OBJECTIVES

The objectives of the Society are:

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

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

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

4. To plant and maintain bamboos in public gardens to display the characteristic beauty of mature plants and to provide plant material for research in the taxonomy, propagation, and culture of as many species as possible.

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

Jinsaburo Oshima: **The Culture of Moso Bamboo in Japan, Part I**

August, 1931
Translated from the Japanese text by Saburo Katsura
in collaboration with Robert A. Young, 1937-1942
Edited by Richard Haubrich

Preface

Because there are few works written in English on the culture of bamboo, I offer the following article which was originally written in Japanese in 1931 by Jinsaburo Oshima. The article was translated into English during 1937 to 1942 by Saburo Katsura in collaboration with Robert A. Young under the auspices of the Division of Plant Exploration and Introduction, Bureau of Plant Industry, U.S. Department of Agriculture at Washington, DC.

Moso (*Phyllostachys pubescens* Houz. de Leh.) is the largest of the hardy bamboos. Its origins are on mainland China where it is today the most commercially important bamboo, covering some 5 million acres. From China, Moso was introduced into Japan over 200 years ago by somewhat uncertain means, as described in Section 1 below. From Japan, it reached Europe in 1880, and it was brought to the west coast of the U.S. ten years later.

In spite of its early introduction here, there are but a few scattered Moso plants in California and in the southeastern U.S. None of these is extensive enough to be called a Moso grove or a bamboo garden as described in the article. A renewed interest in the species has resulted in the establishment of plants at Quail Botanic Gardens in Encinitas, Ca. Also, new material has recently been imported from Japan which will be used to plant a Moso grove at Hakone Gardens in Saratoga, Ca.

Part I consists of two Sections. Section 1 is a general discussion covering the history of Moso in Japan, a description of the plant, its uses, methods of culture, and the economics of operating a Moso bamboo garden. Section 2 tells how to establish a Moso plantation by selecting the land, preparing the soil, and putting in the starter or stock plants.

Part II, which will appear in a later issue of the Journal, deals with the details of bamboo culture in growing plants for their edible shoots.

Although this article describes the culture of just one species of *Phyllostachys*, the methods are generally applicable to other species of the genus. Moso is considered to be the most difficult species to establish. The methods described should thus be sufficient, if not always necessary, for growing a grove of any *Phyllostachys* for shoots or for culms.

I have freely edited the original English translation of Mr. Katsura since it was in rough form and never, as far as I know, formally published. A few footnotes have been added to clarify geography or special terms. I have converted all weights and measures from Japanese units to standard U.S. units. The only unit not converted is the Japanese Yen. In 1931 the Yen was worth about one half dollar U.S. In terms of 1982 dollars one might say that the 1931 Yen is equivalent to about $5.00. This is in sharp contrast to the present Yen which is worth only about ½ cent.

Richard Haubrich

Part I: The Plant, Its Uses, and How to Start a Moso Plantation.

1. General Discussion.

1.1. The History of Moso Bamboo.

Moso bamboo (Moso-chiku) probably originated in Honan, China; this is indicated by one of its local Japanese names, Honan-chiku. Two different accounts are given of its introduction into Japan. One says that the first plants were obtained from the Ryukyu Islands by Prince Sokichi of the House of Shimazu in the Province of Satsuma and transplanted to the yard of his villa in Sengan, Yoshinomuro, Kagoshima, in the first year of Genbun (1714). The other account states that a Buddhist priest of the Zen sect of Mt. Oboku, Uji brought a Moso plant on his way back to Japan from China and planted it in the temple yard as an ornamental and that the present distribution in Japan originated from this plant. It is difficult to say which story is more likely to be true.

On a recent trip to Kagoshima I visited the villa of Prince Shimazu. There in the Moso grove I saw an impressive monument to Honan-chiku. The monument which was 3 ½ ft. high and 1 ¾ ft. wide had been built in 1837 by Prince Naricki, the 27th Lord of the House of Shimazu.

According to a recent survey by K. Takashita of the Okinawa-ken Agricultural Experiment Station, no Moso had grown in the Ryukyus in recent years until a few young plants from Miyazaki-ken were brought and planted there in 1926. Other bamboos, however, were quite common. Because of this, the first Moso imported into Japan by Prince Shimazu must have come directly from China and not from the Ryukyus. It was very likely a mistaken report that the plants came from those islands. Or, perhaps it was a deliberate misstatement since the importation was made in the days of the Tokugawa Government, when a law prohibiting importation of goods from China was strictly enforced.

The famous Moso grove in Meguro, Tokyo is said to have been started from a few shoots brought from the Province of Satsuma by a certain J. Jamaji in the first year of Kansei (1789). The Moso bamboo in Kanazawa is said to have spread from young plants obtained from Tokyo. The famous Moso shoot farms located in various parts of Kyoto are reported to have developed from a young plant, first planted by an

abbot of Jakushoin Temple, who received it from a priest of the Zen sect who had brought the plant back from China. The introduction by this priest is older than that by Prince Shimazu, but no authentic record of it has been found.

When I was in Tsushima on a lecture tour some time ago, I was told by an aged farmer that the introduction of Moso to Tsushima dates back to very early times. Even though the approximate year of introduction is uncertain, it was commonly reported that the first plant was brought there and planted by a Buddhist priest.

According to these various legends it seems probable that the growing of Moso has had some connection with the religion of Buddha.

1.2. The Characteristics of Moso Bamboo.

The rhizomes spread underground in sinuous courses; some reach 3 or 4 ft. below the surface but the majority are found at a depth of about 1 ft. In old bamboo forests it is not unusual to find rhizomes concentrating near the surface of the ground. In extreme cases the rhizomes are partly exposed above ground.

Saito, former director of the Shiga-ken Forestry Service, reports that the average maximum depth of Moso rhizomes is 3 or 4 ft. He believes that deeper rhizomes are usually lacking in vigor and are apt to rot. It is often said that Moso rhizomes always grow toward the south. This opinion is untenable since the principal factor influencing growth appears to be food material in the soil. In case the tip of the rhizome is injured, a branch rhizome grows a few inches away from the mother at an angle of 7° to 15°. The branch then keeps growing in the direction of the mother rhizome. If a branch is produced on both sides of the mother, they usually both grow parallel to the mother, keeping a distance of 5 to 8 in. apart. The direction of rhizomes is often changed by obstacles or by the presence of food materials. A Moso rhizome lives for a little over a decade. Growth is most active from the 3rd to the 6th year; decay begins in the 8th or 9th year becoming complete in the 12th or 13th year.

Rhizome growth begins in June and becomes most active in August, September, and October. In October the growth completely stops. In fertile soil, the rhizomes easily attain a length of 12 ft. or more in a single year with diameters up to 2 ¼ in. The growth in poorly fertilized soil is much smaller.

A survey of the seasonal growth of Moso rhizomes made in Aichi-ken in 1911 shows that 20% of the growth occurred in June and July, 50% in August and September, and 30% in October. No growth was observed from early November to late May.

The shoots start to emerge in March, with peak production normally in April. About 40 days are required to complete the growth of culms after the shoots emerge from the ground. The sheaths gradually fall as the culms grow. The sheaths are thick and densely hairy with fine brownish-purple hairs; they have dark purplish spots and bear bristles at the apex. The sheath blades are small and slender.

Harada of Nagasaki-ken also reports that about 40 days are required for the culms to complete their full growth after the tips appear above ground. The maximum rate of growth takes place about 10 days before growth is complete. Harada estimates that the maximum growth in 24 hours is a little over 3 ft. The growth rate is greater during the day than at night and during the afternoon than in the morning.

The culms are cylindrical but with the upper part having a broad groove on one side. Due to the presence of the groove, the branchlets are almost semi-cylindrical. The surface of the culm is smooth, green or yellowish green, and the internodes are relatively short. The nodes are ringlike. The culms when young are finely pubescent with a band of glaucous bloom beneath each node. Generally the culms are stout with thick walls. In Kyushu[1] the culms often reach 7 ½ in. in diameter with a height of about 80 ft. Unlike Madake (*Phyllostachys bambusoides* Sieb. & Zucc.) Moso is slow in growth. The branches are 2 at a node and grow alternately on opposite sides of the culm; they are semi-cylindrical with prominent nodes. The branchlets are either 1 or 2. The leaves are 2 to 8 at the ends of the branchlets and are lanceolate or narrow-lanceolate.

Culms are normally three times the size of the rhizomes, i.e. a rhizome with a diameter of 1 ½ in. produces a culm with a diameter of 4 ½ in.; conversely, a 4 ½ in. culm grows from a 1 ½ in. rhizome. However, this is largely a question of ecology.

1.3. The Uses of Moso Bamboo.

Compared to Hachiku (*Phyllostachys nigra* (Lodd.) Munro Cv. Henon McClure) and Madake, Moso culms are inferior in quality because the wood is softer and more likely to crack. However, Moso is now widely in demand as a substitute for Hachiku and Madake because of the rise in price of bamboo goods. Although inferior in quality, Moso culms have special characteristics such as stoutness, thick walls, and a characteristic luster when polished; consequently, there are special uses for Moso culms.

Mochizuki prepared a list of uses of Moso culms which is reproduced here together with my brief remarks.

Uses of Whole Culms.

1. Large culms: alcove posts.

2. Large culms as floats: floats for fish nets.

A standard size, common, giant fish net used for yellowtail, *Seriol quinqueradiata*, requires about 1,000 Moso culms as floats for a single net. In Miyazaki-ken alone, about 20,000 culms are used annually for this purpose. The fishermen in Fukuoka-ken use a much smaller net, known as the Masugata net, which calls for about 30 Moso culms. So many nets are made that the annual consumption of culms in two leading villages in the above prefecture is valued at between 20 and 30

1 The Southernmost island of Japan, located at about the same latitude as San Diego, CA or Savannah, GA.

thousand Yen.[2] Hoko, a fishing district of Korea facing the Japan Sea, consumes a tremendous number of Moso culms, valued at 100,000 Yen per year. Most of the material is grown in Shimane-ken, Japan, where Moso is cultivated extensively to meet the demands of Korean customers.

3. Large culms with substantial inner structure: pumping hose, drainage pipes for ships.

4. Large culms with a fresh green surface: ornaments for New Year festivals, flower vases.

5. Large culms with thick walls:

a. Base of culms with short internodes: tea pots, kettle pads, slop basins, alcove ornaments, trays.

b. Culms with soft wood: carved Japanese brush stands.

c. Culm nodes with diaphragm at the base: dippers, cigarette cases, tea boxes, basins for wine cups, sake containers, tobacco cases, etc.

d. Culms cut in pieces: cups, rice bowls, soup cups.

e. Culm sections with a smooth inner surface: containers for confectionery.

6. Culms with thickly growing branches: laver (seaweed) "brushwood" (used in seaweed culture), artificial hedges, brooms.

Approximately a thousand freight cars, each carrying 900 Moso culms 20 ft. long with branches, move from the adjacent coast to the city of Tokyo at the laver season each year. These culms with branches are used for brushwood to catch young seaweeds, which then attach themselves and continue to grow.

Because of its numerous branchlets, Moso is considered the best material for bamboo brooms.

Uses of Split Culms.

1. Culms with thick, elastic walls: lantern holders, framework for cages and fans.

2. Culms having durability: cages, framework for wicker trunks,

2 At the time of this writing in 1931, the Japanese Yen was worth about $0.50.

winnowing baskets.

3. Culms with thick, tough walls: spatulas (small shovels), bamboo plastrons (breastplates), framework for packing cases.

4. Culms with pliability: trays, dippers, coat hangers.

5. Culms with easy-working qualities: combs, forks, knives, spoons, framework for silkworm nets, varnished chopsticks.

Miyazaki-ken furnishes the material for varnished chopsticks with a yearly production worth 200,000 Yen.

The use of Moso culm sheaths is rather limited compared to those of Hachiku and Madake; however, large sheaths are used for wrappers and thick ones for stuffing in slipper soles. Charred sheaths are said to be effective as a remedy for bleeding and stomach-ache, and in the treatment of wounds. Needless to say, the excellent taste of the shoots is the best of all the bamboos.

The chemical constituents of Moso shoots are as follows:

Water	90.21
Crude protein	3.28
Crude fat	0.18
Soluble carbohydrates	4.47
Crude fiber	0.90
Ash	1.01

The rhizomes, like those of Madake and Hachiku, are used in making canes, whips, and umbrella sticks. Those with diameters over 0.8 in. are exported.

Rhizome sections about 4 ft. long with diameters over 0.8 in. are sold for .70 to .80 Yen each. Each stick, when finished as a cane, is worth about 10 Yen. The Sagawa Chujiro Co. in Shigakan makes canes from Moso rhizomes and exports a quantity worth about 200,000 Yen annually.

Moso bamboo grown on river banks or on slopes prevents the land from sliding and controls erosion. Moso has a unique beauty as an ornamental plant. The drooping green leaves have a graceful and restful appearance in rain, in snow, and under moonlight.

1.4. The Meaning of "Moso Bamboo Garden" and Different Methods of Producing Shoots.

A Moso bamboo plantation can properly be called a grove if it is cultivated for its culms. If, however, it is maintained for obtaining the young shoots only (or primarily), it is no longer a grove but simply a vegetable field, or Moso bamboo "garden".

The uses of Moso culms, which were discussed above, are extensive and the demand is increasing every year. The industrial value of Moso culms is, however, lower than that of Madake or Hachiku. For instance, Moso culms are of poorer splitting quality than the culms of the other two so that their manipulation with a knife is more difficult.

The culms of Moso as a rule, therefore, bring a somewhat lower price than those of the other species. However, culms of especially large size do command a good price because of their scarcity. In recent exhibitions in Tokyo, Kyoto, Kumamoto, Omudu, Fukuoka, and Keijo, some Moso culms 7 in. in diameter were easily sold for 10 to 15 Yen. In Kyoto, a culm of that size sold for 38 Yen. This, of course, is not a market price, but an example to show how high a price very large Moso culms may sometimes bring. Unless a Moso grove is conducted to produce large culms, it is wise to operate it for shoots as a Moso garden.

There are five important methods which are used in the production of Moso bamboo shoots.

1. Hanritsu Method

This method has been successfully practiced in many parts of Japan where shoots are the main crop, though culms may also be harvested from time to time. The shoots are usually harvested either early or late, and the large, vigorous ones are left in the field to produce the new culms. When there is a large demand for shoots, most are harvested at one time regardless of size. This may not be a "farm" or garden in the strict sense, but since production is mostly in shoots, it is still properly called a Moso bamboo garden.

2. Chuko Method.

This method is recommended for steeply sloping land. The ground is tilled every year to kill weeds and to promote growth of the bamboo shoots. The method is now used extensively on hillside groves in Kyushu, Fukuoka, and Nagasaki.

3. Meguro Method.

With this method, one attempts to grow the shoots within a very small area by relocating the rhizomes in the ground two or three times each year. The method was first used in Meguro, adjacent to Tokyo.

