle nodes; blades narrow, lance-shaped to strap-shaped, spreading away from the culm or strongly bent back, often wavy, but not crinkled.

Foliage leaves usually without auricles and oral setae; ligules protruding, rounded on the top; blades usually hairless even at the base on the lower surface, up to 6 1/8 by 3/4 in., more commonly 4 by 5/8 in. or smaller.

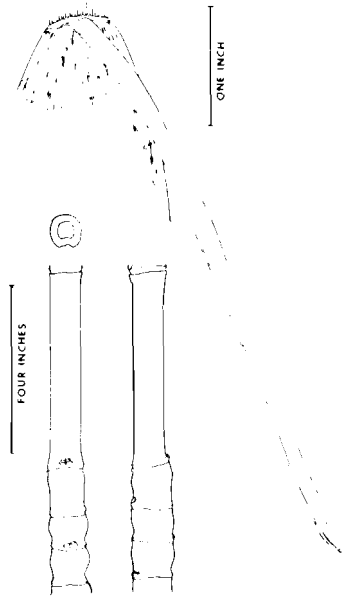

Figure 4. *Phyllostachys aurea* (P.I. No. 75153). Upper end of a culm leaf, showing the blade and fringed ligule; below is the base of culms that have shortened internodes, a feature that occurs on some of the culms of this species.

***P. aurea* A. & C. Riv.**
[*P. bambusoides* Var. *aurea* (Riv.) Makino]
Golden bamboo, Fishpole bamboo, Hotei-chiku

Golden bamboo is the most commonly grown bamboo in the United States where it was introduced as early as 1883. It is grown as an ornamental in warm temperate and subtropical regions throughout the world. Native to China and long cultivated in Japan the culms are used in both countries for fishing poles, walking sticks, umbrella handles and many other things.

Golden bamboo is easily distinguished from other members of the genus by the occurrence of from one to several very short irregularly shaped internodes near the base of some of the culms (see Figure 4). The percentage of culms having this feature is variable so that a small plant with only a few culms may have none with the shortened internodes.

Golden bamboo will survive 0° F with no injury even to the leaves while at -5° F the culms can be killed. It has grown well in Buffalo, NY. for 13 consecutive winters without injury.

Culms to 27 feet tall by 1 5/8 in. in diameter, straight and stiffly erect; internodes up to 10 in. long, green, often powdery soon after sheath-fall, not ribbed, hairless; nodal ridges moderately prominent; sheath scars thin, not strongly flared, as prominent as the nodal ridges, fringed with short white hairs that persist for some time after sheath-fall.

Culm leaf sheaths pale olive green to pale rosy buff, with wine or pale green veins, sparsely strewn with small brown spots, not powdery, bearing minute white hairs along the base, otherwise hairless; auricles and oral setae lacking; ligules short, the apex usually slightly convex, fringed with hairs on the margin on lower sheaths, slightly taller and fringed with longer, coarser hairs on mid-culm sheaths; blades lance-shaped and more or less crinkled on the lower part of the culm, long and narrowly strap-shaped and pendulous above.

Foliage leaves with auricles and oral setae well developed or often lacking entirely; ligules short, scarcely protruding; blades hairless, up to 6 1/2 by 7/8 in., more commonly 4 to 4 3/4 by 3/4 in.

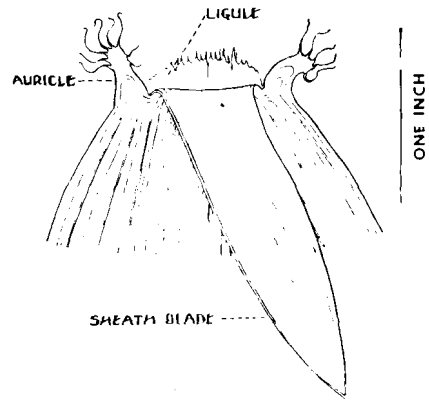

Figure 5. *Phyllostachys aureosulcata* (P.I. No. 55713). Upper end of a culm leaf, showing the blade, ligule, and auricles.

***P. aureosulcata* McClure**
Yellowgroove bamboo

The yellowgroove bamboo was obtained from Tang-si, Chekiang Province, China in 1907. In the U.S. it is probably the most widely distributed species of the genus next to *P.aurea* and *P. bambusoides*.

The leaves of the yellowgroove bamboo are not seriously damaged at -3° F. The culms are often injured at -5° F and even established groves are killed to the ground at -10° F. The species has been successfully grown in Buffalo, NY and Boston, Mass.

Culms to 26 ft. tall by 1 3/8 in. in diameter, erect or nearly so, straight, occasionally strongly zigzag; internodes up to 10 in. long, dull green, with a yellow to greenish-yellow groove on culms that are one or two years old, rough at first, lightly powdery, especially just below the nodes, usually not ribbed; nodal ridges moderately prominent, narrow; sheath scars abruptly flared, almost as prominent as the nodal ridges.

Culm leaf sheaths pale olive with pale green and often pale-wine and cream streaks, with whitish stripes, never spotted, hairless more or less powdery when fresh; auricles usually well developed in the middle of the culm, sparcely fringed with crinkly oral setae; ligules well developed, broadly convex, the margin toothed and

fringed with minute, white hairs; blades lance-shaped and commonly bent back in lower sheaths, triangular and not elongate, sometimes wavy, spreading back in upper sheaths.

Foliage leaves with auricles and oral setae usually lacking; ligules weakly protruding, leaf blades hairless, up to 6 1/4 by 3/4 in., commonly 3 1/2 in. by 1/2 in.

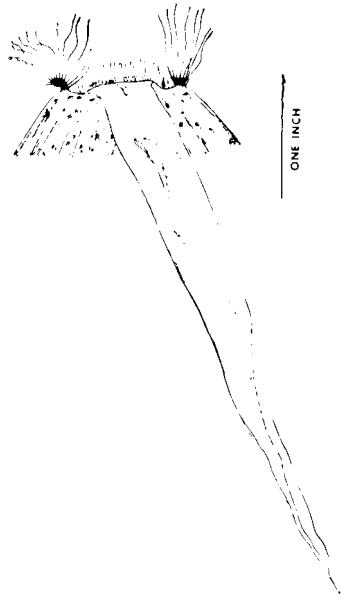

Figure 6. *Phyllostachys bambusoides*, typical form (P.I. No. 40842). Upper end of a culm leaf showing the blade, ligule and auricles.

***P bambusoides* Sieb. & Zucc.**
[*P. reticulata* Koch, *P. quilioi*]
Madake, Giant timber bamboo, Japanese timber bamboo, Hardy timber bamboo.

Madake is a native of China that has long been grown in Japan. It is the most cultivated bamboo in both countries because of its large, straight culms and its high production of edible shoots. Madake has been grown in the U.S. at least since 1889. It is widely distributed along both the Pacific and Atlantic coasts. Many plants died, however, in a general flowering of the species that began in about 1970 in the U.S. (Soderstrom and Calderón, 1976). Some plants are still flowering while others have not flowered at all. (Adamson et al., 1978). Seeds and seedlings have been produced from several different flowering plants. Plants are coming back after flowering in Santa Cruz and Campbell, CA. A small plant has been started at Quail from material collected at a grove that flowered and mostly died near Chico, CA. The species grows in Washington, D.C. but it appears to be less hardy than *P. aurea*.

Culms to 72 ft. tall and 5 3/4 in. in diameter, erect or nearly so, relatively straight; internodes up to 17 in. long on a culm 48 ft. long, green, hairless, without white powder at sheath fall, usually not ribbed; nodal ridges about as prominent as the sheath scars; sheath scars thin, hairless, not strongly flared.

Culm leaf sheaths greenish to ruddy buff, densely spotted with dark brown; auricles usually developed at nodes above the basal ones, with greenish crinkled oral setae; ligules moderately well developed, the apex convex and fringed with minute hairs on smaller culms, the apex nearly straight and fringed with coarse bristles on larger ones; blades short, lance-shaped, bent back and crinkled in lower sheaths to long, strap-shaped and curved back in upper ones, green down the middle, with an equally wide band of blended wine, green, and buff on each side, and a narrow margin of cream.

Foliage leaves usually with auricles and oral setae well developed; ligules well developed; blades up to 7 1/2 by 1 1/4 in. commonly from 1 5/8 by 1/2 to 6 7/8 by 1 in.

***P. bambusoides* Cv. Allgold McClure**
[*P. sulphurea* A. & C. Riv.]
Allgold bamboo

Allgold bamboo differs from the typical form of the species by having bright yellow culms at sheath-fall. An occasional culm will also show a thin vertical stripe of green on a lower internode. Allgold is also smaller in ultimate size than the typical form. Allgold differs from Robert Young bamboo by the color of the culms at sheath-fall - bright yellow for Allgold, yellowish green for Robert Young. Allgold differs from Castillon by the color of the culm grooves - yellow for Allgold, Green for Castillon.