4. Kyoto Method.

This method, which originated in Kyoto, is practically the same as the Meguro Method; it differs only in applying a cover of grass and new top soil after the rhizomes are buried.

5. Quick Method of Producing Moso Shoots.

In this method artificial heat is applied to the ground before the shoots emerge. This is the most recent of the 5 methods.

1.5. The Economics of Operating a Moso Bamboo Grove.

From the standpoint of supply, demand, and income, the operation of a Moso grove is a promising undertaking. It is profitable as a sideline business for farm households and is a hopeful means of improving the condition of rural communities.

1.5.1. Supply and Demand.

Moso shoots emerge early in spring, when other vegetables are not yet on the market. It is quite natural that the shoots, which not only the Japanese, but foreigners, esteem as the most delectable of all Japanese vegetables, should be in great demand at this season. The following table, presented by the Ministry of Agriculture and Forestry, shows the annual production of Moso shoots in Japan.

Year	Quantity kilotons	Value million Yen
1925	62.9	6.3
1926	49.3	4.2
1927	49.7	4.2
1928	62.1	4.9
1929	62.1	4.9
Average	57.1	4.9

As shown above, Japan's annual production of Moso shoots is about 57,000 tons, with a value of about 5,000,000 Yen. When the annual product is divided among the population of mainland Japan, about 60,000,000, per capita consumption is about 2 lb. The edible part is about half of this, after the sheaths and other inedible parts are removed. But the shoots are not totally consumed on the mainland; considerable quantities are shipped annually to Korea, Hokkaido, Karafuto, Europe, America, and the South Sea Islands.

The demand for Moso shoots on the mainland has never been entirely satisfied. Since the Japanese population has recently increased by about 1% per year, there should be an increase in the production of Moso shoots by at least 400 tons annually.

S. Hoshino of the Japan Canned Products Association, reported in the Government Gasette of May 8, 1929 that 32,998 cases of canned Moso shoots were shipped to the United States in 1928. The shoots were first shipped there to meet the demand of Japanese residents, but with the increasing use of chop suey, in which the shoots are eaten by Americans, the demand has since increased. Since Moso is not grown in either Europe or America, the demand for canned shoots increases every year. In 1929 the value of shipments to Europe and America was 500,000 Yen.

Korea has a very small area of Moso groves, so that shoot production will

never meet the demands of the people; they will have to depend on shipments from Japan. Hokkaido and Karafuto are climatically unsuited for growing Moso; they too must depend on raw or canned shoots shipped from the mainland. Taiwan grows about 1,600 tons of Moso shoots per year, but when this is divided among her people it too is insufficient to meet the demand. China, like Taiwan, can never produce enough shoots for export.

The canning of Moso shoots was almost a monopoly of the factories in Kyoto and Osaka about a decade ago, but with increasing demand, canning factories have been built almost all over Japan. A small village known as Shiraki-mura, in Kyushu produces 130,000 cans of Moso shoots with a value of 100,000 Yen annually. It is said that the product is already sold before the shoots are canned.

1.5.2. Management and Income.

Moso cultivation, like that of other agricultural crops, requires land, capital, and labor. Unlike Madake and Hachiku, Moso does not require especially good ground but grows fairly well in poor soil. Moso culture has been successful on inferior land, such as a hillside, mountain side, foot of a mountain, or a plain, where the cost of land and taxes are relatively low.

The red pine forest zone near Kyoto has recently been cleared for Moso groves. A new rural law entitled "Moso Bamboo Groves Tenancy" has been enacted to control the relations between owners and tenants. The rent for tenants who grow Moso on such cleared land is between 16 and 34 gallons of brown rice per quarter acre; however, according to the new law, the tenants need not pay rent for the first three years but are entitled to the entire product as their "plowing fee."

The soil of bamboo groves in Shimono-seki, where shoots are extensively grown, is mostly very poor red clay. The late Tadabumi Nanbu, who once received prefectural recognition for his excellence as a bamboo grower, used to make a profit of 1200 Yen per acre from his bamboo grove; the land was extremely poor and no other crop could be grown on it. Most Moso groves in Shiraki-mura, Fukuoka-ken, are on waste land, such as slopes or mountain sides that had been discarded as sterile. It is evident from this example that one does not need much capital to start a Moso grove.

In Miyazaki-ken, where land is more easily available and the population is relatively sparse, suitable ground for Moso groves that has already been cultivated can be obtained for about 200 Yen per acre. The cost is much less for mountain land. Nihari, a grower in this locality, has been earning about 800 Yen per acre each year. In Kyoto, the ground for Moso groves is about 400 Yen per acre, which is probably the highest price in Japan.

At first the Moso grower may need a fairly large amount of capital to buy land and planting stock. Next come expenses for fertilizer and labor, but compared to the cost of growing vegetables or fruit, growing bamboo is relatively inexpensive. For the first 2 or 3 years, when plants are too small to sell, the growers can raise other crops in the grove to recover the starting capital. The debt is easily paid in the 8th or

9th year. If the land is owned by the grower and the groves are taken care of by the family, the income is much greater and more quickly earned.

Compared to other agricultural crops, bamboo - especially Moso - has developed with less artificial selection. This means that Moso, like other grasses, is fairly resistant to diseases, insects, and climatic injuries. Consequently, growing Moso requires much less labor than growing vegetables or fruit. Although it is desirable to have a large grove, many Moso growers are successful on small ones making a fair profit by saving the expense of hired labor.

2. Methods of Establishing a Moso Bamboo Garden.

There are only two or three methods in use for opening up a new field for growing Moso. Economically, they seem to be the best that could be devised and may be designated as (1) Seed-bamboo Planting, (2) Stump Planting, and (3) Rhizome Extension. Since the last two methods are based on the same principle, and do not differ much from each other, the general principles are discussed rather than the details of each.

In this section only the method of preparing the land for the new Moso field is discussed; the cultivation of the grove and its protection against injuries are discussed in Section 3 below.

2.1. Selecting the Land.

For the same cost and labor, the grower can obtain higher quality and yield along with earlier shoots by selecting the proper soil. Selection is especially important for growing bamboo since, unlike other crops, the enterprise lasts for more than ten years, and once started it cannot be discontinued in a short time. In general, any soil that promotes early shooting and large yields of good shoots is considered ideal.

2.1.1. Climate.

Moso, even more than Madake and Hachiku, grows best in a rather warm climate. More Moso is grown in Kyushu than in any other part of Japan, and the culms grow there to large size. Both the planting area and the culm size decrease toward the north so that Moso cultivation is rather rare in Akita and Aomori.[3] Far north in the cold climate of Hokkaido, Moso is difficult to grow, and it would not survive at all in the cold climate of Saghalen at the northern extremity of Japan. In Korea, Moso grows only in the warmer parts of the South. In the hot climate of Formosa, it grows only at rather high altitudes where the temperature is relatively low.

In Kyushu, where Moso enjoys its most luxuriant growth, the culms easily attain a diameter of 7 ½ in. without special care from the growers. In the vicinity of Kyoto, a little farther north, the largest culms are only about 5 ¾ in. in diameter, even with the utmost care from the growers. In Tokyo, culms with a diameter over 4 in. are rare. Climate is unquestionably an important factor in determining the culm

3 Located at about 40° north latitude.

size.

According to 1926 statistics from the Ministry of Agriculture and Forestry, 7,100,000 bundles of Moso culms were placed on the market of which 330,000 bundles, about half the production, were from 7 prefectures in Kyushu. The Department of Agriculture reported that there were 40,000 acres of Moso groves in Japan in 1924 of which 11,800 acres, or about one third, were in Kyushu.

Of 13 prefectures in Korea only 3 produce Moso; the total area in 1921 was only 4.2 acres, and the largest culms averaged about 2 ¾ in. in diameter. It is possible to increase this bamboo area if protective cultivation is developed.

Of 93,000 acres of bamboo in Formosa only 3,400, or one thirtieth, is planted with Moso. The largest area of Moso is found on the island of Taichu, where it is grown only at elevations above 3,000 ft.

Moso thrives best in a warm temperate climate, which may be either in the southern part of a temperate zone or the northern edge of the Tropics. Moso could thus be cultivated in all parts of the Japanese Empire except Saghalen, most of Hokkaido, and the north half of Korea.[4] Regions in which the minimum summer temperatures go below 15° C. (59° F.) are not suitable, however, since Moso suffers under such cool conditions.

S. Uchida of the Moricka College of Agriculture studied the cold resistance of bamboos and found that Hachiku was more resistant than Madake. When transplanted from a warm to a colder climate, Hachiku survived down to about -17° C. (1° F.) while Madake lived to -15° C. (5° F.). By selecting locations protected from wind - a major factor in freezing - Moso can be grown even in northeastern Japan as long as minimum temperatures do not reach the death point for this species. Uchida concludes that Madake and Hachiku have been growing in northern Korea, where temperatures often drop to - 15° C. (5° F.) or below and that, although the cold resistance of Moso is less than that of the other two, about the same resistance could be expected if Moso is cultivated with special care.

2.1.2. Location - Wind, Humidity, Sun Exposure, etc.

Moso is easily blown over by a wind storm because of its relatively shallow roots. Even a light storm often splits the culms at the base due to shaking by the wind. Continued shaking may also injure the culm above the base as well as the rhizome below. This affects the rhizome's growth as well as its buds, resulting in fewer shoots and loss of vigor for the entire plant. Moso suffers greater wind injury than other bamboos because of its luxuriant growth of branches and foliage, which results from the heavy fertilization and other special attention given by careful growers. Also, the culms are usually spaced somewhat far apart in the grove. Cold winds kill the tips of branches and leaves, which tends to delay the emergence of shoots. A Moso grove should not be located on a mountain top or on the seacoast. It is desirable to have a forest or hill as a windbreak on one side of the grove.

4 In 1931 the Japanese Empire included Saghalen to the north, Korea to the west, and Taiwan to the south.

Snow injury should also be avoided. However, since Moso has thick walled culms compared to Hachiku and Madake, snow injury seldom occurs. If shoots rather than culms are the primary crop, wind and snow injury are less important. But in a grove in which the culm tips have not been removed, protection from wind injury is quite a problem. It is said that the yield of shoots is notably smaller following a year of severe storms, even though a bumper crop was otherwise expected.

Soil moisture is important both for growth and to make plant food available. It also helps to soften hard soil, harden moderately light soil, and control soil temperature. Excessive moisture is, however, harmful. Even when excess water is not readily apparent, if the soil easily yields drops of water when squeezed in the hand, it is too wet for the growth of the rhizomes and causes them to rot. Avoid land with a high water table or land so low that water easily flows in. The land should be well drained. Drying of the soil is not a problem since mulch is spread over the ground to retain moisture. Not only Moso, but bamboos in general, dislike very moist soil.

Bamboo growing is not forestry, but agriculture. Maintaining a Moso garden is really vegetable culture, and abundant fertilizer is required. The garden needs repeated mowing or weeding and it should be topped with grass mulch and soil. When shoots start to emerge in spring, they must be dug almost daily. Since such constant care is necessary, a small grower should select land near his home and not very far from his market. When shoots are in demand and prices are high, a large-scale grower can afford the cost of transportation, but a small producer should avoid such expense. Often Moso shoots are shipped from Shikoku and Kyushu to Osaka and Kobe by large growers who still make a profit. Recently, shoots are being canned and shipped to more distant places. M. Abe, a prefectural horticulturist in Tokyo, emphasizes in his recent book on bamboos, the advantage of having a Moso garden near the grower's residence. Most Moso gardens around Tokyo and Kyoto are near farm houses.

2.1.3. Topography.

Although level land is desirable for a Moso garden, a hillside will serve if the slope is not so steep as to make the work too difficult. The optimum slope is 7° or 8°; it should not be greater than 15°. The land should be fairly well situated for sunlight by sloping toward the southeast, south, or southwest. A mountain or a forest on the north side is best. On such a hillside, the work of the bamboo garden can be done more easily than on flat land. The hillside provides natural drainage. The more direct rays of the sun warm the soil, hastening the decomposition of fertilizer and promoting the growth of shoots in spring. On the other hand, shoot growth is retarded on north slopes. Land receiving less sunlight, such as a valley bottom, is suitable for a garden or grove which produces culms as well as shoots, especially if the Hanritsu method of culture is used. The Meguro method is generally more useful on flat land. The Kyoto method is used for both flat and hillside land, while the Chuko method is best on a gentle slope.

The market price of Moso shoots at Kyoto on March 10, 1927 was .85 Yen per lb.; after this the price fell rapidly so that finally, as the season of largest production

approached in early April, the price dropped to only .07 Yen per lb. This shows the importance of having a Moso garden capable of producing very early shoots.

2.1.4. Soil.

Moso can be grown in most types of soil provided they are not rocky. However, gravelly, sandy, or calcareous soil cannot be regarded as good. Even clay soils or those containing much humus are not the best for producing shoots. The ideal soil is either loam or a marly soil, though the latter is not found in Japan.

Sandy soil consists of over 80% sand and for this reason it is usually dry, poor in minerals, and subject to extreme temperatures during summer. Gravelly sand is probably the worst of all soils. Although loamy soil is easily cultivated and favorable for growing shoots, the quality of shoots grown in loam is rather poor. Sandy soil is commonly believed to hasten the emergence of shoots, but this is really not the case. Gravelly soil consists of more than 60% pebbles and may be of several kinds, such as gravelly sand, gravelly loam, or gravelly clay. Each has some of the characteristics of sandy soil, but none is suitable for growing Moso. When pebbles are present in the soil, extra labor is required in cultivation and in digging the shoots. Calcareous soil contains over 20% calcium carbonate. If the quantity and the size of lumps of lime are especially large, it is just as bad as gravelly soil. If, however, the lime is powdered and mixed with clay or humus, it may help the growth of Moso. Clay soils consisting of over 60% clay have strong cohesive power, so that there is less air space than in ordinary soils. Since these soils are poor heat conductors, they are always cool so that the decomposition of organic matter is slow. When such soils absorb water, they easily become boggy; they are sticky when wet but form a hard surface layer when exposed to the sun. Not only is rhizome growth retarded in such soil, but the true roots also develop poorly. Sticky clay is not satisfactory, but loamy clay may give fairly good results under proper culture practices.

Humus soils containing over 20% decayed vegetable matter is usually brownish black and friable so that it easily absorbs water and tends to become acidic. Since it is easy to work, many gardeners grow Moso on humus soil, but the quality of the shoots is not very good.

Marly soil usually contains over 15% calcium carbonate which is finely divided. This soil, which is similar to loam, is fertile and one of the best for growing Moso.

Loamy soil contains 30 to 60% loam and about 40% sand; it is between clay and sandy soil in character. This is also one of the best soils for Moso. A sandy loam is fairly satisfactory for bamboo growth, but it is not as good as clayey loam for the production of quality shoots. The latter is the soil most sought after by growers in Japan.

The most improved methods for growing Moso shoots in Japan are the Kyoto and Meguro methods. The former is used on clayey loam of the Tertiary[5] and

5 The Tertiary geologic period is from 70 to 5 million years ago. Quaternary covers the time from the end of the Tertiary to the present.