Allgold bamboo no longer is growing at the Garden and I know of no mature stands. There are small plants which are reported to be Allgold; They must grow larger to verify the identification.

***P. bambusoides* Cv. Castillon McClure**
[*Bambusa castilloni* Marliac ex Carrière, *P. Castillonis* (Marl.) Mitf.]
Castillon Bamboo

Castillon bamboo differs from the typical form of the species by having yellow culms with bright green culm grooves. It is smaller than the typical form reaching a height of about 30 ft.

All of the Castillon bamboo in the U. S. may have died due to the recent flowering. In all known cases the mother plants either died or the new growth that came up after flowering reverted to the typical form of the species. The seedlings produced have also all been of the typical form (Soderstrom and Calderón, 1976).

P. bambusoides Cv. Marliacea (Mitf.) Makino

Marliacea differs from the typical form by having short internodes at the base of its culms that are longitudinally wrinkled. The culms only reach a height of about 10 ft.

P. bambusoides Cv. Slender Crookstem McClure
[*P. reticulata* f. *genticulata* Nakai]

Slender Crookstem bamboo differs from the typical form by having some culms which curve gently to one side and then up again. The curvature is limited to 1 or 2 internodes that are within a few feet of the base of the culm. The culms are more slender for their height and both the nodal ridges and sheath scars are less pronounced than in the typical form.

The propagating material for Slender Crookstem was obtained from Tang-wan-foh, near Tak-hing, Kwangtung Province, China in 1925. A small grove is growing at the Huntington.

P. bambusoides Cv. White Crookstem McClure

White Crookstem bamboo is similar to Slender Crookstem except that the culms are covered with a heavy layer of white powder which in older culms may completely obscure the green color. The cultivar was obtained from Lung-tau Mountain, Kwangtung Province, China in 1926 and now grows in the Garden.

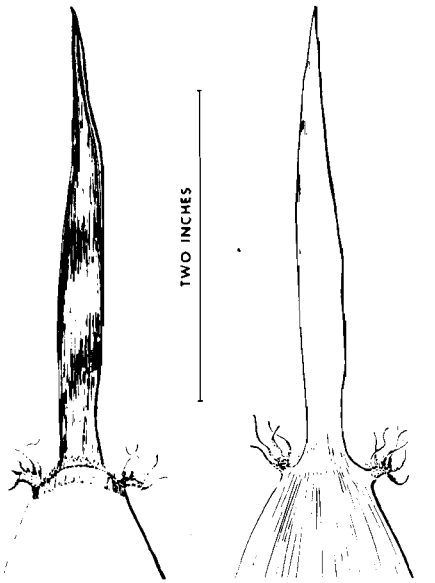

Figure 7. *Phyllostachys bissetii* (P.I. No. 143540) Inner (left) and outer (right) views of the upper end of a culm leaf, showing the blade, ligule and auricles.

P. bissetii McClure

P. bissetii was collected from cultivated plants at Cheng-tu, Szechwan Province, China in 1941. It somewhat resembles *P. aureosulcata* but it lacks the yellow colored culm groove.

The species is killed at temperatures below -5° F and is not as hardy as *P. aureosulcata*, *P. dulcis*, and *P. nuda*. There are two groves of the species growing at the Huntington.

Culms up to 23 ft. tall and 1 in. in diameter, erect or nearly so; internodes up to 13 in. long, green, with loose white powder at sheath fall, hairless or the lower ones rough on the upper half due to minute erect hairs; nodal ridges moderately prominent; sheath scars hairless, rather strongly flared, about as prominent as the nodal ridges.

Culm leaf sheaths pale green or yellow green, tinted with wine, not spotted, irregularly powdery, thin, splitting, dusky beige on drying, the lower ones somtimes hairy on the back and margins; auricles developed or sometimes one or both lacking; oral setae few or lacking; ligules about 1/8 in. tall, convex at the apex, the margin irregular and fringed with slender, white hairs; blades pressed against the culm or bent back, narrowly triangular to ovate lance-shaped, extending into the auricles at

the base.

Foliage leaves usually with auricles; ligules moderately developed; blades up to 4 by 1/2 in., more commonly 2 1/4 to 3 1/4 by 3/8 to 1/2 in.

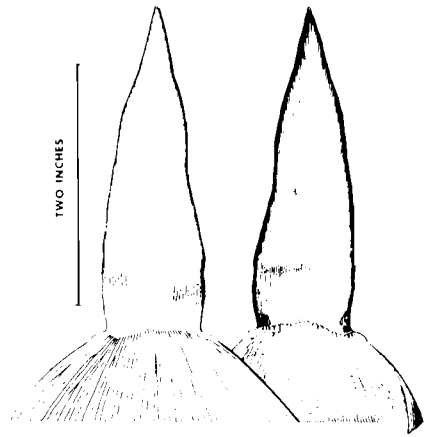

Figure 8. *Phyllostachys congesta* (P.I. No. 80149). Outer (left) and inner (right) views of the upper end of a culm leaf, showing the blade and ligule.

P. congesta Rendle

P. congesta was introduced into the U. S. in 1907 with material collected from Tang-si, Chekiang Province, China. The species is limited in its distribution and there is no information on its hardiness.

Culms up to 25 ft. tall and 2 1/8 in. in diameter, strongly tapered, stiffly erect or nearly so; internodes up to 11 in. long, loosely powdery, especially below the nodes at sheath fall, green, hairless, perceptibly but not markedly ribbed; nodal ridges rather prominent; sheath scars thick, prominently flared, hairless.

Culm leaf sheaths hairless, dark green mixed with wine, powdery near the base and apex; auricles commonly lacking, sometimes replaced by a few weak oral setae; ligules as wide as the blade but very short, the apex straight to slightly convex, the margin slightly irregular, densely fringed with minute white hairs; blades broadly triangular or lance-shaped, pressed to the culm and flat in the lower sheaths.

Foliage leaves with auricles mostly reduced to a narrow line, oral setae few to several or lacking; ligules very short, scarcely protruding; blades hairless or nearly so,

up to 5 by 5/8 in., commonly 3 to 4 in. long by 3/8 to 1/2 in. broad.

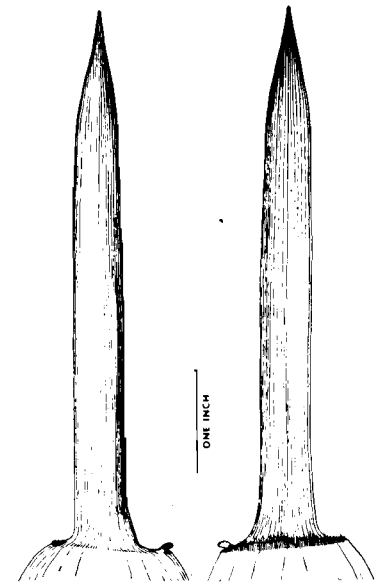

Figure 9. *Phyllostachys decora* (P.I. No. 128789). Outer (left) and inner (right) views of the upper end of a culm leaf, showing the blade and ligule.

P. decora McClure

P. decora was introduced in 1938 from Kiangsu Province, China where it has a common name that means Beautiful bamboo. Although the distribution of this species is limited, it does well in eastern Maryland near Baltimore where it is found to be as hardy as *P. bissettii.* It is killed at temperatures below -5° F.

Culms up to 24 ft. tall and 1 1/4 in. in diameter, green; nodes and internodes at first sparsely strewn with very short hairs which soon fall off; internodes up to 6 in. long, at first slightly powdery becoming densely so beneath the nodes; sometimes slightly ribbed; nodal ridges and sheath scars moderately and equally prominent, sheath scars hairless.

Culm leaf sheaths wide and straight at the apex, abruptly rounded, hairless, not powdery, spotless or sparsely strewn with minute dark spots, dark green with pale green or white stripes with a purple margin at the apex; auricles one, two or none, with or without oral setae; ligules purple at first, very wide and short, straight or slightly wavy or weakly convex at the apex, the margin fringed with white hairs backed by thick, rough, dark bristles; blades broadly lance-shaped to strap-shaped, the lower ones pressed to the culms, the upper ones sometimes spreading, sometimes

wavy.

Foliage leaves with auricles that are small or lacking; oral setae few, fragile, soon falling off; ligules not protruding; blades up to 6 in. long by 1 in. broad, more commonly 4 in. by 3/4 in., sparsely hairy below.

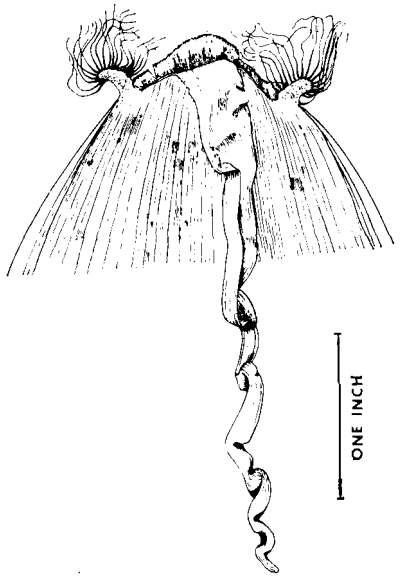

Figure 10. *Phyllostachys dulcis* (P.I. No. 73452). Upper end of a culm leaf, showing the blade, ligule, and auricles.

P. dulcis McClure
Sweetshoot Bamboo

Sweetshoot bamboo is named for the superior taste of its shoots. It was introduced from Chekiang Province, China by Frank Meyer who described it as "the edible bamboo of Central China". It is a fast growing, agressive species that produces a good supply of shoots. The culms, however, are of inferior strength compared to other species. *P. dulcis* is almost as hardy as *P. aureosulcata.*

Culms up to 39 ft. tall and 2 3/4 in. in diameter, strongly tapered, sometimes erect, often strongly curved; internodes up to 13 in. long, dull green, often finely striped with cream or pale green, with abundant loose powder, especially below the nodes at sheath fall, hairless, strongly and unevenly ribbed; nodal ridges fairly prominent; sheath scars thick, abruptly flared, hairless.

Culm leaf sheaths somewhat powdery, hairless or with scattered stiff erect hairs, sparsely strewn with small brown spots and sometimes striped with white and tinged with lavender or pale rose when fresh, pale straw or nearly white, thin,

splitting and showing prominent veins when dry; auricles well developed, fringed with well developed, crinkled oral setae; ligules strongly convex, with minute hairs on the undulating margin, extending down the sides on lower sheaths; blades lance-shaped to strap-shaped, strongly crinkled, pressed to or slightly spreading away from the culm in the lower sheaths, arched or drooping in the upper ones.

Foliage leaves with auricles and oral setae strongly developed to lacking entirely; ligules strongly protruding, with minute hairs on the margin; blades up to 5 by 7/8 in., more commonly 3 5/8 to 4 in. by 5/8 to 3/4 in., sometimes hairy on the lower surface.

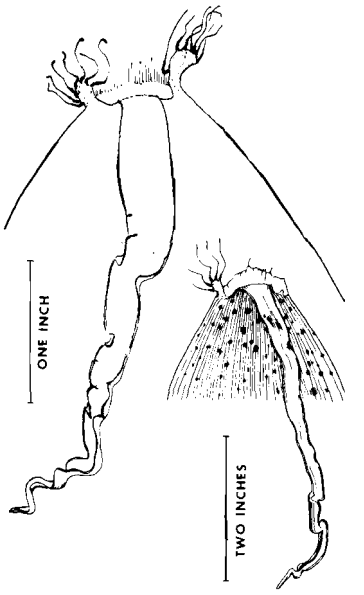

Figure 11. *Phyllostachys elegans* (P.I. No. 128778). Upper end of a culm leaf, showing the blade, ligule and auricles. The inset below shows a leaf with only one auricle; the margin of the ligule has lost most of its originl fringe of hairs.

P. elegans McClure

P. elegans was introduced in 1938 from Hainan Island, China. The species is highly regarded for its shoots but the culms are not of a high technical quality.

P. elegans differs from *P. dulcis* by having unstriped culm leaf sheaths that are more densely spotted, straight erect culms, and shorter internodes in the lower part of the culm. *P. elegans* differs from *P. viridi-glaucescens* by having short, broad leaves that are hairy on the lower surface. Since this species has not been distributed outside of the Garden its hardiness is unknown.

Culms up to 32 ft. tall and 2 1/4 in. in diameter, evenly tapered from base to tip, fairly straight, erect or nearly so; internodes up to 12 in. long, finely ribbed, hairless, dull green at first, later obscurely speckled with tiny, rusty-brown spots where exposed to full sunlight, with conspicuous loose white powder at sheath-fall; nodal ridges narrow, not very prominent; sheath scars thin, hairless, as prominent as the nodal ridges.

Culm leaf sheaths somewhat powdery, olive green, sometimes suffused with lavender, moderately to densely strewn with small brown spots, rough to the touch, especially toward the margins near the apex, sometimes sparsely strewn with erect bristles; auricles one or two, occasionally lacking, with prominent, crinkled oral setae; ligules well developed, weakly convex, fringed with rough bristles; blades lance-shaped to strap-shaped or narrowly triangular, usually crinkled, spreading, arched, or bent back.

Foliage leaf sheaths commonly tinted with wine, with auricles usually well developed and fringed with oral setae; ligules slightly protruding with a few minute hairs on the margin; blades lance-shaped, up to 4 by 3/4 in., more commonly less than 3 1/8 in. long by 3/4 in. broad, densely hairy on the lower surface.

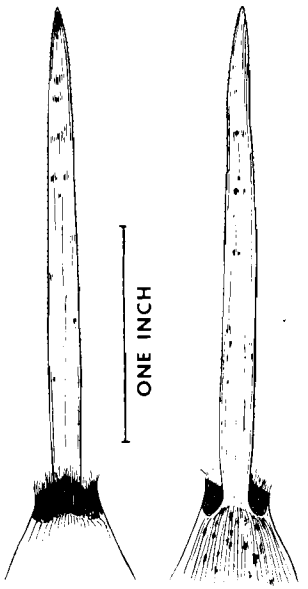

Figure 12. *Phyllostachys flexuosa* (P.I. No. 52686). Inner (left) and outer (right) views of the upper end of a culm leaf, showing the blade and ligule.

***P. flexuosa* A. & C. Riv.**

P. flexuosa is a native of China, that was introduced into the U.S. by way of France in 1921. The species gets its name from the zigzag character of some of its culms. The wood is of medium quality and has been used for fishing poles and plant stakes.

P. flexuosa is rather widely distributed. It grows well in Buffalo, NY. and Long Island, NY. At Orchard Park, NY. it has proven to be about as hardy as *P. aureosulcata*. The leaves have survived -3° F. without damage while at -5° F. the culms suffered some injury. A grove of *P. flexuosa* is growing at the Huntington.

Culms up to 31 ft. tall and 2 3/4 in. in diameter, erect or nearly so, straight or sometimes somewhat zigzag and occasionally strongly zigzag, internodes up to 14 in. long, green, perceptibly powdery, especially below the nodes at sheath fall, hairless, ribbed; nodal ridges moderately prominent; sheath scars as prominent as the nodal ridges, thin, hairless.

Culm leaf sheaths greenish beige with purplish close-set veins, blotched with small brown areas, hairless, not powdery; auricles and oral setae lacking; ligules strongly developed, dark maroon, the apex straight to convex, fringed with minute to long, coarse hairs; blades narrow, lance-shaped to strap-shaped, mostly bent back or strongly arched.

Foliage leaves usually without auricles or oral setae; ligules moderately developed, usually not tinted with wine, blades 2 by 3/8 in. to 6 by 3/4 in., densely hairy to almost hairless on the lower surface.

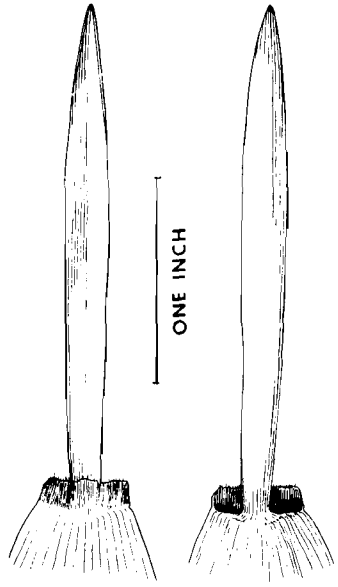

Figure 13. *Phyllostachys glauca* (P.I. No. 77011). Inner (left) and outer (right) views of the upper end of a culm leaf, showing the blade and the ligule.

P. glauca McClure

P. glauca was collected from a garden in Nanking, Kiangsi Province, China in 1926 by McClure. Although it is similar to *P. flexuosa* in appearance, *P. glauca* is more vigorous and grows to a larger size. The young culms of *P. glauca* are completely and evenly covered with white powder which makes them distinctive even at a distance. Because of its limited distribution the hardiness of *P. glauca* is unknown.

Culms up to 34 ft. tall and 2 in. in diameter, internodes up to 16 1/2 in. long, green, hairless, completely covered with white powder at sheath fall, straight or rarely slightly bent at the base, not ribbed; nodal ridges and sheath scars moderately and equally prominent, the sheath scars hairless.