Quaternary period. This type of soil, which produces good sweetpotatoes and taro, produces Moso shoots of excellent quality. Shoots grown in a red clayey loam become a bright color, have a soft texture, good fragrance, and good taste. In whitish clayey loam the sheaths of the shoots become whitish, the shoots are tender in texture and of excellent quality, but the yield is less than in a red clayey loam. In the market of Fukuoka the shoots with blackish soil are sold cheaper than the shoots with red soil on the sheaths. Crafty merchants wash off the dark soil and rub red soil on the sheaths before the shoots are brought to market. Red soil is thus well known for producing shoots of good quality.

The Meguro method of culture is mostly practiced on humus soils. It is quite successful and is extensively used in Miyasaki-ken. Since the soil is friable and light, it is worked quite easily. The only disadvantage with this method is that the color of the shoots is not quite satisfactory.

According to M. Abe, in parts of the Musashino Plain and the bank region of the lower course of the Tamagawa - which supply the water for 3,000,000 people in the city of Tokyo - Moso shoots are produced by the Meguro method. Here the soil belongs to the Quaternary period; the top soil is light loamy humus mixed with volcanic ash. The top soil varies in depth, the deepest being 5 to 6 ft. deep.

2.2. Preparing the Land.

The method treated here is for opening up and clearing wild forest or mountainous regions, putting the soil into fit condition for growing bamboo. This requires much labor but it pays, since Moso is not an ordinary field crop but a vegetable which yields profit each year once the garden is developed.

2.2.1. Clearing the Ground.

Shrubs and weeds are first dug out and burned during the winter. The tillage is done during the idle season on the farm, in mid-summer. When all vegetation and roots have been cleared, the soil is dug up to a depth of about 1.6 ft. It requires about 25 helpers per quarter acre.

Although Moso rhizomes may go as deep as 3 to 4 ft., the optimum depth is about 1 ½ ft. Since deep rhizomes produce no marked benefit on the shoots, it is a waste of labor and expense to cultivate deeper than 1 ½ ft. It is generally thought that the deeper the cultivation the better the penetration of air and water, but the extension of roots to a length longer than required for practical results is useless. Soil with much humus or sandy loam is cultivated to about 1.3 ft., while clay soil is worked to about 2 ft. Nowhere in Japan is the soil treated to a depth greater than 2 ft. for a Moso garden.

During tillage, stones are collected and removed from the garden; weeds, shrubs, and especially small bamboos (sasa group) are dug and burned. Tree roots are also dug out, cut up, and placed on the ground to decay. The preparation of the ground is done mostly with a hoe. In Korea, cows are used to plow the ground for a Moso garden, while in Miyazaki-ken, plowing is done by tractors. With a tractor one

can easily plow 1 ¼ acres per day. During the preparatory tillage fertilizer such as compost, manure, hay, etc. are applied. The initial cultivation is complete when all large lumps of soil have been broken up.

Spot Cultivation.

This procedure is used when a large area of land cannot be prepared at one time due to financial reasons or when it is too close to the planting season for the proper preparation of a large area. As the name indicates "mother" plants, rootstocks, or rhizomes are planted at wide intervals. The first year scattered circular areas of about 10 ft. in diameter are prepared and set with plants. The following year additional areas may be prepared and planted, taking up to 3 years to complete the entire tract. The method is not ideal. At first it was thought to reduce labor costs, but the operation is not only difficult but it also takes time. When the entire area is cultivated the first year, full yield can be expected sooner and the ground can be fertilized uniformly.

Belt Cultivation.

This method, like spot cultivation, is used when the entire area cannot be prepared at one time. The whole field is sectioned off in strips about 12 ft. wide using ropes stretched from one side to the other. Every other section is prepared the first year and the alternate ones the following year. On flat land, the lines can be drawn in any direction, but on sloping ground it is best to run the lines at right angles to the slope, though working the field is easier if they are parallel to the line of slope. In a plot near a river bank the lines should be at right angles to the stream. In many ways the belt method is better than spot cultivation.

Cultivation of the Entire Field.

Since under this plan the entire tract is cultivated at one time, the immediate labor cost is high compared to the other two methods, but some income may be obtained by growing another crop temporarily between the bamboo plants.

2.2.2. Secondary Cultivation.

Ground on which other crops have been grown usually needs no special preliminary treatment. However, secondary cultivation is sometimes necessary if the soil is lumpy, too shallow, or too full of weeds. If the soil is dry and caked, it should be worked to a depth of at least 1 ½ ft. When the top soil is shallow, the ground should be well stirred to a depth of about one ft. and hay, straw, or rice chaff mixed with it. When weeds are thick, plow the ground using horse or cow power. However, if the weeds are too large, rooty, and persistent, mere secondary cultivation will not do, but plowing of the entire field is required. If a paddy field is used, dig a 2 ft. deep ditch to drain the land before further preparation of the ground.

2.2.3. Drainage and Correction of Soil Acidity.

Flat land usually has many low spots where rain water collects and interferes with the necessary aeration of the soil causing roots to rot. A properly planned drainage ditch must be constructed. There are two types; one is an open ditch while the other is closed with wood or stone covered by soil. The latter is called a blind ditch. Both types have advantages and disadvantages, but the former seems preferable for the Moso garden. The degree of inclination as well as the curve of the ditch should be studied with reference to the areas requiring drainage.

Soil acidity must be corrected when necessary before planting is started. An application of 700 to 900 lbs. of lime per acre will usually neutralize an acid soil. Humus soil commonly called Kuroboko or previously forested land often tend to become acid. Lime is quite effective since it not only neutralizes the acid but it also makes otherwise insoluble nutritive elements available and hastens the decomposition of organic matter.

Stones collected from the ground may be used to line ditches or to make fences. Outside the fence, a gutter or ditch may be dug to carry away drainage water and also to prevent the rhizomes from spreading beyond the garden. As a windbreak, plant forest trees such as cedar on the side from which the cold winds blow in winter. Since Moso needs liquid fertilizer, erect a concrete storage tank near the garden. Some gardens in Kyushu have open-top storage, where rain water is collected to which soybean or other oil cake is added.

2.3. Bamboo Stock Plants.

2.3.1. Selection of Stock Plants.

The quality of stock plants is of great importance since the future development of the bamboo grove depends upon them. In selecting the stocks for quality and price one must be a keen observer, like an experienced farmer who selects crop seeds or nursery trees.

(a) Age of plants.

The ideal stock plant is one with an attached rhizome fully capable of producing shoots, i.e., a vigorous rhizome capable of propagating. It is not difficult to recognize the vigor of a culm but it is almost impossible to tell the condition of the rhizome without digging into the ground. For this reason, young bamboo plants are usually used as stocks because their rhizomes are vigorous. It is a safe assumption that the rhizomes of old plants will be weak and incapable of propagating simply because they are old. Select plants between 1 and 2 years old as stocks for transplanting in autumn, and between 2 and 3 years old for transplanting in spring. Plants over four years old are hopeless as stock plants.

K. Kanda, an expert on bamboo culture, says that 1 year old plants are best for stocks, while 2 year olds may be adaquate but are not best.

T. Nakabayashi and some other bamboo specialists state that the age of stocks for autumn planting should be between 1 and 2 years while those for spring planting should be 1 year old. It seems wise to choose young stock, as many authorities emphasize the importance of this.

Abe believes that the optimum age for stocks is one full year. The stock planted in spring should be one that grew the previous spring. Planting may be postponed until autumn, using stock that is 1 ½ years old with satisfactory results. Bamboo plants over 3 years old are useless as stock plants.

Bamboo growers in Kyoto transplant spring-grown plants in autumn of the same year. Abe is opposed to this practice, stating that stocks should not be transplanted so young, but should be left in the ground at least until the spring of the following year. His only question is whether young plants should be planted at the end of the growing season in autumn or at the beginning of the growing season in spring. It is not a matter of great importance between the two procedures.

It seems that 2 to 3 year old stock plants produce more new culm growth than 1 year stocks, at least in the earliest years. But the number of new rhizomes is said to be much greater for the younger stocks. Although there is no definite experimental data, it is theoretically incorrect to use mature stocks simply because they produce more new culms. It is not the growth of new culms above ground but the spreading of rhizomes underground that is the important consideration in the development of a strong and luxuriant Moso grove. Fully mature stocks may establish quickly when transplanted, but they do not propagate in the new environment and they grow old and die.

(b) Size of Stock Plants.

Large stock plants do not necessarily produce large new culms or large rhizomes. Conversely, small stock plants do not always produce small culms. Actually, the offspring are all rather small, regardless of the stock plant size. Since there is little advantage in using large stocks to obtain large offspring, I prefer using small stocks which saves labor in digging, transporting, and transplanting. The savings will probably exceed the value of a few large shoots even if the latter were possible. The most convenient size stocks are those whose culms are about 1 ½ in. in diameter.

The culms of Moso stock in Korate-gun, Fukuoka-ken are 1 ½ to 4 in. in diameter. New culms from these stocks measure about 1 ½ in. the first year and 2 ¼ in. in diameter the second year. New growth in successive years thus gradually increases.

The following table, presented by M. Abe of Tokyo, shows the effect of stock size on the growth of new culms.

Size of new culms in 1929, 3 years after planting stocks.

Stock culm diameter, in.	No. of plants	New culm diameter, in.	New culm height, ft.
2.3	1	.9	3.2
2.6	2	.9	2.3
		.8	2.6
2.7	1	.9	1.9
2.7	1	.9	2.2
2.8	1	.8	2.2
3.0	1	.8	2.4

As shown in the table, the size of new culms is not necessarily proportional to the size of the stock plant. From the data given, Abe suggests that the culms of stock plants should be about 2 ½ in. in diameter.

The foregoing shows that it is unprofitable to use large plants as stocks. In Kyoto where the first Moso groves were established, the size of culms recommended for stocks is about 2 in. in diameter. The grower should consider rhizome size as more important than culm size. Some say that the size of a new culm is usually three times that of the rhizome. In fact large rhizomes produce large culms. The culms that develop from near surface rhizomes or those from a grove that has been thinned are usually large with correspondingly large rhizomes. These are the plants best suited for use as stocks.

From results obtained in the Moso groves of Fukuoka-ken Experimental Forest, I. Tsuboi says that success is mainly due to the use of good stock plants. T. Nanbu of Kyushu used stock plants that were extremely small, like sasas, collected from a small area - about ¼ acre - in a Moso grove. They did not look very promising during the first one or two years, but after several years they had grown splendidly and were producing shoots worth 1200 Yen per acre.

(c) The Condition of Stock Plants.

Short newly planted culms are better than tall ones because they are less likely to be damaged by wind. In addition short culms require no support stakes, which saves labor and expense. Stock plants should have the first branch on a rather low node; the lowest branch should not be higher than 3 or 4 ft. above the ground. Culms with low branches can be obtained from a new grove where the culms are still well separated, or in a thinned grove. The optimum height of the lowest branch for culms 1 in. in diameter is 2 ½ ft.; for 2 in. culms it is 4 ft. and for 2 ½ in. culms it is 5 ft.

Use young stock plants with vigorous culms having many branches. Stocks that have grown in the shade or in poor soil have culms, branches, and leaves with a soft and inferior texture; they are likely to die after planting. Even if the leaves appear to be healthy in color and growth, it is wise to avoid stocks grown in the shade.

(d) The Health of Stock Plants.

Moso is comparatively free from disease, but occasionally it is attacked by Suiko-byo (water-disease) or by a sooty (smut) disease. Since the diseases are contageous, care must be taken when selecting stock plants. Among insects, one should watch for the "Moso Tamabachi", a parasitic wasp that especially attacks Moso. In young plants the attacks of this insect are relatively light.

Stock plants with their branchlets blown off by the wind are not uncommon. They are useful as stock even without branchlets, but those with a crack or other injury at the junction of the culm and rhizome, due to wrenching by the wind, are worthless.

Stock rhizomes should have at least five buds, for without buds shoots cannot grow. It is impossible to determine the presence of buds without digging into the ground; however, it is safe to assume that plants with culms in their third year have live buds on their rhizomes. Examine the rhizome nodes closely after they are removed from the soil. Buds that are dried are, of course, not to be considered. The size of the buds is not important. Rhizome with young, strong buds can be found in any bamboo grove.

2.3.2. Growing Young Bamboo Plants for Stocks.

Growing very young plants as stock for later transplanting has not been generally practiced. The common procedure has been simply to select any suitable plants at the time of transplanting. Since the later method is not fully satisfactory, the early selection of very young plants should come into general favor in the future. Four methods of doing this are described below.

(a) Growing Young Plants from Early Shoots.

Unless the grove has been well fertilized, a liberal application should be made after the shoots are harvested. In the following season leave in the field only the early shoots which have a diameter less than 2 ¼ in. The reason for selecting early shoots is that they can be dug out more easily, since most emerge from rhizomes near the surface of the ground. When these have produced branches from 4 or 5 nodes, cut off all branches from the 4 lowest branch bearing nodes. To make a good plant the branches must be cut off as described. The plants are transplanted either in autumn or in the following spring.

Although a large number of plants are not obtained by this method, the plants produced are vigorous ones. In a dense grove this method cannot be used until the culms have been thinned. It is better to use it in a newly established grove. Many

growers have been using this method with profit.

(b) Growing Young Plants by First Cutting Down All Culms.

A grove or field in which this method is to be used should be free of stones or pebbles. Sufficient fertilizer must be used beforehand. In February of the following year, cut all the culms in the grove; this is to induce the growth of slender shoots. If a large shoot comes up, cut it off to give more chance for slender ones to grow. When the shoots have produced branches from several nodes, cut off the branches from the 4 lowest branching nodes. Transplant in the autumn or the following spring. This method is ideal for large scale planting. When it is desired to restore the grove, a scattering of shoots should be left to grow in the field.

(c) Growing Young Plants from Newly Extended Rhizomes.

This is the newest method of growing young plants. A belt form of cultivation, previously mentioned (Sect. 2.2.1), is used during midsummer in a Moso grove. The mature culms in alternate sections are dug out and the soil tilled by spading to a depth of about 2 ft. Break up the lumps of soil and remove any pebbles during the season from autumn to winter. Place compost, stable manure, rice bran, etc. to a depth of about 6 in. and then turn it under. Into this soil the rhizomes will grow from the adjoining untilled section.

(d) Growing Young Plants from Rhizome Cuttings.

This method is used from mid-February to mid-March. Dig into the edge or other part of the grove and obtain healthy rhizomes with buds and fibrous roots. Cut them into lengths of 1 to 1 ½ ft. Do not allow them to dry. With care not to injure them, place them as soon as possible in a nursery bed. The bed should be fully exposed toward the south and the soil should be moderately wet, sandy loam, well tilled, and well fertilized with soy-bean cake or rape-seed oil cake. Prepare trenches of about 2 ft. in width, place the rhizomes at intervals of 7 to 8 in., and cover them with a thin layer of soil. Spread straw on the surface to prevent the rhizomes from drying and to check the growth of weeds. Occasional weeding may also be necessary. Apply additional fertilizer lightly at least twice up until September.