Culm leaf sheaths narrow and straight at the apex, hairless, green suffused with wine, with a few small brown spots, especially at the base and apex, occasionally almost without spots; auricles and oral setae lacking; ligules dark, wide and relatively short, straight or slightly wavy at the apex, rarely slightly concave in the lower sheaths, hairy on the margins; blades lance-shaped to strap-shaped, lower ones bent back, upper ones spreading away from the culms.

Foliage leaves usually without auricles; ligules moderately developed, at first slightly tinted with purple; blades at first sparsely hairy along the veins on the lower

surface, up to 7 by 1 1/4 in. in young culms, commonly around 4 5/8 by 3/4 in. in older culms.

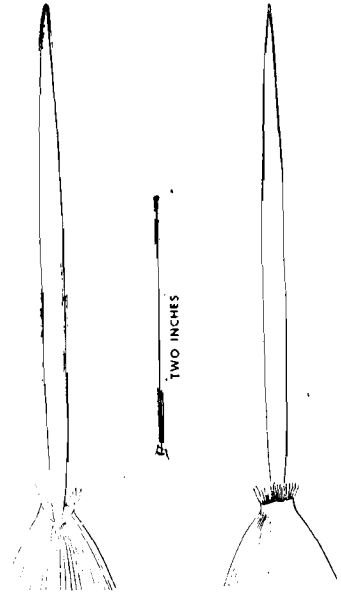

Figure 14. *Phyllostachys makinoi* (P.I. No. 195284). Outer (left) and inner (right) views of the upper end of a culm leaf, showing the blade and ligule.

P. makinoi Hayata

Although *P. makinoi* grows 60 ft. tall in Formosa, the plants introduced in 1951 were only 12 ft. tall at the Garden when McClure described them four years later. McClure says that the young plants of *P. makinoi* closely resemble young plants of *P. viridis* and that the original description of *P. makinoi* is not complete enough to establish whether the young plants at the Garden are in fact *P. makinoi* or *P. viridis*. In February 1980 I observed plants designated as *P. makinoi* at the Garden. The plants grew in a field among bushes and small trees; none of the culms were taller than about 15 ft. The species is said to be hardy in Washington, DC.

Culms up to 60 ft. tall and 2 5/8 in. in diameter 3 ft. above the ground in Formosa, up to 12 ft. high and 5/8 in. in diameter in four year old plants, stiffly erect; internodes pale green with purplish-brown spots just above the nodes, hairless, covered with white powder which is densest just below each node, becoming gradually thinner downward, rapidly becoming thicker throughout the internode immediately after sheath-fall, giving a pale blue-green overall effect; nodal ridges and sheath scars of moderate prominence, the later thin, without hairs.

Culm leaf sheaths pale green, hairless, sparsely to densely strewn with smoky-brown spots, white powder barely perceptible or none; auricles and oral setae lacking; ligules straight, prominantely fringed with dark bristles that are red when fresh, dark brown when dry; blades lance-shaped to strap-shaped, spreading in lower sheaths to broadly arched or drooping in upper ones, pale green, sometimes tinted with wine, with a broad white or cream border.

Foliage leaves with auricles and oral setae; ligules well developed, pale green to smoky, blades 4 1/2 to 5 1/2 in. long by 5/8 to 1 in. broad.

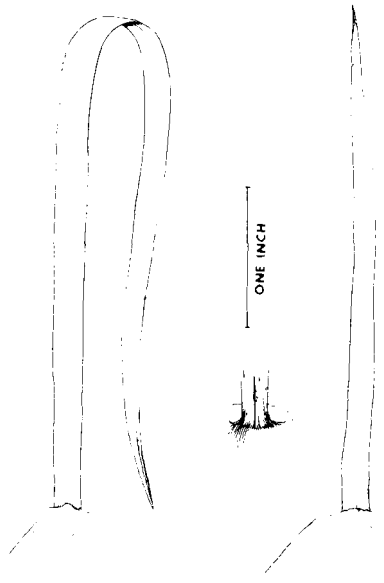

Figure 15. *Phyllostachys meyeri* (P.I. No. 116768). Inner (left and right) and outer (center) views of the upper end of a culm leaf, showing the blade and ligule.

P. meyeri McClure

Meyer bamboo was introduced in 1907 from Tang-si, Chekiang Province, China. The culms are among the finest and strongest of the genus. *P. meyeri* resembles *P. aurea* except that although the first few basal internodes are often rather short, they never show the irregular swelling that occurs in *P. aurea*. Also the culm sheath ligule is longer, humped, and less prominently fringed with hairs on *P. meyeri* than on *P. aurea*. The fringe of white hairs on the border of the culm sheath of *P. meyeri* distinguishes it from *P. propinqua*.

The single clone of *P. meyeri* introduced in 1907 flowered from 1967 to 1971 at the Garden and survived. A stand near Chico, CA. also flowered in recent years

and now has mostly died. The species is hardy to slightly below 0° F.

Culms up to 33 ft. tall and 2 in. in diameter, erect, straight or nearly so; internodes up to 14 in. long, green, perceptibly powdery especially below the nodes at sheath-fall, hairless, not ribbed; nodal ridges moderately prominent; sheath scars as prominent as the nodal ridges, thin, sharp, fringed with minute white hairs.

Culm leaf sheaths greenish buff, spotted and blotched with brown, perceptibly powdery, fringed along the base with a narrow band of small white hairs, otherwise hairless; auricles and oral setae lacking; ligules protruding, of medium length, the apex convex with a hump in the middle, often slightly asymmetrical, the margin with hairs that soon fall off; blade lance-shaped to narrowly strap-shaped, very long at midculm, broadly arched, wavy to slightly crinkled.

Foliage leaves with auricles and oral setae usually weak or lacking; ligules prominently protruding, the apex strongly convex; blades up to over 6 in. long by 1 1/2 in. wide, commonly 3 to 4 in. by 1/2 to 3/4 in., hairy at the base and decreasingly so toward the apex on the lower surface.

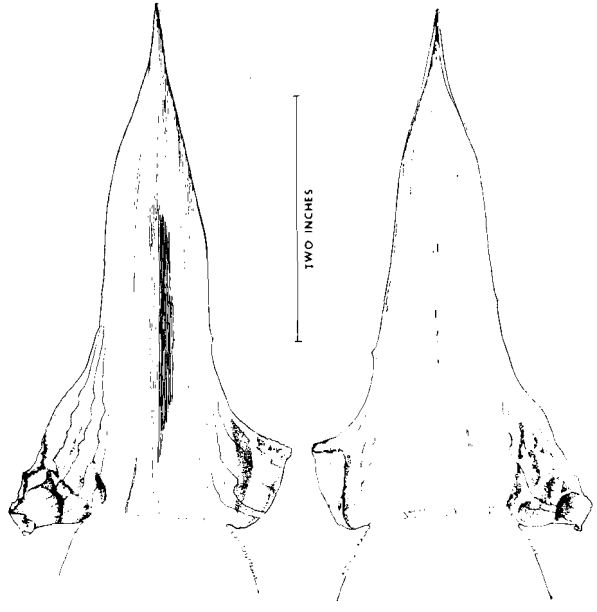

Figure 16. *Phyllostachys nidularia*, typical form (P.I. No. 63696). Outer (left) and inner (right) views of the upper end of a culm leaf, showing the blade, ligule, and auricles.

P. nidularia Munro

P. nidularia is distinctive from the other members of the genus by its prominent culm nodes and by its large, wide culm leaf blades which blend into large

auricles on each lower side. Nine different introductions of the typical form of the species have been made from various parts of China. Four of these have flowered at the Garden; one recovered and the other three died. The clones differ from each other in several respects such as culm-wall thickness, culm internode thickness and even the taste of the new shoots. The species is hardy in Washington, DC.

Culms to 33 ft. tall and 1 1/2 in. in diameter, straight and erect, sometimes sinuous, often arched under the weight of the foliage; internodes up to 16 in., green, usually ribbed, the lower ones sometimes solid or nearly so, with much loose, white powder at sheath fall, usually hairless; the nodal ridges very broad and prominent; sheath scars thick, strongly flared, conspicuously fringed at first with long, brown hairs.

Culm leaf sheaths olive green to pale green and white, usually streaked vertically with these tints and wine at the lower nodes, loosely powdery near the apex and base, with shaggy, brown hairs near the base, hairless elsewhere on the back, the margins with hairs; auricles very large, often crinkled, clasping; oral setae few, small, inconspicuous; ligules short, narrower than the blade, the apex convex, rarely straight, the margin fringed with dense, small, white hairs; blades large, pressed to the culm, broadly spear-shaped, continuous below on either side into the auricles.

Foliage leaves usually with auricles and oral setae weakly developed or lacking; ligules very short, not protruding; blades up to 5 1/2 in. long by 3/4 in. broad, commonly 3 to 4 in. by 5/8 in., hairless or nearly so on the lower surface.