In the first year the rhizome cuttings may produce shoots looking very much like small bamboos of the sasa type. Second year shoots will be ½ to 1 in. in diameter. When they produce branches, cut the latter off up to the 4th branching node and cultivate the ground. Yasuda of Kumamoto-ken who used this method in 1922 and 1923 reports that out of 2400 rhizomes as many as 1680 sprouted, i.e. 70%. T. Matoba of Hyogo-ken has been using this method for the past ten years with satisfactory results. He advises that during dry weather in summer the field should be amply irrigated. Weeding should not be done during the season when shoots emerge. If the leaves of young plants turn yellow, use ammonium sulphate and soy-bean cake from September to October.

At the time of transplanting, in March or April, the plants with their rhizomes are dug out carefully. Since the rhizomes have many fibrous roots, it is unnecessary

to keep the old soil with them.

2.3.3. Season of Planting.

Bamboos can be planted at almost any time except in the cold of winter and the heat of summer, but the best times are either during March or from October to November. If transplanting is necessary during cold months, the roots must have a substantial ball of earth. When transplanting in summer, wrap the roots in wet straw. Sometimes the culms may need to be wrapped also. After transplanting, proper watering is essential. Because protection of the roots in cold or hot weather is rather troublesome, winter or summer transplanting leads to a high rate of mortality.

Before transplanting, the rhizomes should have a sufficient store of food material; therefore, it is best to transplant in autumn when growth is about to cease or in spring before active growth begins. These seasons, being intermediate between hot and cold weather, are within the resting stage of the bamboo, and there is less danger of injury to the rhizomes due to handling. In spring new shoots are ready to emerge, and transplanting is apt to injure them. With respect to this, autumn planting is better, but in a cold climate spring planting is much safer. According to some people spring planting is always better than autumn planting, but this is the layman's view. Rhizomes with buds normally produce shoots if planted in spring, but shoots alone do not mean success and lack of shoots the first spring does not mean failure. In fact, success is judged by the development of the rhizome; if it develops quickly, it will naturally produce many shoots. Experienced growers often cut off first year shoots to conserve food in the rhizomes.

An old Chinese book states that the best time for planting bamboos is in June. This is a rainy month when the air is moist so that transplants are not likely to die from lack of water, but at this time the vigor of the plant is low because food stored in the rhizomes has been used up by the shoots. Plants dug at this time should be replanted instantly, otherwise the roots will quickly dry up in the summer heat. Transplanting is laborious if done in the rain, while if it is dry, most transplants will die. All things considered, spring or autumn are better times to transplant than June.

K. Kanda of Kyoto, an expert bamboo grower, says that the best times for transplanting are March to April and October to November. The ideal day is a cloudy one with no wind. If done the day before a rain it will be almost totally successful. Even in unsatisfactory weather the plants will survive if the original soil is not shaken from the roots and transplanting is done quickly. Transplanting on a rainy day should be avoided.

2.3.4. Digging the Plants.

S. Sato, an expert in Moso culture, has said that a bamboo "stump" planted by one grower takes ten years to make a grove, but a large stump requiring ten growers to plant it makes a grove in one year. Large bamboo stumps grow better, but the larger the plant the greater the expense of planting. All things considered, a plant with attached rhizomes about 2 ½ ft. long is the best size for transplanting.

Before digging, the shrubs and weeds around the plant should be cleared away. Next dig a circular trench with vertical walls and a radius of 1.2 to 1.3 ft. around the plant. The rhizomes crossing the trench are cut. Using a stout pry bar, force the plant out of the ground. A plant on a slope can be moved more easily than one on level ground. In any case, it is important not to hold the culm in the hand when pulling the plant to avoid injuring the delicate attachment of the culm to its rhizome.

In most but not all cases the rhizomes run in the direction of the culm branches. If the direction of the rhizome is found before digging, it is easier to dig it out. Sometimes it is hard to tell which rhizome belongs to the plant being dug, since neighboring plants have also extended their rhizomes. In case of doubt, strike the different rhizomes with a metallic object and listen for vibrations by placing your ear close to the culm. The sound travels from the rhizome to the attached culm.

When the direction of the rhizome is found, it is best to cut the growing or distal end longer than the other, say 1 ½ ft. on the distal end and 1 ft. on the other. New rhizomes and shoots should grow from the distal end. Although the other end of the rhizome may seem unnecessary, it is needed not only for the growth of new rhizomes and shoots but also for the well-being of the plant after transplanting. Do not use a hoe to cut the rhizome, for it makes a rough cut, causing injury. A knife can be used but it is best to use a saw or a pair of pruning shears. When two culms stand within 6 in. apart, they should be dug together. Separation of two close culms somtimes kills both unless one is quite small.

After being dug, the plant must be kept in equilibrium of absorption and transpiration of moisture. To protect it from wind injury cut the branches from the 3 or 4 lowest branching nodes before planting. Plants dug in the young nursery stage do not really need to have branches removed, though on the other hand "seed" bamboo plants do not need more than 3 or 4 leafy branches. A saw is probably the best tool for cutting branches. A knife or sickle may also serve, as long as the cutting does not cause injury to the culm. Cutting is usually done about 2 in. above a branch node. Some growers cover the cut end with a bottle or wrap it with a bamboo sheath, but it is doubtful whether the treatment has any value. When a culm or branch is cut, the tissue dies locally from the cut end to the first node, but the tissue below the node does not die.

The rhizomes should be studied after shaking off the soil. A rhizome without buds or one on which the buds have been injured during digging or transplanting is worthless and should be discarded. So long as the buds are living, the size does not matter, whether it is as small as a soybean or has already started to swell.

A "seed" bamboo plant should have a good ball of earth surrounding the roots. The larger the ball, the more easily the plant will establish itself after transplanting. When plants must be carried some distance, the ball of earth has to be small to economize on transportation costs. There should be just enough soil to cover the feeding roots. Naturally the "ball" is made oblong instead of circular. However, if the plants are planted quickly after arrival at their destination, it may not always be necessary to have the ball of earth, even when transporting them to a

distant place. But it is always safer in the latter case , when feasible, to ball bamboo plants. Abe considers that 130 to 250 lbs. of soil should be attached to a bamboo plant whose culm is 2 to 3 in. in diameter.

2.3.5. Packing and Transporting Plants.

Packing need not be elaborate when plants are carried short distances; as long as the ball of earth is securely tied with rope, no damage will occur. In shipping greater distances, however, the ball is first tied with rope, then wrapped with a straw bag and again tied with rope. When little soil is left on the roots, the rhizomes must be wrapped with wet straw before bagging. Branches are tied lightly to the culm, but not so close as to injure them or the leaves. Usually a few plants are put together in one bag.

For short distances the plants are carried by hand, but for longer distances they are carried by wagon, automobile, train or steamship. It is important: (1) that plants do not dry out in transit; drying may be avoided by placing them in the shade or covering them with straw or mats; (2) that shaking does not injure the attachment between rhizome and culm; (3) that the rhizome buds are not injured; (4) that the ball of earth remains unbroken, since some types of soil fall easily from roots; and (5) that there be no delay in transit that might cause drying of the roots and death of the plants. The writer once shipped Moso plants from the city of Kurume to Mokp'o, Korea. It took 27 days from digging to arrival at their destination. Of 135 plants only 26 died en route. Survival of plants after a long journey depends on the packing and other care given them.

2.3.6. Spacing Stock plants in the Field.

There are economic considerations to the question of how thickly to set the stock plants in the field. The more plants used, the sooner the grove becomes well-filled, but the expense is also higher. It is unprofitable to plant either too many or too few plants in a given area. I personally believe that the proper number of plants is about 180 per acre, which is in agreement with several experts who say the best number is from 120 to 240. Use the maximum number when stock plants are inexpensive, otherwise use fewer. Using less than 120 per acre would waste both fertilizer and land, using more than 240 per acre would waste labor to plant them.

At 120 plants per acre the area occupied by one plant is 363 square ft. If the plants are placed in a square array, the spacing between them is about 19 ft.

2.3.7. Planting Stock Plants

The planting hole should match the shape of the root ball and be somewhat larger than it with a depth of about 1 ½ ft. If the holes must be oblong or rectangular, dig them all in the same direction and if the land is sloping make the longer side at right angles to the slope. Later, when applying fertilizer, it is important to know the direction in which the rhizomes are spreading. Fill the holes with pulverized top soil that is without pebbles, roots, or other debris.

(a) Setting the Plants

The holes should be just deep enough for the transplanted bamboo to have the same ground line as before. When a hole is too deep, adjust it by partly filling it with top soil. In windy or dry areas the transplanting hole is made somewhat deeper, but in moist land it is safe to make a shallow hole. Bamboo plants dug for transplanting always show the ground line rather clearly. The part above ground is usually green, while the underground part is yellow. In ordinary cases of transplanting cover the yellow part in the ground.

It has already been stressed that bamboos planted on sloping land should be placed so that the rhizomes run at right angles to the slope and thus lie horizontal. This is the normal way that rhizomes grow. Such rhizomes often produce culms which are slightly inclined, but it does not matter as long as the rhizomes, the organs of future development, are in their proper position.

(b) Fertilizer.

Fertilizer is important during transplanting to increase the vigor of the rhizomes. It can be placed all around the rhizomes in the hole at planting time, but do not apply fertilizer in direct contact with the rhizomes. Although almost any kind of fertilizer is effective at planting time, stable manure is recommended on flat land and soy-bean or rape-seed cake or a combined fertilizer on sloping land. On sloping land apply the fertilizer on the ground above and on both sides of the plant, i.e., in a crescent shape. On flat land apply it in a circle around the plant. In either case apply the fertilizer about 7 in. deep and cover it with soil.

(c) Soil Covering.

Fill the planting hole with top soil using a stick to push soil into any spaces left around the rhizomes. Next, step lightly on the ground around the culms. Sometimes water is applied to settle the soil around the rhizomes, but this may not be becessary with a plant which has the original soil bound by its roots.

(d) Water Culture.

A method known as "water culture" is used to plant bamboos that have been stored for a long time after digging, plants whose roots are dry or have a small root ball, or those that are transplanted in a dry season. The method is to place water in the bottom of the hole and add soil, and stir to make mud. The bamboo plant is placed in the hole and more water added after the hole is filled. The success rate with this method is quite high.

(e) Straw Mulch.

All transplanted bamboos should be mulched with hay or straw around the culms. The diameter of the mulch should be 5 to 6 ft. Spread soil on top of the hay or straw, covering it. The coverings protect the ground from drying, control the soil temperature, and check the growth of weeds.

(f) Culm Supports.

The transplanted bamboos must be supported with bamboo culms or poles to protect them from snow or wind. If the plant is upright use 3 supports, but if it is inclined 2 supports are enough. Tie the supports tightly to the culms; if loosely tied, they do more harm than good.

2.4. Transplanting Root-stumps.

In this method, developed by Tsuboi, the transplants are "root-stumps", the rooty base of culms with attached rhizomes; the culms are cut off at ground level. The method is simple because with culms removed the stumps are easy to transport, and no supports are needed after planting. One or two additional years are required, however, to establish the bamboo plantation. Also many growers have failed using this method due to difficlty in obtaining successful transplants.

2.4.1. The Time to Transplant.

The best time to transplant by this method is just before the emergence of the new shoots. This will be from the middle of February to early March in a warm locality and about the middle of March in a colder one. Once the shoots have emerged, root-stumps should never be transplanted sooner than the following January.

2.4.2. The Selection of plants.

Select plants which are 2 or 3 years old with vigorous rhizomes having 4 or 5 new buds. Since the culms are to be cut off, it is only necessary that they appear normal with no evidence of disease.

2.4.3. Digging and Transporting Root-stumps.

Digging is the same as that of the "mother plant" described earlier. The culm is cut off at ground level. Leave about one foot of rhizome on each side of the culm. Keep a moderate amount of soil attached to the rhizomes, but not enough to make them too heavy. When transporting to a distance, wrap the rhizomes and the root-stump with wet moss and cover with and old straw bag.

2.4.4. Number of Root-stumps to Plant.

Plant about 300 root-stumps per acre. It is better to have a smaller number of good, large plants than more small ones. If planted in a square array the spacing is about 12 ft. apart.

2.4.5. Planting.

The usual planting method is followed, but of course no supports are needed for the culms. Plants from which shoots do not develop before June may be considered dead.

According to Tsuboi the "water-planting" method may be useful in dry ground, but in clay or in a moist soil there is always danger of causing the rhizomes to decay. Without culms the plant has no means of transpiring, so that an excess of water absorbed by the root-stump causes it to rot. Use little water but mulch the plant with straw that is kept wet. Use the water-planting method only on very dry land.

2.5. Increasing the Grove Area by Extension of the Rhizomes.

Bamboo rhizomes spread in the direction in which food is found; they also tend to spread toward friable soil. One can use these characteristics to extend the Moso plantation into a new field. The method is economical since it requires no transplanting. The only drawback is that the new field must border on an established grove.

There is a large grove of Moso in a certain part of Miyazaki-ken which was started 40 years ago with a few plants. Without help from the growers except for fertilizing the adjoining land, the grove has spread widely. There is an old saying that bamboo can even cross a stone bridge if the soil on it is nourished with the horses' hoofs. A Korean proverb says "Plant bamboo in your east garden and raise the soil high in your west garden." This means that when you plant bamboo on a piece of land you should prepare the soil well in the adjoining lot so that the rhizomes will spread toward this good soil.

When harvesting shoots, we unavoidably cut rhizomes. No matter how many rhizomes we cut, however, they still spread vigorously if the land is good. Once bamboos start to spread it is hard to stop them. It is said that bamboos spread toward the south, but they really spread in any direction in which they are attracted by fertile or loamy soil.

2.5.1. Increasing the Grove Area by Successive Belts.

The ground alongside a Moso grove is excavated 1 ½ ft. deep in a belt about 12 ft. wide. Pebbles and roots of weeds are removed and compost or stable manure is placed in the bottom. The excavation is then refilled with soil which is topped with a mulch of hay, straw, or rice chaff about 2 in. deep to keep it moist and prevent the growth of weeds. Instead of using this mulch it may sometimes be wise to grow cover crops. The rhizomes spread about 12 ft. a year. Whether or not shoots have emerged on a prepared area, keep on preparing more each year in the manner described. The best time for preparation of the soil is immediately after the emergence of the shoots. Needless to say, only well nourished bamboos will extend their rhizomes rapidly, so it is quite important to properly fertilize the grove.

If there is a ravine or ditch alongside the grove, it must be filled with soil, and if it contains running water, the course of the stream must be changed upstream.

Somtimes a bridge is made to cross over a small ravine, or the rhizomes are conducted across by means of large bamboo culms filled with soil. Since bamboo moves out about 12 ft. each year, a 60 ft. wide grove should take about 5 years to prepare. An additional 4 years is required for the new ground to be completely occupied by the bamboo.