P. nidularia Cv. Smoothsheath McClure

Cultivar Smoothsheath differs from the typical form by the lack of shaggy brown hairs near the base of the culm leaf sheath and on the sheath scars. Smoothsheath was introduced in 1924 from wild plants collected by McClure in Kwangsi Province, China.

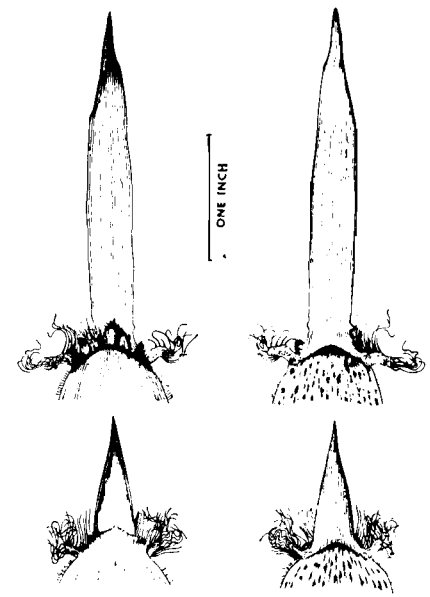

Figure 17. *Phyllostachys nigra*, typical form (P.I. No. 66784). Inner (left) and outer (right) views of the upper end of culm leaves, showing the blades, ligules, and auricles.

P. nigra (Lodd.) Munro

[*Bambusa nigra* Lodd. ex Lindl., *P. puberula* Var. *nigra* H. de Leh.]
Black bamboo, Kuro-Chiku

Black bamboo is a favorite garden ornamental because of its jet black culms and branches. The wood of the culms although not very thick, is hard enough to be used for decorative panels, inlays and cabinet making.

In Southern California where Black Bamboo usually grows no taller than about 15 ft., the leaves often show a brownish burn at the tips due to the high salt content of the tap water. In Northern California at Hakone Gardens Black bamboo grows much larger, up to 30 ft. tall with culm diameters of more than 2 in.

Culms up to 30 ft. tall and 2 in. in diameter, internodes up to 13 in. long, green at first, gradually becoming speckled, then more or less completely covered with purplish to brownish to black spots, with much loose white powder at sheath fall, often covered with minute bristles at first, then almost hairless, sometimes hairless from the first, especially in small culms, smooth or sometimes ribbed; nodal ridges moderately prominent; sheath scars as prominent as the nodal ridges, thin, usually flared, hairless or fringed with brown hairs.

Culm leaf sheaths greenish buff to pale buff to ruddy buff, unspotted, usually sparsely strewn with erect hairs; auricles prominently developed, fringed with numerous bristly oral setae; ligules well developed, convex; blades broadly to narrowly triangular, wavy, especially in larger culms, pressed to the culm in the lower sheaths, spreading away from the culms in the upper ones.

Foliage leaves with auricles and oral setae usually weak or lacking, ligules very short, scarcely protruding; blades commonly up to 3 5/8 in. long and 1/2 in. broad, exceptionally up to 5 in. by 3/4 in., usually hairless, rarely with hairs on the lower surface.

***P. nigra* Cv. Bory McClure**

[*P. boryana* Mitf., *P. puberula* Var. *boryana* Mak., *P. nigra henonis* F. *boryana* Mak.]

Bory bamboo differs from the typical form by the appearance of a few purplish or dark brown spots or blotches on the culms generally at some time during the first year. The blotches are not so dense as to completely cover the internodes as in the typical form. Bory is also larger than the typical form reaching a height of 50 ft. with culms 3 in. in diameter. The species is not widely distributed and its exact hardiness is not known.

***P. nigra* Cv. Henon McClure**

[*Bambusa puberula* Miq., *P. puberula* (Miq.) Munro, *P. henonis* Mitf., *P. nigra* Var. *henonis* (Mitf.) Stapf ex. Rendle]

Henon bamboo, Ha-Chiku

Henon bamboo differs from the typical form by having culms and branches that remain green and by growing to an ultimate size that may reach 54 ft. in height with culms up to 3 1/4 in. in diameter. It is distinguished from other members of the genus by the rough feel of the new culms which are at first covered with short stiff hairs, by the unspotted culm sheaths that are inconspicuously coated with spreading brown hairs, and by the well-developed culm leaf auricles that are fringed with lavender bristles.

Henon is a native of southern China that was introduced into Japan at an early unrecorded date. It was introduced into the U.S. from Japan in 1909, from Kwangtung Province, China in 1926, and from Kew, England in 1927. Henon bamboo is less hardy than *P. aureosulcata*, *P. flexuosa* and *P. dulcis*. Mature stands grow at Santa Cruz, CA. and at Williamsburg, VA.

***P. nigra* f. *punctata* (Bean) Nakai**

Form *punctata* differs from the typical form by having culms which remain spotted and generally do not become completely covered with a solid dark color. The light brown to dark maroon spotting is much denser than in Bory. A grove of *punctata* is growing at the Huntington.

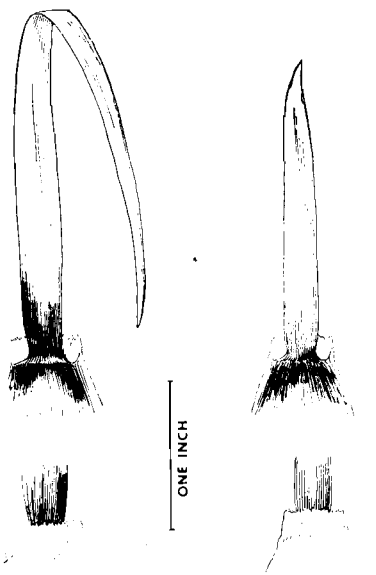

Figure 18. *Phyllostachys nuda* (P.I. No. 103938). Outer (above) and inner (below) views of the upper end of culm leaves showing the blades and ligules.

***P. nuda* McClure**

The name "nuda" refers to the complete lack of auricles and oral setae on both culm and foliage sheaths. A single introduction of *P. nuda* from Chekiang Province was made in 1907. *P. nuda* resembles *P. arcana* from which it can be distinguished by its straight culm leaf ligules.

P. nuda could well be the most hardy species of the genus. It has survived -10° F with no damage and - 16° F with only leaf damage; it has been killed to the ground at -20° F. A 34 foot high grove at Glen Dale, MD. planted in 1918 has survived when all other *Phyllostachys* species were killed to the ground. *P. nuda* still survives at Glen Dale but it no longer grows at the Garden.

Culms up to 34 feet tall and 1 5/8 in. in diameter, internodes up to 7 1/2 in. long (in a culm 16 ft. long), green, with much loose white powder at sheath fall, hairless, perceptibly ribbed; nodal ridges rather prominent; sheath scars as prominent as the nodal ridges, hairless.

Culm leaf sheaths grayish wine, powdery, rough due to minute hairs, the margins hairless, basal ones blotched with wine, the upper ones spotless; auricles and oral setae lacking; ligules strongly protruding, the apex straight, the margin fringed with hairs; blades relatively short, narrowly triangular to lance-shaped, crinkled, spreading

away from the culm.

Foliage leaves without auricles and oral setae; ligules prominently protruding, the apex strongly convex, the margin at first fringed with minute hairs; blades up to 6 in. long and 7/8 in. broad, commonly 3 to 4 in. long by 3/8 to 1/2 in. broad, rough throughout due to small hairs.

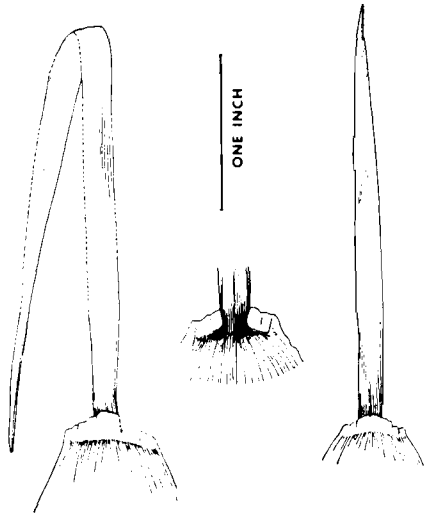

Figure 19. *Phyllostachys propinqua* (P.I. No. 76649). Outer (center) and inner views of the upper end of culm leaves, showing the blades and ligules.

***P. propinqua* McClure**

McClure introduced *P. propinqua* in 1928 with plants collected along the West River near Wuchow in Kwangsi Province, China. The species no longer grows at the Garden. *P. propinqua* resembles *P. meyeri* but differs by not having the narrow line of white hairs at the base of its culm leaf sheath or on the sheath scar.

Culms up to 23 ft. tall and 1 1/4 in. in diameter; internodes up to 10 in. long, green, faintly powdery at sheath fall, hairless, not ribbed; nodal ridges moderately prominent, sheath scars as prominent as the nodal ridges, thin, hairless.