2.5.2. Preparation of an Entire Area for Addition to a Grove.

An entire field adjoining a Moso grove may be prepared at any time after the emergence of the shoots up to the following February. The field is fertilized and crop plants are cultivated in it. Discontinue the cultivation of the crops gradually as the rhizomes from the grove invade the new field.

If the ground has not been under cultivation, clear away all roots of weeds and grasses. If mulberry, tea, or fruit trees are being grown, remove them each year as the bamboo rhizomes invade the new area.

Legumes are the best crop to grow in the prepared land before the invasion of the bamboo. Sometimes upland rice is grown, provided organic fertilizer in sufficient quantity is used. If no crops are cultivated, the ground will be covered with weeds; by having crops, the grower profits by the yield and the tillage.

2.5.3. Transplanting "Mother" Plants to a New Area.

The preceding two methods are used only when the new field adjoins a Moso grove, while the present method can be applied to any field. It is practically the same as that previously described for transplanting on a sloping field, flat land, or narrow strips. Using this method the distance between the mother plants should be at least 15 ft. to give enough space for the spreading rhizomes. Before transplanting, fertilize the soil with a liberal amount of basic fertilizer. Fertilize again the year following transplanting.

W. C. Adamson[1], M. O. Bagby, and W. B. Roth[2]: **Oil, Polyphenol, and Hydrocarbon Content in Culms of *Phyllostachys* Species**

Introduction

Bamboos are grasses with considerable productive potential. They are widely used for the manufacture of paper, for food, and as construction materials. In seasoning bamboos for construction uses it is reported (2,3) that, as a bamboo culm is heated, an oily material flows from it. This material is normally wiped from the culm. If it is not removed, the oily material hardens into a sticky, waxy coating on the outside of the culm. A bamboo grove will burn with unexpected rapidity and heat, making considerable noise due to the explosions as heated air in internodal spaces expands, shattering the culms. Several species of *Phyllostachys* were investigated as possible crops for oil and hydrocarbon production due to these observations. Numerous preliminary evaluations have been made by USDA-ARS and cooperating institutions on a wide range of plant species as a part of the search for potential energy crops. Several diverse species, including grasses, have been found to produce sufficient oil or hydrocarbon to be of interest as possible new crops for energy production (1).

Materials and Methods

Phyllostachys species were chosen for analysis because of their productive potential, wide adaption in North America, and the ease of their propagation. All samples were taken from the plots of the bamboo collection at the U. S. Plant Introduction Station at Savannah, Georgia which has since been closed. Materials analyzed were *P. bambusoides* Sieb. & Zucc. (PI 40842) and the *P. bambusoides* cultivars 'White Crookstem' McClure (PI 66785) and 'Slender Crookstem' McClure (PI 146420); *P. purpurata* McClure (PI 128771) and the cultivars 'Solidstem' McClure (PI 128800) and 'Straightstem' McClure (PI 128797); *P. nigra* (Lodd.) Munro (PI 49505) and the larger non-black cultivars 'Bory' McClure (PI 77258) and 'Henon' McClure (PI 24761). Species and cultivars are as described by McClure (4). Five current year culms and 5 older culms were harvested from each plot. Culms were split and approximately one quarter of each culm was folded and bundled. Bundles were dried at 32°C forced-air dryer. Sections of about 20 cm each were cut from the basal end of each quartered culm and further dried at 105°C in an oven until they reached a constant weight. These sections were reduced by sawing on a bandsaw. Sawdust samples were extracted for 24 hours with hexane in Soxhlet apparatus. The acetone extracts of one sample from each plot were partitioned between hexane and 9:1 methanol-water in a separatory funnel in order to separate the oil and polyphenol fractions. Details of the procedure are given by Buchanan *et al.* (1).

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Results and Discussion

None of the samples produced oil, polyphenol, or hydrocarbon fractions that were high by comparison with other species studied (1). All oil fractions were less than 1% (Table 1). All hydrocarbon fractions were less than 0.25% and most were 0. Most of the oil and polyphenol extract was partitioned into the polyphenol fraction. The surface exudate from heated bamboo culms is therefore most likely a polyphenol.

Statistical analysis of the oil and polyphenol extracts, including all 90 samples reveal that there is no significant difference among species. Old culms were not significantly different in oil and polyphenol yields than the current year's culms.

There appears to be little real difference in oil and polyphenol yield in these bamboos.

The results indicate that the bamboos studied are not good prospective crops for the production of oils, polyphenols, or hydrocarbons. It is likely that the rapid burning characteristic of bamboo and the surface accumulation on heated culms are due to a substance in the general classes studied. However, the overall concentration in culms is too low to be of practical interest.

Species PI Number and Cultivar	Culm Age	Percent Oil	Percent Polyphenol	Percent Hydrocarbon
P. bambusoides PI 66785	new	0.31	3.22	0.02
'White Crookstem'	old	0.76	2.88	0.00
P. bambusoides PI 40842	new	0.60	2.71	0.08
	old	0.99	2.25	0.10
P. bambusoides PI 146420	new	0.35	3.19	0.03
'Slender Crookstem'	old	0.30	3.32	0.01
P. purpurata PI 128771	new	0.93	3.03	0.02
	old	0.47	2.07	0.09
P. purpurata PI 128800	new	0.53	3.37	0.00
'Solidstem'	old	0.60	2.99	0.00
P. purpurata PI 128797	new	0.68	3.37	0.00
'Straightstem'	old	0.40	2.93	0.00
P. nigra PI 24761	new	0.30	1.40	0.02
'Henon'	old	0.33	3.56	0.00
P. nigra PI 49505	new	0.95	2.89	0.00
	old	0.35	3.45	0.00
P. nigra PI 77258	new	0.41	2.78	0.23
'Bory'	old	0.31	3.31	0.09

Table 1. Oil, Polyphenol, and Hydrocarbon Yields of *Phyllostachys* Culms.

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Jinsaburo Oshima: **The Culture of Moso Bamboo in Japan, Part II**

August, 1931
Translated from the Japanese text by Saburo Katsura
in collaboration with Robert A. Young, 1937-1942
Edited by Richard Haubrich

Preface to Part II

Part II deals with two different methods of growing Moso bamboo shoots and with several methods of forcing early shoots. The yield and quality of shoots depends on healthy rhizomes that grow uncrowded at the proper depth. Section 3 describes the Kyoto method of culture in which the rhizomes are covered with an additional layer of top soil each year. Section 4 describes the Meguro method in which the rhizomes are thinned out and reburied several times each year. Section 5 describes several methods for forcing early shoot growth by providing soil heat during winter and early spring.

Richard Haubrich

Part II: Methods for Growing Moso Bamboo Shoots.

3. The Kyoto Method of Growing Moso Bamboo Shoots.

This method which is popular in the area around Kyoto is both comprehensive and profitable.

3.1. Cultivation.

Shoot yield varies greatly both with the method of culture and with the quality of care given the plants.

3.1.1. Weeds.

The bamboo shoot garden, unlike a regular grove, receives almost full sun because the culms are kept at a relatively wide separation. The sunlight encourages the growth of weeds which take away food from the bamboo. Heavy weed growth shades the ground, lowering soil temperature and retarding shoot emergence.

If weeding is neglected, more work is required later; therefore frequent weeding is best. If there is a shortage of help, weeding should still be done at least three times during the year: immediately after the shoot harvest, in July or August, and in September. Always do the weeding on a dry day.

Usually weeding is done using a hoe to scrape the ground surface. A hoe should never be used just before the shoots emerge; weeds should then be pulled up by the roots by hand.

Small bamboo grasses should be dug out and all the rhizome pieces removed. Sometimes Moso rhizomes produce slender sasa-like stems called kibae that grow from old rhizomes. The kibae should be carefully removed since they take up nutrition that would otherwise go to good shoots.

Weeds may also be controlled by growing another crop between the bamboos. This is done only when the garden is new; it should not be continued after the garden is three years old.

3.1.2. Fertilizer.

Bamboo is a heavy feeder so that even rich soil becomes depleted after a few years if no fertilizer is added. A Moso garden can never receive too much fertilizer, and there is no recorded instance in which shoot yield or quality was poor because of too much fertilizer. Although fertilizer may be applied at any time of year, it is usually done after shoot harvest and again in late summer just before mulching with dry grass. Since the rhizomes are continuously active except in the cold season, it is better to apply small amounts of fertilizer several times than a large amount all at once.

Moso requires nitrogen and potassium which are found in home-made fertilizers such as compost, stable manure, fallen leaves, weeds, green manure, and wood ashes. Commercial fertilizers include soybean or rape-seed oil cake, herring-cake, bone ash, and calcium phosphate. Lime is often used both as a fertilizer and as a neutralizer for acid soil. Hay, weeds, green manure, and straw are simply spread on the ground. Stable manure, ash, calcium phosphate, potassium chloride, and similar materials are buried in small pits to avoid being carried away by rain or birds. Oil cake and rice bran should first be decomposed in water before burial in pits.

Legumes which are able to capture and retain nitrogen from the air offer an ideal fertilizer for Moso. Sometimes soybeans are planted after shoot harvest; these are cut and spread on the ground in September. Winter lupins, vetch and broad beans can be grown in winter and harvested for fertilizer in April and May.

3.1.3. Mulching.

Mulching the bamboo with hay or grass is most important. Depending on its composition the mulch furnishes various useful substances to the bamboo. It also improves the physical condition of the soil. Mulch protects the shallow growing Moso rhizomes both from cold in winter and from drought in summer. It also checks weed growth and tends to maintain the proper soil moisture. Mulch decay lightens the soil allowing the penetration of air which promotes rhizome growth. The fermentation provides heat and moisture which accelerates the emergence of shoots. Although the sun can raise soil temperature, it tends to dry things out and impede shoot growth.

Mulch should be spread during September in cool climates or during October in warm ones. Although hay and straw are the most popular, twigs, weeds, green soybean stems, wheat straw, rice chaff, fallen leaves, and seeweed are often used.

3.1.4. Cover-soil.

Cover-soil is a layer of soil which is spread on top of the mulch. It increases mulch decay, supplies chemical substances such as silicic acid which are required for bamboo growth, and improves the physical condition of the soil.

Bamboo rhizomes after growing horizontally for several years tend to grow up through the ground surface becomming exposed. These must be covered or the plants will suffer. The cover-soil serves this purpose also.

a. When to Use Cover-soil.

Cover-soil should be added to the Moso garden every year. Although this may be done at any time from early fall to late December, the best time is during October or November. If added too early, it will encourage weed growth. If, however, early shoots are harvested during November and December, the cover-soil must be applied immediately after harvesting.

b. Sources of Cover-soil.

Since its main purpose is the improvement of physical conditions and not nutrition, the cover-soil need not be particulary rich. Collect the soil from the top of a hill or from a field outside the grove. Do not leave depressions in the grove as these will hold water and impede the normal spread of rhizomes. Sometimes excavations from the drainage ditch are used as cover-soil.

Although bringing soil from outside the grove is expensive, it may be justified since digging in the grove itself can easily injure the growing rhizomes.

c. Amount Required.

No cover-soil is necessary the first year after planting the grove. In the second year use 4 bags per plant and in the third year use 8 bags; each bag weighs about 130 lb. Thus with 180 plants per acre one would add about 94 tons of soil per acre in the third year.

d. Digging the Cover-soil.

The cover-soil should be broken up with a pick or hoe as it is dug. Remove all weeds, pebbles, and stones.

e. Treatment Before Spring.

During winter the cover-soil is likely to become hard. It must be loosened before spring so that the shoots can emerge without restriction. As rain compacts the cover-soil and exposes pebbles on the surface, these should be collected and discarded before they impede shoot growth.

3.2. Care of the Mother Bamboo Plants.

Mother bamboos are plants that produce shoots; they are therefore the most important part of the bamboo garden.

3.2.1. Early Treatment of Plants.

The bamboo plants are closely observed for some time after they are first planted to see that they develop into good mother plants. Plants showing poor development should be removed.

Autumn planting will produce shoots the following spring. Spring planting will usually produce shoots the same season though sometimes not until a year later. The first year shoots are usually small. If two shoots grow from one plant, remove the smaller one. When the culm has grown enough to produce branches, cut off the top leaving the lower 10 branch bearing nodes of the culm. This saves the culm from being beat down by strong winds.

In the second spring most plants will produce 1 or 2 shoots which come up close to the mother. Leave only one shoot with each mother. Remove the smaller ones or the one closest to the mother if 2 shoots are about the same size. This conserves food for the rhizome of the mother. Usually about 200 shoots per acre are left to grow.

In the sixth year after autumn planting or the fifth year after spring planting a young grove should have about 800 mother culms per acre. In this year the increase by selection of new mother culms is complete. Remove about 200 of the weakest culms per acre. The spacing of the mother culms is important. Sometimes healthy culms must be removed if they are too crowded.

3.2.2. Improvement by Thinning.

If the mother culms are too densely spaced, sunlight is cut off from reaching the ground and shoot emergence is retarded. Late shoots bring a lower market price. Also, closely spaced culms produce dense rhizome growth which results in poor shoot quality. On the other hand, spacing can not be too great or the yield of shoots per acre will be low.

The proper spacing of mother culms depends on the soil. A rich soil allows wider spacing than poor soil. Climate is also a factor. On average about 600 mother plants per acre is desirable, fewer for rich soil and more for poor soil.

If culms are harvested, they are cut when they are 4 or 5 years old. In the shoot garden, however, such culms are not cut. In properly fertilized soil culms maintain their vigor for 6 or 7 years and are harvested only after 7 or 8 years. Non-vigorous culms are, of course, cut out even if they are much younger.

After about 7 years an equilibrium is reached where the number of new culms left each year equals the number harvested. For example, suppose there are 120 culms in a grove, and culms are harvested when they are six years old. There will be 20 culms of each age from one to six years old. In spring 20 of the new shoots are

allowed to grow into new culms. In fall the 20 six year old culms are harvested and the garden is back to its original 120 culms.

The young rhizomes generally grow up near the ground surface during the year. Older rhizomes being less vigorous are more likely to be deeper because of the yearly addition of soil. Near surface rhizomes produce the earliest shoots. One should choose among these for the future mother culms and avoid the late shoots which come from the less vigorous old rhizomes. The young rhizomes also have the best root system for anchoring the culms firmly. The very earliest shoots from the uppermost rhizomes should, however, be avoided as they are often too young.

A highly fertilized Moso grove produces large culms with many branches and leaves. Because the culms are also widely spaced, there is a serious problem with wind and snow injury especially to the rhizomes at the base of the culms. To avoid this damage the culms should be topped. Topping also allows more sunshine to reach the ground promoting early shoots.

The best time to cut the top is just after the lowest 2 or 3 branching nodes have extended their branches and the upper branches are still enclosed in the sheaths. Count from the lowest branches up to about the 12th node, and cut off the culm above it. Always cut with a knife or sickle; do not break off the culm by hand. Some growers cut the top off before the lowest branches have come out, but at so early a stage one can not determine the lowest, branching nodes.