Culm leaf sheath pale olive with green veins, lustrous with bronzy sheen, sparsely covered with small brown spots, hairless; auricles and oral setae lacking; ligules weakly developed, the apex convex with a hump in the middle, the margin hairless or with some minute hairs; blades green with a very narrow white border, all tinted with wine, lance-shaped to ribbon-shaped, bent back, not crinkled or only

slightly so.

Foliage leafs with auricles and oral setae of variable development, often lacking; ligules strongly protruding, the apex strongly convex, the margin irregular, minutely hairy; blades commonly 3 to 5 in. long and 7/16 to 5/8 in. broad, usually rough due to small hairs.

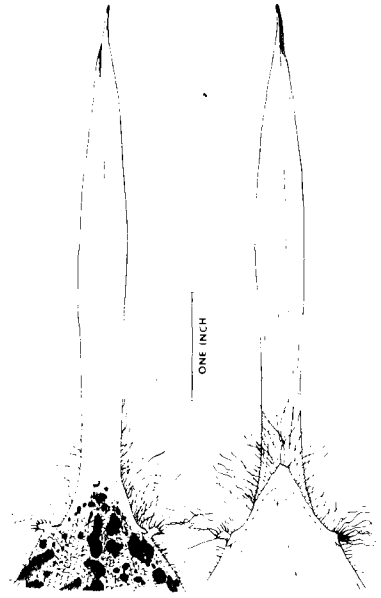

Figure 20. *Phyllostachys pubescens* (P.I. No. 80034). Outer (left) and inner (right) views of the upper end of a culm leaf, showing the blade, ligule and auricles.

***P. pubescens* Mazel ex. H. de Leh.**
[*P. edulis* H. de Leh., *P. heterocycla* (Carr.) Mitf.]
Moso bamboo, Moso-Chiku

Moso bamboo is the largest and perhaps the most handsome of the hardy bamboos. Native to China it was introduced into Japan in about 1738 and from Japan it reached Europe in 1880. It was brought to the west coast of the U.S. about ten years later. The Moso bamboo still growing at the Garden is about the same size that McClure described in 1957 with culms up to 39 ft. tall. The species is not widely distributed in the U.S. On the West Coast I have seen mature plants only at a nursery in Castro Valley, CA.

Moso bamboo is more difficult to propagate than other species of *Phyllostachys*. Since Moso rhizome cuttings often sprout and die, it is better to use propagules that include leafy culms attached to rhizomes.

The mature Moso bamboo is easy to recognize by its strongly tapered, velvety culms which have relatively short internodes near the base. Small plants are more difficult to identify and may be confused with Henon bamboo which also has culms which are hairy when young.

Culms up to 75 ft. tall and 7 in. in diameter in Japan, up to 39 ft. tall and 4 in. in diameter at the Garden, strongly tapered, straight and erect or more commonly curved and broadly arched at the tip; internodes short near the base, up to 12 in. long near the middle of a culm 39 ft. long, pale green, densely velvety at first, gradually almost hairless, sometimes perceptibly ribbed, sometimes powdery at first, nodal ridges hardly visible at unbranched nodes; sheath scars marked at first by a prominent fringe of brown hairs, not prominently flared.

Culm leaf sheath greenish-smoky buff, densely blotched with dark brown, abundantly powdery, densely strewn throughout with brown erect hairs; auricles strongly developed, fringed with numerous coarse, very long wavy oral setae; ligules long, protruding, narrowly convex at the apex, fringed on the margin with long, coarse, dark, rough bristles; blades lance-shaped to narrowly triangular to nearly strap-shaped, rather stiff, green, the lower ones often wavy, pressed to the culm, the upper ones spreading away from it.

Foliage leaves with auricles and oral setae usually lacking, or rarely with 2 or 3 small, weak oral setae; ligules very short, scarcely protruding; blades up to 5 by 5/8 in., more commonly 2 to 3 in. long by 3/8 to 1/2 in broad.

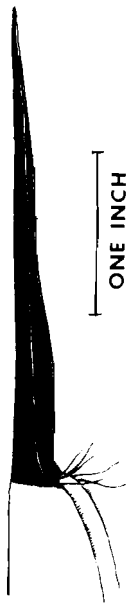

Figure 21. *Phyllostachys purpurata*, typical form (P.I. No. 128771). Upper end of a culm leaf, showing the purple blade in black.

P. purpurata McClure

P. purpurata is one of the smallest species of the genus. It was introduced in 1928 from Kwangtung Province, China. The typical form of *P. purpurata* has slender, zigzag culms with rather long internodes that are so weak that they often bend to the ground under a wind or by the weight of the foliage when it is wet. The species is not generally cultivated outside of the Garden and its hardiness is unknown.

Culms to 18 ft. tall and 3/4 in. in diameter, weak, arched broadly to one side and zigzaged, especially in the branched portion; internodes up to 14. in. long (in a culm of Cv. Straightstem, 26 ft. long), green, powdery, hairless or with a few hairs; nodal ridges narrow, prominent; sheath scars hairless, moderately thick and slightly flared.

Culm leaf sheaths hairless, green, sometimes stained with wine, not spotted, often powdery especially near the base; auricles weakly developed, purplish; oral setae few, weak or lacking; ligules short, weakly convex at the apex, fringed with small hairs or weak bristles on the margin; blades broad to narrow, triangular, boat-shaped, pressed to the culm, often wavy, tinted purple.

Foliage leaves usually lacking auricles and oral setae; ligules very short, scarcely protruding; blades commonly 2 to 3 in. long and 3/8 to 1/2 in. broad, hairless or nearly so on the lower surface.

P. purpurata Cv. Solidstem McClure

Solidstem bamboo differs from the typical form in that the lower half of the culms have solid internodes. Also the culm nodal ridges are less prominent and the culm leaf blades are not as purple as in the typical form.

The cultivar was first introduced in 1920 from material obtained from Anhwei Province, China. Later introductions came from Kiangsu and Chekiang Provinces, China. Small plants of the cultivar now growing in California were obtained from the Garden from Plant Introduction No. 128800, which originated in Chekiang Province. The plants have proven to be vigorous growers.

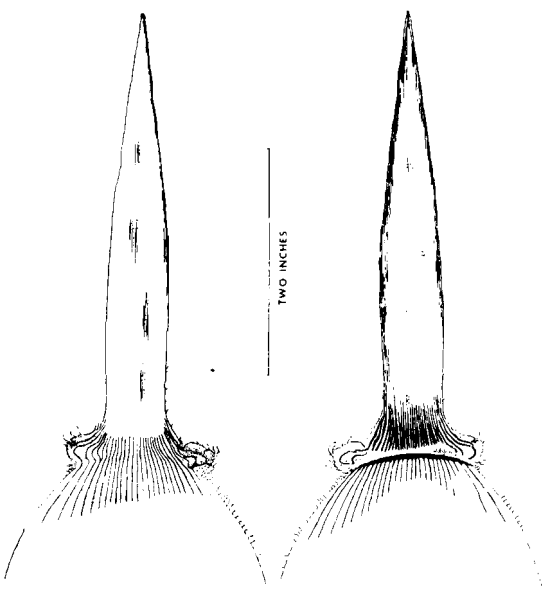

Figure 22. *Phyllostachys purpurata* Cv. Straightstem (P.I. No. 116711). Outer (left) and inner (right) views of the end of a culm leaf, showing the blade, ligule and auricles.

P. purpurata Cv. Straightstem McClure

Straightstem grows larger than the typical form, up to 33 ft. high with culms 1 1/2 in. in diameter. It also is stiffer, grows more erect and has less prominent culm nodes. The culm leaf blades are more green and less purple than those of the typical form.

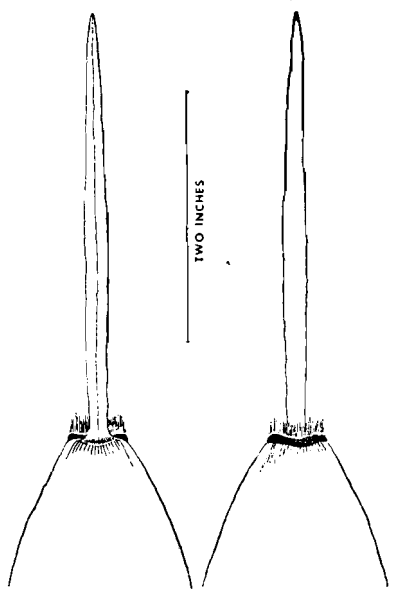

Figure 23. *Phyllostachys rubromarginata* (P.I. No. 67398). Outer (left) and inner (right) views of the upper end of a culm leaf, showing the blade and ligule.

P. rubromarginata McClure

This species is grown in southern China principally for its edible shoots. The wood is good quality and has been used for making baskets and garden stakes. *P. rubromarginata* is distinctive in its long slender culm internodes, culm leaves that lack auricles and oral setae, and culm leaf ligules fringed with red bristles. The species has not been widely distributed and its hardiness is unknown.

Culms up to 32 ft. tall and 1 1/4 in. in diameter, erect, nearly straight to strongly curved; internodes relatively long, up to 16 in, pale green, not powdery at sheath fall, gradually becoming coated with wax, in slender culms hairless, in larger ones sparsely strewn with minute white bristles barely perceptible to the touch, later hairless; nodal ridges narrow, only slightly elevated; sheath scars sharp, clean, hairless, not flared.

Culm leaf sheaths olive green to buff, often striped or stained on the back, not spotted, hairless, not powdery; auricles and oral setae lacking; ligules dark red when fresh, short, straight or slightly concave and often asymmetrical at the apex, with small white hairs backed with red, rough bristles on the margin; blades narrowly triangular to ribbon-shaped, pressed to the culm in lower sheaths, spreading away from the culm in upper ones, not crinkled.

Foliage leaves with small auricles fringed with oral setae; ligules protruding, fringed on the margin with long, dark red hairs; leaf blades up to 6 1/2 by 1 in. commonly 4 to 5 in. long and 3/8 to 3/4 in. broad, rough along the midrib on the upper surface due to small hairs, sparsely hairy to hairless on the lower surface.

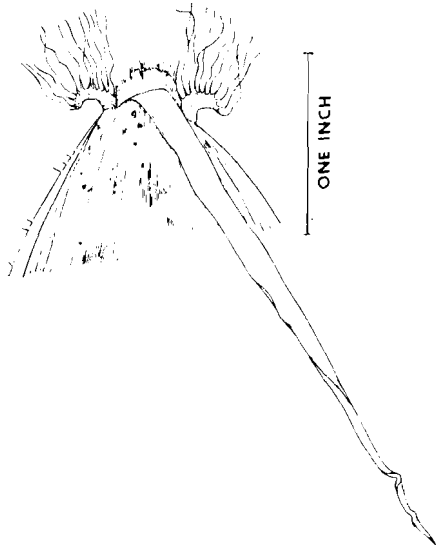

Figure 24. *Phyllostachys viridi-glaucescens* (P.I. No. 75160). Upper end of a culm leaf, showing the blade, ligule and auricles.

***P. viridi-glaucescens* (Carr.) A.C. Riv.**
[*Bambusa viridi-glaucescens* Carr.]

This species is a native of China from which it was first brought to France in 1846. From there it reached England and was introduced into the U.S. from the Royal Botanic Gardens, Kew, England in 1936. An earlier introduction from Kew flowered in 1955 and died. The culms of *P. viridi-glaucescens* are very straight and the wood is of excellent quality but the species has not been widely grown in the U.S. I know of no mature stands except at the Garden.

P. viridi-glaucescens is similar to *P. elegans* from which it differs by having culm internodes which are not ribbed and by having larger leaves which are not densely hairy on the lower surface.

Culms up to 35 ft. tall and 2 in. in diameter, straight and erect or nearly so; internodes up to 15 in. long, green with much loose, sometimes unevenly distributed white powder at sheath fall, hairless, not ribbed; nodal ridges prominent; sheath scars hairless, weekly flared, about as prominent as the nodal ridges.

Culm leaf sheaths pale buff, tinged with green and strewn with small brown spots and blotches throughout, with loose white powder, rough and often sparsely bristly; auricles usually two, sometimes one, rarely none, long, narrow, falling off when dry, fragile; oral setae few but prominent when auricles are present, otherwise lacking; ligules tall and narrow, often asymmetrical, convex at the apex, the margin irregular and fringed with hairs, later smooth; blades narrow, ribbon-shaped, bent back, usually crinkled.

Foliage leaves with auricles and oral setae usually developed, soon falling off; ligules protruding, soon split and mutilated; blades commonly 4 to 5 in. long and 1/2 to 3/4 in. broad.

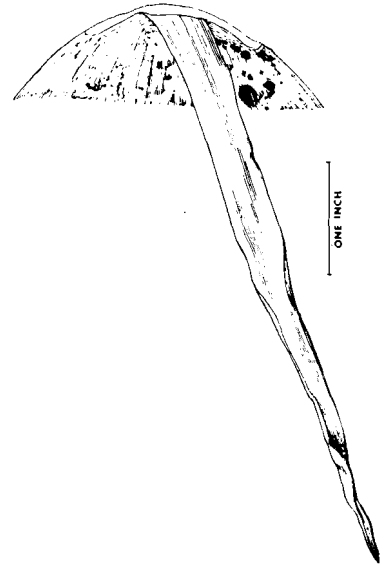

Figure 25. *Phyllostachys viridis*, typical form (P.I. No. 77257). Upper end of a culm leaf, showing the blade and ligule.

***P. viridis* (Young) McClure**
[*P. sulphurea* var. *viridis* R.A. Young, *P. mitis* A. & C. Riv.]

P. viridis was brought to Europe over a century ago from an unknown habitat in China and was introduced into the U.S. from France in 1928. It is highly rated both for the quality and taste of the shoots and for the technical quality of its culm wood. It is not widely distributed; its culms are killed at temperatures below -5° F. It has the reputation of spreading slowly.

Culms up to 47 ft. tall and 3 1/4 in. in diameter, suberect, usually somewhat curved but not zigzag; internodes up to 19 in. long, pale green, hairless, powdery, especially below the nodes, the surface not ribbed, but marked by minute

indentations perceptible to the touch; nodal ridges imperceptible or nearly so at unbranched nodes; sheath scars thin, hairless, not at all flared, the nodes marked by a broad band of white powder.

Culm leaf sheaths hairless, often powdery, light rosy buff, the veins green and darker than the background which is spotted with dilute smoky brown; auricles and oral setae lacking; ligules straight in small culms to strongly convex in large ones, the margins fringed with rough bristles in small culms, with fine to rough hairs in large ones; blades narrowly triangular to ribbon shaped, wavy, not or only slightly crinkled, usually spreading away from the culm, the lower ones usually completely bent back.

Foliage leaves with auricles and oral setae usually well developed on young culms, often lacking on older culms; ligules well developed, protruding; blades commonly 3 to 5 in. long and 5/8 to 7/8 in. broad, sometimes slightly hairy on one side.

P. viridis Cv. Robert Young McClure
[*P. sulphurea* A.& C. Riv.]

Robert Young bamboo differs from the typical form by being smaller and by the distinctive color of its culms, which are yellow green with darker green vertical stripes at sheath fall. Gradually the yellow green background turns to a golden yellow, while the green stripes stay the same color. The stripes are quite variable from culm to culm and generally do not run along the culm grooves. Some culms have no stripes at all; some stripes are very thin and short while others may be 1/4 in. or more in width and extend the length of the culm.

Robert Young bamboo differs from *P. bambusoides* Cv. Allgold in that the later has culms which are bright yellow (with some green stripes) at sheath fall. Robert Young differs from *P. bambusoides* Cv. Castillon which has a green stripe inside the culm groove.

P. viridis Cv. Houzeau McClure

Houzeau Bamboo differs from the typical form of the species by having green culms with a greenish yellow groove. The cultivar no longer grows at the Garden; it is not known if it still exists.

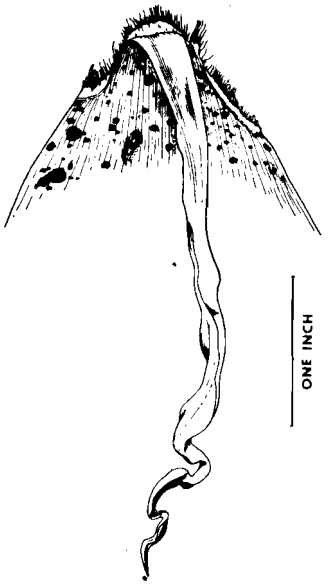

Figure 26. *Phyllostachys vivax* (P.I. No. 82047). Upper end of a culm leaf, showing the blade and ligule.

P. vivax McClure

P. vivax is one of the largest members of the genus rivaling *P. bambusoides* and *P. pubescens* in ultimate height and culm diameter. According to the late E.A. McIlhenny *P. vivax* is a more vigorous species than *P. bambusoides* reaching maturity much sooner. The culms are however, thinner walled than those of *P. bambusoides* and may not be as good for construction purposes.

P. vivax may be distinguished from *P. bambusoides* by its culm sheath which lacks auricles and oral setae and by the culm sheath ligule which tends to be strongly convex extending down each side of the sheath some distance from the blade. These characteristics hold for the larger culms (greater than 1 or 2 in. in diameter). Small culms of the two species may look much alike except that *P. vivax* tends to be powdery below the nodes.