Some say that topping injures the culm, but it is the only way to protect it from the greater injury caused by wind or snow. Topping may increase the number of leaves on a culm; it never decreases the total number.

Those who remove the tops of culms say that if many nodes are left on the standing culms, shooting is delayed and fewer but larger shoots are produced resulting in an overall larger yield. On the other hand, extreme topping which leaves fewer nodes on standing culms produces earlier, more numerous, smaller shoots and a smaller total yield. If early shoots are desired for the city market, use extreme topping. Also, since large shoots are difficult to sell in the city, it is best to top culms down to where only about 12 branching nodes remain. In remote areas where early shoots do not bring a high price, it is better to leave the culms with more nodes.

3.3. Harvesting Moso Bamboo Shoots.

The quality of bamboo shoots varies to some extent with the season and the method of harvesting.

3.3.1. Time of Harvest.

Moso shoots begin growing in the autumn. Hay spread on the ground tends to keep the soil warm making the shoots larger on the near surface rhizomes. Some growers dig the larger shoots, which are still underground, in November and December before the cover-soil is applied. These are called ground shoots or winter shoots. They bring a high price.

The shoots emerge from the ground between March and May; the exact time depends on soil temperature, moisture, and depth of the rhizome. Shoots that emerge before mid-April are the early shoots, those that come up in the later half of April are midseason shoots, and those after that are late shoots. Midseason shoots are the most abundant.

It is important to dig shoots promptly. Shoots that rise above the ground soon become dark and fibrous; the base becomes too tough to eat and the shoot loses its fresh fragrance. Early shoots should be dug before the tips become exposed above the ground, while midseason and late shoots should be taken when the tips are barely exposed.

3.3.2. Tools for Digging Shoots.

Although many kinds of tools are used to dig shoots, the best is the digging sickle used in Kyoto. It looks much like an ordinary pick with a steel blade 3 ft. long and a cutting edge about 1 in. wide. The oak handle is 2½ ft. long and 1½ in. in diameter. The complete tool weighs about 8 lb.

3.3.3. How to Dig Shoots.

To dig winter shoots remove the cover grass and locate a crack in the ground. Look for the tip of the shoot in the crack and then dig it out with the proper tool. Fill the hole and replace the cover grass. These shoots are usually small, about 6 in. long and 2 in. in diameter, but as mentioned above they bring a good price.

Since early shoots are also dug before their tips emerge, one needs a way to detect them as sunlight and many insects cause cracks in the ground. Experience helps distinguish the cracks caused by shoots. The worker usually carries a 2 ft. long spatula made of bamboo culm or metal. He inserts this into the crack and tells by touch whether or not a shoot is there. Each shoot location is marked before the digging. Early shoots are dug every three days.

Midseason and late shoots are easier to locate since they are dug when the tips are already exposed. They must be dug every day, otherwise a rain will cause them to grow too long and deteriorate in quality.

Shoots are curved in shape. The side towards which the tip points is the ventral side and the opposite side is the dorsal side. The pick is first driven into ground on the dorsal side to loosen the soil. Next swing the pick into the ground on the ventral side, loosen the soil, and then cut the base of the shoot from the rhizome using the sharp edge of the pick point. Hold the pick with both hands and pull away from the rhizome; the shoot easily comes out of the ground.

3.3.4. Treatment After Digging.

Do not remove too much soil in digging the shoots. Never wash them. Remove the wiry roots. Do not expose the shoots to sun or wind since they will loose their fragrance if they become dry. A shoot that is fairly stout, light yellow or light brown, purple on the rootbuds, and white at the basal cut will be tender,

fragrant, and tasty. On the other hand, a slender shoot with purple black skin, reddish root buds, and a dark colored cut base will be tough and have little fragrance. Shoots that have grown above ground are very poor in quality.

3.3.5. Yield.

Shoot yield depends upon many factors such as soil, fertilizer, and climate. Yields vary from 3 to 12 tons per acre; usually it is about 8 tons per acre.

3.4. Protection of the Moso Grove from Pests and Climate Injury.

3.4.1. Natural Death from Flowering.

The death that often follows the general flowering of bamboo is called natural death. This occured recently on Hoteichiku (*Phyllostachys aurea* A. & C. Riv.). An historic natural death overtook almost all plantings of Hachiku (*P. nigra* (Lodd.) Munro Cv. 'Henon' Mitf.) and Kurochiku (*P. nigra*) in Japan from 1905 to 1908. There is no historic record of a general flowering and dying of Moso. Although flowering occurs occasionally in a Moso grove, it is on only a few culms. Perhaps this is due to the excellent care always given to Moso.

Hori believes that the major immediate cause of death in flowering bamboos is direct sunlight in summer, dry air, dry soil, and starvation. Kawamura thinks that flowering is periodic and that death can be prevented by sufficient care to supply fertilizer, to weed, and to mulch the culms. Bamboo that is weakened during flowering will regain its vigor within a few years.

3.4.2. Water Death.

Water death is a disease which causes Madake (*Phyllostachys bambusoides* Sieb. & Zucc.) to loose all its leaves. Moso when stricken with the disease retains some leaves but these loose their healthy, green color. Shooting soon stops. Moso resists the disease for a while, probably because of its thick culms.

The disease gets its name because water is found inside of a cut culm. Kitashima says that the water collects because the loss of leaves cuts off transpiration. The disease is caused by a fungus which invades the entire plant. The stricken culms should be dug up along with their rhizomes and lime sprinkled in the holes left from digging.

3.4.3. Insect Pests.

The worst insect enemy of Moso is the Moso gall-wasp. Females lay eggs on the base of leaves or on the leaf sheaths. The hatched grubs attack the culm producing a swollen spot that looks like a bamboo seed. The affected culms often break in the injured area. New culms are not attacked as they have not yet leafed out when the eggs are laid. Affected culms should be cut and burned.

Another pest is the "night-burgler" insect. It attacks the shoots that are left to grow. It lays its eggs in May; these hatch into larvae which feed on and injure the

shoots. There is no effective method of control other than picking the individual insects when found attacking the bamboo.

3.4.4. Injury due to Weather.

New culms that have been properly topped suffer little injury from rain, wind, and snow. Excess moisture is injurious because it excludes air from the soil, keeps soil temperature low, and sometimes causes the rhizomes to decay. Dig a drainage ditch where soil moisture is excessive. Summer drought can also kill bamboo. To prevent this spread a 5 in. layer of straw around the base of the culms and irrigate every 2 or 3 days.

Avoid injury due to cold by mulching with straw in autumn. Gardens in cold climates should be protected by wind-breaks of trees on the windward side. Freezing injury can also be reduced by wrapping the culms with newspaper.

3.5. Renewal of the Moso Garden.

After years of growing Moso, shoot yield decreases despite the application of fertilizer. Partial renewal of the garden each year can be obtained by digging up a small section of land to provide the cover-soil. This excavated area can be set with new mother plants or it can be filled with soil and fertilizing material to induce new rhizomes to enter the space. Over a period of several years the entire garden can be renewed in this way.

The belt method is used to improve and renew the entire garden more quickly. Belts 12 ft. wide are marked off from north to south on flat land or perpendicular to the slope on hillsides. All the bamboo from every other belt is removed. The soil is excavated to 2 ft. deep adding compost, stable manure, hay, etc. In addition add about 1,000 lbs. of lime per acre. After a few years the bamboo in the uncultivated belts extends into the newly prepared areas. After mother culms have grown in the new areas, the alternate belts are cultivated and the process repeated.

4. The Meguro Method of Growing Moso Shoots.

The Meguro method is most popular in the Tokyo area. It is a well developed method but since it requires large land areas, it has not been widely practiced in Japan.

4.1. Preparation of the Moso Garden.

Shoot yield with the Meguro method is largely determined by the specific land preparation technique used.

4.1.1. Weeding.

Weeding may not be necessary if a crop is grown between the bamboos during the first 3 years, but otherwise weeding is required 3 or 4 times a year. Weeding during the first 3 or 4 years requires about 8 farm hands per acre. At about the sixth year shoot harvesting and burying of rhizomes begins, giving the weeds little chance

to grow.

4.1.2. Fertilizer.

Spring fertilizer is applied in the holes from which shoots were dug. Winter fertilizer is applied in the holes dug for winter shoots or in those left after removing old culms. The fertilizers used include stable manure, rice bran, compost, soybean cake, rape-seed oil cake, bone ash, tankage, chemical fertilizer, fallen leaves, straw, wheat stalks, and hay. In the Meguro method fertilizer is used to provide ample nutrition and to generate heat which will accelerate shoot emergence.

The fertilizer is applied in 4 different ways:

1. Surface Application. Scrape the surface to a shallow depth and spray lime or liquid fertilizer.

2. In Holes. Dump the fertilizer into the holes left from digging up shoots or old culms, or use holes specially dug. Cover all holes with soil.

Holes which are 1 ft. in diameter and 1 ft. deep are used in winter to fertilize and draw rhizomes into parts of the grove where culms are sparse. Sometimes ditches are used instead of circular holes. These are 1 ft. wide, 1 ft. deep and about 3 ft. long.

3. Ditch Application. This is used for rhizome planting from July to September. The ditch is 1½ ft. wide by 1½ ft. deep and as long as the rhizome to be planted. Place the rhizome in the bottom of the ditch. Fill the ditch with a 5 in. layer of soil, a 5 in. layer of stable manure, a 5 in. layer of rice bran and the remaining 3 in. with soil.

4. Bowl Application. The method is used on new mother culms before they extend their branches or when they show a lack of vigor in winter. There are two techniques, crescent and full moon.

a. Crescent. Draw a circle centered on the culm with a radius of 1½ ft. (2 ft. in winter). Dig a ditch 8 in. wide and 1 to 2 ft. deep along half the circle (the crescent). Fill the ditch with 5 in. of stable manure, fallen leaves or rice bran. Top this with bean cake, bone ash, or calcium phosphate and finally fill the remaining part with soil to ground level. The following year repeat the process using the opposite semi-circle.

b. Full Moon. The method is the same as above except that the full circle is used at one time.

Care must be taken not to injure the rhizomes when digging the ditch. Use a quick fertilizer in May or June. In winter, from December to February, a slow fertilizer is better. The depth of the ditch depends on the depth of the rhizome. The bottom of the ditch should be about 4 in. above the rhizome. It is important that no fertilizer touch the rhizomes.

4.1.3. Burying Emerged Rhizomes.

Rhizomes that emerge from the ground are replanted in the Meguro method by digging up the growing end and burying it deeper. The procedure replaces the addition of cover-soil used in the Kyoto method. During replanting the soil is loosened, old and weak rhizomes are removed and fertilizer is usually added. Weeding is done at the start to locate the exposed rhizome tips.

Replanting is done at 3 different times during the months from July to October. The first replanting lasts for about 25 days starting in early July. The second replanting period starts 10 days after the end of the first and lasts for about 20 days. The third period starts 20 days after the end of the second and lasts for 30 days. Not all exposed rhizomes are replanted. There is selection which depends on the age of the grove, the development of the rhizomes, their location, and their vigor. The last is most important to the yield of shoots.

During the first two years after setting out new plants the rhizomes are vigorous and few in number; only very few appear above ground. All that become exposed are immediately reburied. In the third to the fifth year all exposed rhizomes are replanted unless they become crowded in which case the weak ones are removed.

As the grove becomes older only selected rhizomes are reburied. In a year with poor weather few rhizomes come to the surface; all of these are reburied. In a good year when rhizomes are usually vigorous the weak ones are removed and even good ones may have to be discarded to avoid overcrowding. In selecting rhizomes to rebury keep those that originate from others lying about 1 ft. below the surface and that come to the surface at a moderate angle. Rhizomes that originate from too near the surface or from too deep and those that come almost straight up are usually discarded except in a poor growth year.

Rhizomes coming to the surface in July are usually exhausted from the recent culm development. They also originate mostly from shallow rhizomes. Only about 20% are kept; the rest are removed. By August and September the rhizomes have regained their vigor. Those which appear above ground usually come from deeper rhizomes and many come from previously replanted rhizomes. Most of these are replanted. Rhizomes emerging in October originate either from very deep levels or from those that have been replanted once or twice. The former are from old, weak rhizomes; they should be discarded. The later are reburied only if they are exceptionally good ones. Finally the rhizomes which surface in November and December are of no use; discard all of them.

A first class rhizome capable of producing shoots has a robust tip. For about 2 ft. back from the tip it is enclosed in purplish to pinkish, white sheaths. It is medium in size, with short internodes, somewhat curved, and with plump buds. Feeding roots may or may not be present. A poor rhizome is one that is too large or too small or one that shows injury from insects or disease. The tip is slender and pointed. The internodes are covered rather loosely with dark brown or pale green sheaths.

Dig up rhizomes that have emerged about 3 in. using a roundnosed shovel. Hold the rhizome up in the air and dig a trench beneath it for reburying. If two rhizomes lie across each other the upper one is lifted first and the lower one is replaced first. The point at which the rhizome is attached to its mother rhizome is very slender and delicate. Since it is easily injured, be careful not to bend the rhizome at any place closer than 1 ft. from this point of attachment.

The depth of burial affects shoot yield. Shallow burial will produce earlier shoots than deep burial, but shallow planting decreases both the yield and the quality of shoots. Usually the replanting trench is 1 to 1½ ft. deep, 2 ft. wide at the top and 1 ft. wide at the bottom. If the grower wants to harvest all shoots at the same time, he must make the trenches all the same. A large scale grower may want to vary the depth to spread the harvesting time.

Replant by placing the rhizome on the bottom of the trench. Be careful not to bend the rhizome too sharply. The bottom of the trench should not be flat but somewhat uneven to match the natural undulating shape of the rhizome. Place the rhizome so that the buds are at the sides and the tip is slightly lower than the rest. Press it slightly to the bottom of the trench and cover it with 5 in. of soil. Leave it for about 4 or 5 days; the shallow cover raises soil temperature and provides aeration to encourage growth of the rhizome. In clear hot weather compensate by deepening the soil and shortening the period of shallow covering. If rain occurs, burial should be completed to avoid water collecting in the trench.

After 4 days the rhizome should become established in its new position. An important part of the Meguro method is that a heat generating fertilizer is now added to provide nourishment and to hasten shoot emergence. A 5 in. layer of compost, rice, bran, fallen leaves, hay, stable manure or similar material is placed in the ditch and covered with soil. The ideal way is to use a 3 in. layer of compost, cover with a 3 in. layer of rice bran and fill the trench with soil. The holes from which rhizomes were removed should also be fertilized in the same way. The replanted areas should be marked to avoid later confusion in replanting.

4.2. Care of the Garden during Development.

4.2.1. Care of the Young Garden.

For the first 2 or 3 years most shoots are allowed to grow into culms. Only those that grow poorly or are too close to others are removed. From the third to the sixth year the number of new culms allowed to remain each year is brought up to about 200 per acre. In the seventh year the original, oldest culms are removed. The remaining ones are thinned to obtain a uniform spacing and a final stabilized density of 800 culms per acre.

4.2.2. Care after Stabilization.

The density of about 800 culms per acre is maintained. Higher density produces too many rhizomes which makes the job of replanting them more difficult. Culms are cut after about 7 years so that about 120 shoots per acre are allowed to grow into new culms each year. It is best to select these shoots from those that sprout early in the midseason of shoot production. The new culms are topped as described above. Each must be carefully marked with the year of its emergence so that there will be no uncertainty at cutting time.

5. Methods for Promoting Early Shoot Growth.

The methods described here are for the production of shoots between December and February, the time when shoots are rather rare and bring a high price. If enough food is stored in the rhizomes, the shoots will begin to grow by the end of November provided that proper soil temperature prevails. The problem is to determine this temperature and to find practical ways of maintaining it in the soil.

Although 74° to 77° F. is used to force growth in ordinary vegetables, a test at Mimazuki College of Agriculture showed that 77° F. caused Moso shoots to decay and rot. According to M. Iahino of Shizu-oka-ken a soil temperature of 55° F. for 20 days will cause shoots to emerge in about a month. M. Abe states that a 1 ft. layer of compost and stable manure piled above the rhizomes will produce shoots in 30 days. T. Audo says that an excavation 1½ ft. deep around the buds filled with fallen leaves and stable manure will cause the shoots to emerge in about 2 weeks. Neither of the last two investigators mentions temperatures, but the material used in the two cases should hold the temperature at 68° F. for 30 days.

Higher temperatures cause faster shoot growth, but one must consider that it also damages both the shoots and the mother plant. A temperature of about 60° F. seems to be optimum for the growth of Moso shoots since this is the average temperature recorded in April, the month of maximum shoot production for an unheated garden.

Since electricity is now available in rural areas of Japan, it can be used to provide heat to growing shoots. In addition to compost and manure, hot springs can also be used.

The rhizomes that are heated must have buds near the ground surface. The garden should therefore be at least 10 years old since most rhizomes in a young grove tend to lie deep in the ground.

5.1. The Trench Heating Method.

The rhizomes are first carefully dug into to locate those having buds. These are then selectively covered with a heat producing mulch. This method is more efficient when used with the Meguro method than with the Kyoto method since the rhizomes have already been located and staked during replanting.

Choose an area that is naturally warmed by southern exposure to the sun, by having a windbreak or by having widely spaced culms. The method can be started at

any time from November to February. If desired it can be started so that the shoots are harvested during the holidays when there is great demand.

Dig up the soil in a trench about 1 ft. wide alongside the rhizome. After October the buds which will develop into shoots are larger than the others. They look like miniature shoots and may be up to 3 in. long. Look for buds only on plants that are at least 3 years old. After digging the trench the length of the rhizomes, cover the buds with 6 in. of soil. On top of this place a layer of suitable fermenting material topped with a thin layer of soil. Finally a layer of straw is spread on the surface to insulate the trench.

It is important to use the correct mix of leaves, compost etc. so that the temperature does not rise above the optimum, 60° F. Soil temperature should be measured from time to time as a check on the mix. Also, the fermenting material should never come into direct contact with the rhizomes.

Most shoots will reach an edible size in 30 days if the correct temperature is maintained. Dig carefully so as not to injure those that may still need more time to grow. The shoots produced by this method usually weigh between ½ and 1 lb. compared to 1¼ to 2 lbs. for unforced shoots emerging in March.

5.2. Heating after Removing Top Soil.

This method removes the top soil over a broad area before applying the heating mulch. It requires less labor for large scale production than the trench method.

Dig out and remove a layer of soil down to the top of the rhizomes. The thickness removed depends on the depth of the rhizomes; about 6 in. is a typical depth. Cover the rhizomes with a 3 in. layer of soil followed by about 3 in. of fermenting material. Finally add a thin layer of soil and spread straw on the surface. The fermenting material can be varied in thickness and composition to give shoots in 30 days by maintaining a temperature of 60° F. or a lower temperature can be used to produce shoots in 40 or 50 days.

5.3. Heat Applied to the Ground Surface.

The method requires less labor by avoiding the digging. There is some difficulty, however, in obtaining heat penetration to the rhizomes. It is important to select a grove with shallow rhizomes.

Although several fermenting materials can be used as mentioned above, the fallen leaves of broad leafed trees provide a low cost material. The leaves are applied in a layer 1½ ft. thick. For straw use a 1 ft. layer, and for stable manure or rice bran use 9 in. The fermenting material is held in place by a frame.

5.4. Solar Heat.

Choose a grove that has good sun exposure and in which the rhizomes are close to the surface. Prepare a hot-bed using a wooden frame having one side higher than the other. Fill it with baked rice chaff. Heat is retained at night by covering the frame with oil paper. The method has been tested at the Miyazaki College of

Agriculture with satisfactory results. The hot-bed temperature averages 55° F. Shoots are produced in about 45 days.

Since the hot beds must be fully exposed to the sun, the method can only be used on small areas. It also requires a great deal of labor.

David McClintock*: ***Arundinaria simonii Variegata***

At Kew there is the flowering specimen from which was drawn, by Miss Matilda Smith, Plate 7146 in Curtis's Botanical Magazine (1890) of *Arundinaria simonii* var. *variegata*. It came from a Camellia house at Paul & Sons of Cheshunt, Herts, England on 21 April 1888, where it was cultivated as *Bambusa simonii* var. *variegata*, an unpublished name. Pauls had obtained it from M. Saumarez in France.

Specimen and plate, however, differ. The leaves on the plate are all of similar size and all variegated - "*folius viridibus albo-striatis*" is all the description Hooker gives. Those on the type specimen are also longer, narrower and not all variegated, i.e. artist's license was selective. This shows that this variety is what Makino (1900a) named var. *heterophylla*, and not a distinct one as shown, e.g. in Suzuki (1978).

Makino (1900b) indeed places his own *heterophylla* (and Bean's *albo-striata*) under *variegata*, amplifying the description of the latter to "Leaves dimorphous, mixed with narrowly lanceolate and usually green ones and linear and angustate-linear (the narrowest one about 2½ mm broad) and usually albo-variegated ones." He also (1912) again gives as a synonym, Bean's (1894) var. *albo-striata* "leaves smaller, narrower, striped white" (Bean's type, also at Kew, is annotated "*Bambusa vittata argentea* Hort. Kew gardens Sept. 1890, received from Marliac in 1889.") and Mitford's (1896) var. *striata*, adding that this is a garden variety not found in the wild state. It is this taxon that has been flowering recently, while type *A. simonii* ceased some time ago except for the odd aberrant individual. All four names are probably synonymous and the earliest alone is correct, i.e. *variegata*. Mitford (1896) sowed seed, but the result seems unrecorded. Tsuboi (1916: 27 in the translation at Kew) wrote "In 1889 the writer planted seeds in his garden, but they grew into the mother type." The assumption therefore is that this garden variety is a clone.

This taxon is not the same as the clumps of *A. simonii* with variegated leaves, usually low down on the culms. This is in fact typical of the species, described in 1866 by Carrière as having "feuilles très étroites, lineaires, les unes panachées blanches, les autres completement vertes". Not all clumps have this feature, which usually disappears as the plant grows on. It is probably best cited as 'Variegata'.†

* Bracken Hill, Platt, Kent, TN15 8JH, England.

† The species is now usually placed in *Pleioblastus*, but is retained here in *Arundinaria* because the cited references to it are in that genus.

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3. Environmental Conditions.

The most favorable climatic condition is warm and damp, with an annual rain-fall of 1,300 to 2,000 mm and an average temperature of about 17°C, the maximum temperature not higher than 38°C and the minimum not lower than -10°C. But successful cultivation is found in areas with temperatures ranging from 40°C to -18°C and the annual rain-fall under 1000 mm. It grows best in loose, fertile, moist and slightly acid soil. So a thick layer of rich sandy loam with 5 to 6 pH is ideal. The preferred site is a gentle slope, because collected water will cause the rotting of its rhizomes. *P. pubescens* is not windfirm; windfall occurs whenever it is attacked by strong wind. It is thus best grown in areas surrounded by mountains on three sides.

Fig. 1 *Phyllostachys pubescens* forest in Hangzhou, China.

4. Geographic Distribution.

It is mainly distributed in the following regions in China: the Changjiang Valley and the area to the south of it, northern Fujian, most of Jiangxi and Hunan, and western Zhejiang. The (natural) climatic and soil conditions in these places are favorable to the growth of *P. pubescens*. It is mostly distributed in mountainous areas, often forming vast stretches of pure or mixed forest. Distribution in flat areas is quite limited and the stands are often small and scattered. Latitude and landscape are the two factors that affect its distribution. In areas of low latitude it can reach an elevation of over 1000 m, but in major distribution regions the usual elevation is around 100 to 500 m. Plants grow taller on a high mountain range than on an

50%. The dead shoots should be cleared away as soon as possible. Rhizome shoots which are also called rhizome sprouts, are actually the growing tip of the rhizome. So the enlarging of a forest and the regeneration of rhizomes are closely related to the growing condition of rhizome shoots. Digging of rhizome shoots must be strictly forbidden and those that emerge from the ground should be protected by covering them with soil.

2. Clear away weeds, shrubs and arbors to transform the mixed forest into a pure forest.

3. Prevent windfall and snow-break. Before the snow season comes, cut off or shake off the tops of some of the newly matured culms (to prevent windfall and snow break).

4. Rational felling. Winter is the best season for felling and the suitable felling age is seven years or more. The number of culms to be felled should not exceed that of the newly matured culms. Felling in growing season and the felling of immature culms and culms that bear winter shoots on their rhizomes should be forbidden.

5. Prevent and control diseases and pests. *P. pubescens* is often attacked by diseases and pests. The *P. pubescens* forests in Eastern China have been greatly damaged by stag-head disease and *Coclebotys coclesalis* (Walker) Munroe & Mutuura*. Now they are under control. The method used to control stag-head disease is to cut off and dispose of the tops of culms and diseased branches. Measures like trapping with lamps, air-spraying of insecticides, raising natural enemies and so on have also been adopted to control *Coclebotys coclesalis*.

7. Management of Timber Forests for the Fishing Industry.

In China a large number of *P. pubescens* culms are used in the off-shore fishing industry and very often the demand exceeds supply. Straight, thick-walled, huge culms are ideal for this purpose. Thus the objective of the management of such a forest is to produce huge, thick culms of high quality. Stress should be laid on soil management. Loosen the soil every year or every other year, clear away stones and old stumps, and apply organic fertilizer and chemical fertilizer N and P in large quantities. In the shooting period dig out small shoots, shoots on the path and shoots that are too dense or too close together. If the facilities are available, irrigate the forest in dry weather. When the rainy season comes, make sure that the forest is well-drained. The preferred density of the forest is over 4500 culms per hectare. To improve the canopy structure cutting off the tops of some plants is necessary.

* This moth was formerly known as *Hedylepta coclesalis* Walker. The name was changed in 1969. My thanks to Julian P. Donahue of the Natural History Museum of Los Angeles County for his assistance. – Ed.

Qui Fu-geng*: *Phyllostachys pubescens* in China

Phyllostachys pubescens Mazel ex H. de Lehaie is native to China and has been introduced into Japan and some other countries. Among all the bamboo species in China, *P. pubescens* has the widest distribution, the largest forest area and the highest yield. No other species can equal it in variety of uses.

1. Major Uses

P. pubescens is grown both for its edible shoots and for its timber. It grows fast and produces large numbers of long, straight, thick walled culms that are useful for many purposes. The culms are good building material for scaffolding and boards and for building temporary sheds or simple farm-houses. The culms are also split and used for weaving, small farm-tools, daily articles and various kinds of handicraft articles. Its wood is suitable for making paper. In the off-shore fishing industry, the culms are used to build support network for supporting or propping up fyke-nets. Its edible shoots are often dried, canned (to store away), or eaten fresh. The sheaths of its shoots contain a high percentage of fibre, therefore they are often used for making paper, carpet or as sofa stuffing. Its durable branches can be used to make very good brooms. It is an ideal species for ornamental plantation in that it is evergreen and its stand has a canopy closure all the year round because of the selective-felling method (see Fig. 1). Its twisted and intertwined roots make it a good plant to be grown for the purpose of conserving soil.

2. Morphological Characteristics

It has thick and durable running rhizomes with a diameter of about 1.5 to 3 cm and an internode length of 3 to 6 cm. The culms are straight, slightly arched at the top, with a height of 10 to 20 m and a diameter of 8 to 16 cm. The maximum height is over 22 m and the maximum diameter is over 19 cm. The thickness of the culms at the height of 1.3 m is 0.5 to 1.5 dm. The culm nodes at which branches develop are prominent while those without branches are flat. The shooting period is rather long. Shooting starts in fall and continues till the spring of the following year, but the shoots remain in the ground throughout fall and winter and are called winter shoots. They begin to appear in the spring of the following year and are called spring shoots. The shoot sheaths are thick and leathery with brown setae and fall off as the shoots grow. Branches grow from the upper culm nodes, two to each node; one is typically thicker and longer than the other. Foliage leaves are lance-shaped, measuring up to 5 to 10 cm long and 5 to 15 mm wide. Flowering is seldom found in the center of the distribution zone, but common in its southern fringe.

* The Chinese Academy of Forestry, Subtropical Institute of Botany, Fuyang, Zhejiang, China.

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isolated mountain.

Distribution is also found in coastal areas and on islands where the soil is non-alkaline, but it does not grow as well here as in inland areas.

5. Propagation.

The common method is vegetative propagation. Afforestation is almost always through transplanting mother plants. The chosen plants are usually 2 or 3 years old, relatively short and healthy. The mother plants should be dug with an attached rhizome about 80 cm long which has sufficient soil attached to protect the buds. The rhizomes should be wrapped carefully. The culms should retain 5 to 7 nodes with branches; the rest of the upper culm is cut off. The best time for afforestation is in spring, one or two months previous to the onset of the shooting period. It can also be done in fall or winter. The appropriate depth is 3 to 5 cm deeper than the original depth of the mother plant. If too deep, shooting will be hampered. An improved propagation method is through stumps. Dig out the stump in the same way as digging out the mother plant, but with no culm or branches attached. The suitable density of plants for a plantation is between 300 and 450 per hectare. The new forest will take seven years to mature and produce culms. Some other methods are also used, such as transplanting rhizomes or shoots, but the success rate is very low and the culms produced are poor in quality, so these methods have not been used in production.

Afforestation through seedlings is another propagation method commonly used in the production of *P. pubescens* in China. The seedlings are raised in the same way as raising any other kind of seedlings with seeds in the form of small grains. Within one year the seedlings will reach a height of 30 to 40 cm and be ready to be transplanted. They should be planted in small clumps, each containing 3 or 4 seedlings. This method has a low cost but a high success rate. Its disadvantage is that the new forest takes a long time to mature and to produce culms. The period of time required can be greatly shortened by letting the seedlings remain in the nursery until they reach the height of 1 to 2 m before transplanting.