There are several mature stands of *P. vivax* growing in Southern California; one at the Huntington has culms up to about 35 ft. tall with diameters to 3 1/2 in. Many of the stands have been mis-identified as *P. bambusoides.*

P. vivax flowered at the Garden between 1961 and 1970 after which it died. The species has, however, survived flowering at the Huntington and at other places in Southern California. In colder regions of the country *P. vivax* has shown itself to be second only to *P. nuda* in hardiness. Established groves have withstood -10° F.

Culms up to 70 ft. tall and 5 in. in diameter, erect or nearly so, sometimes perceptibly zigzag, often somewhat curved; internodes up to 14 in. long on a culm 46 ft. long, green, powdery just below the nodes at sheath fall, hairless, strongly and irregularly ribbed; nodal ridges slightly prominent, about equalling the sheath scar; sheath scars hairless.

Culm leaf sheaths creamy buff, spotted with smoky brown, the lowest spots sometimes almost black, powdery; auricles and oral setae lacking; ligules short, extending down each side of the sheath, convex at the apex, the margin minutely hairy to bristly; blades narrowly triangular to ribbon-shaped, bent way back, very crinkly.

Foliage leaves with or without auricles and oral setae; ligules weakly protruding; blades 1 3/4 by 5/8 to 8 by 1 in., more commonly 4 to 6 in. long by 5/8 to 3/4 in. broad, hairless or nearly so on the lower surface.

5. Locations of Growing Bamboo Mentioned in the Text

Campbell, CA: Bamboo Garden Nursery, 440 N. Llewellyn Ave., Campbell, CA 95008.

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

Chico, CA: Chico Tree Improvement Center, Nimshew Stage, Box 29A, Chico, CA 95926.

The Garden: The United States Barbour Lathrop Plant Introduction Garden, Agricultural Research Service, U.S. Department of Agriculture, Savannah, GA 31450.

Glen Dale, MD: Mr. George Darrow, Olallie Farms, 5900 Belt Station Rd., Glen Dale, MD 20769.

Hakone: Hakone Gardens, 21000 Big Basin Way, Saratoga, CA 95070.

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

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

Santa Cruz, CA: Mr. William E. Henneuse, (Bamboo Bill), 240 Sims Rd., Santa Cruz, CA 95065.

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Table 1 Phyllostachys Characteristics

	Species	Culm											
		Total Culm				Internode						Node	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
		ht	diam	curve	zig-zag	1st	5th	col-or	hair	pow-der	rib	ridge	scar
1	*angusta*	22	$1\frac{1}{4}$	0	0	3	7	0	0	0	0	1	0
2	*arcana*	27	$1\frac{1}{4}$	1	1	3	9	1	0	2	1	2	2
3	*aurea*	27	$1\frac{5}{8}$	0	0	2	5	0	0	1	0	1	0
4	*aureosulcata*	26	$1\frac{3}{8}$	0	1	1	5	3	1	0	0	1	1
5	*bambusoides*	72	$5\frac{3}{4}$	0	0	4	10	0	0	0	0	1	0
a	Allgold	25	$1\frac{1}{2}$					2					
b	Castillon	30	2					2					
c	Marilacea	10	1					0			2		
d	Slender Crookstem	48	3		2			0				0	
e	White Crookstem	35	2		2			0		2		0	
6	*bissetii*	23	1	0	0	4	9	0	1	1	0	1	1
7	*congesta*	25	$2\frac{1}{8}$	0	0	4	6	0	0	1	1	2	2
8	*decora*	24	$1\frac{1}{4}$			3	5	0	1	1	1	1	1
9	*dulcis*	40	$2\frac{3}{4}$	2	0	4	10	0	0	2	2	2	2
10	*elegans*	32	$2\frac{1}{4}$	0	0	1	5	1	0	1	1	1	0
11	*flexuosa*	31	$2\frac{1}{4}$	0	2	3	10	0	0	1	2	1	0
12	*glauca*	34	2	0	0	2	9	0	0	2	0	1	1
13	*makinoi*	60	$2\frac{5}{8}$	0	0			1	0	2	0	1	0
14	*meyeri*	33	2	0	0	1	7	0	0	1	0	1	0
15	*nidularia*	33	$1\frac{1}{2}$	0	1	1	7	0	0	2	1	3	2
a	Smoothsheath												
16	*nigra*	30	2	0	0	3	9	1	1	1	0	1	0
a	Bory	50	3					1					
b	Henon	54	$3\frac{1}{2}$					0					
c	Punctata	20	$1\frac{1}{4}$					1					
17	*nuda*	34	$1\frac{5}{8}$			2	6	0	0	2	1	2	2
18	*propinqua*	23	$1\frac{1}{4}$			3	7	0	0	0	0	1	1
19	*pubescens*	75	7	2	0	2	4	1	2	1	1	0	0
20	*purpurata*	18	$\frac{3}{4}$	2	2	2	7	0	1	1	0	2	1
a	Solidstem				2			0				1	
b	Straightstem	33	$1\frac{1}{2}$	0	0			0				1	
21	*rubromarginata*	32	$1\frac{1}{4}$	2	0	5	13	0	1	0	0	1	0
22	*viridi-glaucescens*	35	2	0	0	2	6	0	0	2	0	3	2
23	*viridis*	47	$3\frac{1}{4}$	2	0	1	8	1	0	1	0	0	0
a	Robert Young	45	3					2					
b	Houzeau	12	1					3					
24	*vivax*	70	5	1	1	2	8	0	0	1	2	1	0

Table 1 (continued)

Sp	Culm Leaf									Foliage Leaf					Hardy
	sheath			ligule			blade			sheath		blade			
	13	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**
	spots	hair	auricle	ht	convex	hair	shape	bent back	crinkled	auricle	ligule	lgth	wdth	hair	
1	1	0	0	2	1	2	0	1	0	0	2	$4\frac{1}{2}$	$\frac{3}{4}$	0	0
2	1	1	0	2	2	0	0	2	1	0	2	4	$\frac{5}{8}$	0	
3	1	1	0	0	1	1	0	1	1	1	0	$4\frac{3}{8}$	$\frac{3}{4}$	0	-5
4	0	0	2	2	1	0	1	1	0	0	1	$3\frac{1}{2}$	$\frac{1}{2}$	0	-10
5	2	1	2	1	2	2	1	2	1	2	2	$4\frac{1}{4}$	$\frac{3}{4}$	1	0
a															
b															
c															
d															
e															
6	0	1	1	1	2	1	1	1	1	2	1	$2\frac{3}{4}$	$\frac{1}{2}$	1	-5
7	0	0	0	0	0	0	1	0	1	0	0	$3\frac{1}{2}$	$\frac{1}{2}$	0	
8	1	0	1	0	0	2	0	0	0	0	0	$4\frac{1}{4}$	$\frac{7}{8}$	1	-5
9	1	1	2	1	2	0	0	1	2	1	2	$3\frac{7}{8}$	$\frac{3}{4}$	1	-8
10	2	1	1	2	1	2	0	1	2	2	1	3	$\frac{3}{4}$	2	
11	2	0	0	2	0	1	0	2	0	0	1	4	$\frac{1}{2}$	1	-10
12	1	0	0	0	0	0	0	2	0	0	1	$4\frac{5}{8}$	$\frac{3}{4}$	1	
13	1	0	0	1	0	2	0	1	0	2	2	$4\frac{1}{2}$	$\frac{3}{4}$	1	
14	2	1	0	1	1	0	0	1	1	0	2	$3\frac{1}{2}$	$\frac{5}{8}$	1	0
15	0	2	2	0	1	0	2	0	0	0	0	$3\frac{1}{2}$	$\frac{5}{8}$	0	
a		0													
16	0	1	2	2	2	0	1	0	1	0	0	$3\frac{5}{8}$	$\frac{1}{2}$	0	
a															
b															
c															
17	1	1	0	2	0	1	0	1	2	0	2	$3\frac{1}{2}$	$\frac{1}{2}$	2	-20
18	1	0	0	0	1	0	0	2	0	1	2	4	$\frac{5}{8}$	1	
19	2	2	2	2	2	2	1	0	1	0	0	$2\frac{1}{2}$	$\frac{1}{2}$	0	0
20	0	0	1	0	1	1	1	0	1	0	0	$2\frac{1}{2}$	$\frac{1}{2}$	0	
a															
b															
21	0	0	0	0	0	2	0	0	0	1	2	$4\frac{1}{2}$	$\frac{1}{2}$	1	
22	1	1	1	2	2	1	0	2	2	2	2	$4\frac{1}{2}$	$\frac{5}{8}$	0	
23	1	0	0	1	1	2	0	2	1	2	2	4	$\frac{3}{4}$	1	-5
a															
b															
24	2	1	0	0	2	1	0	2	2	1	1	5	$\frac{3}{4}$	1	-10

Notes

Notes

Notes

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