6. The Management of a Timber Forest.

Most of the *P. pubescens* forests in China are timber forests. The following methods are commonly used in management.

1. Protect the winter shoots, retain the spring shoots, clear away the dead shoots in time, and forbid the digging of rhizome shoots. Shooting has two stages. In the first stage the shoots remain in the ground and are called winter shoots, but as soon as they reach the second stage by breaking through the soil they are called spring shoots. Measures should be taken to protect the winter shoots; digging them up for food at will should not be allowed. As many spring shoots as possible should be retained.

   Spring shoots come out in large numbers. When the spring shoots reach the stage at which they grow most vigorously, lack of nourishment and bad climatic conditions can cause severe damage. The death rate can be as high as

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Richard Haubrich*: **Handbook of Bamboos Cultivated in the United States**
Part IV: Mountain Bamboos of the Old World

Introduction

As a rule there are two kinds of bamboo, the tropical clumpers and the hardy runners. Far less common in cultivation are the hardy clumpers. They are the mountain bamboos, medium size clumping species which are tolerant of mild to severe frost. Native to elevations above 5,000 ft. they grow throughout the tropical regions of the world. Many are native to the Americas but none of these are at present cultivated in the U.S. The present article describes ten species which have long been grown as ornamentals in Europe and which now grow in the U.S.; nine are from Asia and one is from South Africa.

1. Common and Related Characteristics

There has been general disagreement among botanists on the genera to which the ten species belong. All have been assigned to *Arundinaria* Micheux at one time or another, but rhizome type and branching pattern sets them apart from this genus. I have divided the species into 3 groups. Group 1 consists of 3 species which differ from the other 7 species by having untessellated leaves and branches which originate immediately above the nodal sheath scar of the culm. Group 2 consists of 3 species which are similar to *Thamnocalamus* Munro in their vegetative features but differ from it in floral structure. Because of the uncertainties which still exist in their assignment to genera, I have retained the name *Arundinaria* for both Groups 1 and 2, although I feel that they represent 2 distinct genera, neither of which is *Arundinaria*. Group 3 consists of 4 species which fit well into the genus *Thamnocalamus*. A sensible grouping would be to expand the concept of *Thamnocalamus* to encompass the species in Group 2 and to define a single new genus for Group 1.

1.1. Rhizomes

Rhizomes are underground stems which make up the foundation or chassis of a bamboo; they determine the spacing of the culms and thus the general growth pattern of the plant. McClure (1966) distinguishes two basic types of bamboo according to whether the rhizomes are pachymorph (thick shaped) or leptomorph (thin shaped). Leptomorph rhizomes are generally long as well as thin allowing the culms to grow several ft. apart producing a running bamboo. Pachymorph rhizomes are short as well as thick so that the culms generally grow close together in clumps. Some pachymorph species, however, have developed the ability to run.

How does a short, thick rhizome produce a running bamboo? To answer this we must look more closely at McClure's definitions. A rhizome is an axis (stem) consisting of two separate parts called the neck (at the end of origin) and the rhizome

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proper (at the distal end). Both parts have nodes, but neck nodes are without buds or roots while nodes of the rhizome proper have at least one bud and generally some roots. The terms pachymorph and leptomorph refer to the rhizome proper only, not to the neck. A rhizome is pachymorph if the rhizome proper is short and thick compared to the culms arising from it. Short thick rhizomes can, however, develop long, thin necks which allow culms to grow some distance apart and thus run.

All ten species treated here have pachymorph rhizomes. This is a basic vegetative feature which distinguishes the group from the typical *Arundinaria* and *Chimonobambusa* Makino. The species in Group 1 grow in tight clumps while those in Groups 2 and 3 form more open clumps. All of the later are, however, considered clumping bamboos except for *Arundinaria anceps* and *A. racemosa*.

1.2. Branching

All ten species have branch complements that consist of multiple, subequal branches at midculm nodes. The details of the pattern is somewhat different from that of *Arundinaria* (Soderstrom and Ellis, 1982). The branches of Group 1 arise directly from above the sheath scar whereas the other species have branches which arise from a point a small distance above the scar.

1.3. Flowering

There is great diversity in the observed flowering habits of the ten species. *A. falcata* has flowered almost continuously in the U.S. over the last 10 years while *A. nitida* has never flowered since its introduction into Europe from seed about 100 years ago.

1.4. Propagation

The mountain bamboos are a bit more difficult to propagate than most other bamboo species. The best method is to divide the plant leaving 3 or more culms with their attached rhizomes in each division. Propagation is best done in spring before the new shoots appear except for *A. falcata* which should be divided in summer since it usually shoots in fall or winter. New divisions should be placed in shade until the roots have been established. The culms must usually be topped to remove some of the leaves. If the remaining leaves curl or wilt, further trimming should be done until the plant can maintain itself. Protect the division against dry winds and extreme cold.

Lawson (1968) states that all ten species can also be propagated either by rhizome cuttings or by single rhizomes with a basal portion (about 1 ft.) of the culm attached. I have found such methods to work with some of the species and not at all with others. In all cases the success rate is less than that for plant division.

1.5. Uses

The mountain bamboos make outstanding ornamentals as most are noninvasive, medium in size, and tolerant of cool or cold climates. All seem to prefer partial shade to full sun. Their primary disadvantage at the moment is availability in the U.S. *A. falcata* is the only species sold by a number of nurseries while *A. nitida* and *T. spathaceus* have appeared on the market occasionally. *A. anceps* and *T. tessellatus* are fairly fast growing and should become available in the near future.

2. The Species

Table 4 lists the ten species and summarizes the features of each. Columns 3 to 16 and 19 give a 0, 1, or 2 for each species for the feature in the column heading. A 0 indicates that the feature is lacking, a 2 indicates that the feature is prominent, and a 1 indicates something in between. The features for each of these columns and the explanation of the remaining columns is given below.

Col. 1: The maximum height of mature culms in feet for plants growing under favorable conditions.
Col. 2: The maximum diameter of culms (as above) in inches.
Col. 3: Culms are spaced some distance apart rather than closely clumped.
Col. 4: Culms are arching rather than erect.
Col. 5: Culms are purple or brown rather than green.
Col. 6: Young culms are covered with a white or bluish white powder.
Col. 7: The nodal ridge is prominently swollen.
Col. 8: The sheath scar is wide.
Col. 9: The culm leaf sheath has hairs on its outer surface (in addition to those on its margins).
Col. 10: Culm leaf oral setae (hairs or bristles growing on top of the sheath on each side of the blade) are well developed.
Col. 11: The culm leaf remains attached to the culms for up to a year rather than falling off soon after shooting.
Col. 12: The culm leaf ligule (extension of the sheath apex up beyond the base of the blade) is prominently tall.
Col. 13: The culm leaf ligule has prominent hairs usually on its upper margin.
Col. 14: The foliage leaf sheath has hairs on its outer surface (in addition to those on its margins).
Col. 15: The foliage leaf oral setae are well developed.
Col. 16: The foliage leaf ligule is prominently tall.
Col. 17: The typical average length of a foliage leaf blade in inches.
Col. 18: The typical average width of a foliage leaf blade in inches.
Col. 19: The lower surface of foliage leaf blades is hairy.
Col. 20: An estimate of the lowest temperature in degrees F. that the species will tolerate.

2.1. Group 1

Group 1 consists of 3 species which are native to the Himalaya Mountains of India. They have the following common features. The culms grow close together in tight clumps. Branches arise on the culms from a point immediately above the nodal sheath scar. Foliage leaf blades do not have cross veins so that there is no tessellation pattern. All three species are markedly less hardy than the other mountain bamboos considered here, in agreement with the general rule that bamboos without tessellated leaves are not hardy. However, unlike tropical bamboos, the Group 1 species appear to thrive in cool climates in locations with little direct sunlight.

Based on their flowers the three species have been placed in two new separate genera by Keng (1983). *A. falcata* and *A. hookeriana* are assigned to *Drepanostachyum* for having sickle shaped spikes, 2 stigmas, and separate culms for flowers and leaves. *A. falconeri* is assigned to *Himalayacalamus* on the basis of having rather large bracts below spikelets on leafy culms and 3 stigmas.

Arundinaria falcata Nees

[*Chimonobambusa falcata* (Nees) Nakai, *Drepanostachyum falcatum* (Nees) Keng f.]
Blue Bamboo

Gamble 1896; Lawson 1968; Mitford 1896; Munro 1868.

This bamboo is native to the north-west Himalayas from the Ravi to Nepal at elevations from 4,000 to 12,000 ft. but usually below 7,000 ft. It grows in the understory of forests of white oak, firs, and mixed trees usually in shady places like northern slopes and ravines. It has frequently been found in flower in the wild, where culms are beaten to the ground each year by snow with new ones growing again in spring.

A. falcata is a beautiful ornamental which tolerates direct sunlight by rolling up its dark green leaves. When the sun goes away, the leaves quickly uncurl. The flowering habit of this species makes it a poor risk in the garden. Most of the plants that I have seen have few, to many flowers. Such plants usually grow slowly or not at all; the plant expends more and more of its energy on the flowers and less on vegetative growth. In spite of abundant flowers only a very few seed are produced. None have been known to germinate in Southern California.

There is a small clump growing at Quail which at present has several flowering culms.

Culms forming tight clumps up to 20 ft. tall and ¾ in. in diameter; **internodes** green at first, often covered with a bluish white powder, yellowish to reddish brown when older; **branchlets** numerous, slender, purple in color, abruptly bending at the nodes.

Culm leaf sheaths soon deciduous, papery, straw colored, as long or longer than the internodes, hairless above, minute hairs below, tapering to a narrow,

truncate tip fringed with hairs; **ligules** up to ½ in. tall, toothed on the upper margin; **blades** small, tapering to a point, bending back.

Foliage leaf sheaths grooved, hairless except for short ciliate sides and the upper end which is a minutely hairy ring below the petiole; **auricles** and **oral setae** usually lacking; **ligules** tall, thin, toothed or fringed on the upper margin; **blades** usually 3 to 4 in. long by ½ in. broad, up to 12 in. long and 1 in. broad on young culms, rough due to short stiff hairs on the upper surface, soft hairs on the lower surface when young.

Flowers frequently, the flowers usually on culms with few or no leaves.

Arundinaria falconeri (Hooker f. ex Munro) Bentham and Hooker f. ex Duthie

[*Thamnocalamus falconeri* Hooker f. ex Munro, *Himalayacalamus falconeri* (Hooker f. ex Munro) Keng f.]

Gamble 1896; Lawson 1968; Mitford 1896; Munro 1868.

This species is native to the Himalayas in Nepal extending eastward into Bhutan and westward into Kumaon at elevations from 7,000 to 9,000 ft. According to Mitford it grows 20 to 25 ft. tall in the usually warm climate of Western Ireland. An unusual frost with temperatures down to 6° F., however, killed it to the ground so that the culms which came up the following year were only 6 to 8 ft. tall.

Flowering of *A. falconeri* occurs about every 30 years according to McClintock (1979). The last flowering in England was in the late 1960's. The mother plants die but seed is usually set, producing a new generation.

Over the years *A. falconeri* has been introduced several times into this country by the USDA, yet the species is quite rare here. I have seen it planted in the ground only at Inadomi Nursery in Castro Valley, California. According to Mr. Inadomi the plants were grown from seed obtained from a mother plant that flowered and died several years ago.

Culms forming tight clumps up to 30 ft. tall and 1¼ in. in diameter; **internodes** bright green covered with a white waxy bloom at first, later dull yellow with a brownish-purple stain near the nodes; **nodes** fairly prominent; **branches** numerous at every node from the first season.

Culm leaf sheaths striate, hairy when young, truncate at the top; **ligules** short, dark colored, hairy; **blades** tapering from base to apex, curved back.

Foliage leaf sheaths hairless except fringed with hairs on the edges; **ligules** rounded, hairy, elongate; **blades** 3 to 6 in. long by ½ to ¾ in. broad, smooth and hairless on both surfaces except for a few long hairs below at the base of the midrib.

Arundinaria hookeriana Munro

[*Chimonobambusa hookeriana* (Munro) Nakai, *Drepanostachyum hookerianum* (Munro) Keng f.]
Praong

Gamble 1896; Lawson 1968; Munro 1868.

A. hookeriana is native to the foothills of the eastern Himalayas in Sikkim and Bhutan at elevations of 4,000 to 7,500 ft. It was named after its discoverer, J. D. Hooker, who wrote in 1854 (McClure, 1966, p. 272): "Near the top [of the pass from Teesta to the Great Rungeet, Sikkim] I found a plant of 'Praong' (a small bamboo), in full seed; this sends up many flowering branches from the root [rhizome], but few leaf-bearing ones; and after maturing its seed, and giving off suckers from the root, the parent plant dies. The fruit is a dark, long grain, like rice; it is boiled and made into cakes, or into beer, like Murwa." The species flowered in England in 1899 (Bean, 1907) when some plants died while others recovered; it flowered again in 1979 (McClintock, 1979).

I can find no record that this species was grown in the U.S. before its introduction in 1981 from Werner Simon in West Germany. The plant when released from quarantine in January, 1983 was about 2 ft. tall with 10 culms measuring up to ¼ in. in diameter. Each node on the upper part of the culms carried about 10 small subequal branchlets. A few of the leaves were variegated with distinct, narrow white stripes. In January, 1983 two living plants were collected in the wild at about 7,500 ft. elevation near Darjeeling, India by Thomas Soderstrom. According to Soderstrom the wild plants grow up to 30 ft. tall with 2 in. diameter culms that are pure blue in color. These plants are now growing in the quarantine greenhouse at Quail.

Culms, clumping, up to 30 ft. tall and 2 in. in diameter; **internodes** glaucous green or blue when young, turning yellow when older with a dark bluish ring at the top, often striped green or yellow, about 8 in. long, thin walled; **nodes** not very prominent, but ringed by the persistent base of the sheath; **branches** short and numerous, especially from upper nodes.

Culm leaf sheaths papery, striate, tapering concavely upwards in the upper half to a narrow, truncate apex; **ligules** tall, irregularly toothed on the concave upper margin. **Foliage leaf sheaths** striate, hairless except for small hairs on the edges, ending above in a callus without oral setae; **ligules** tall and conspicuous, often dark in color and pointed, **blades** 3 to 12 in. long by ½ to 1½ in. broad, smooth to rough above, pale and hairless below except for a few white hairs at the base of the midrib.

2.2. Group 2

Group 2 bamboos differ from those in Group 1 by having culms which grow from somewhat open clumps to spacing several ft. apart. The branches arise from a point which is distinctly above the nodal sheath scar. The foliage leaf blades are clearly tessellated. Group 2 species are similar to Group 3 species in vegetative characteristics but differ in certain floral aspects.

Arundinaria anceps Mitford

[*Yushania anceps* (Mitford) Lin]

Lawson 1968, Lin 1974; Mitford 1896.

Mitford described this species in 1896 giving it the name *anceps*, the "doubtful" *Arundinaria*. At the time, its country of origin was uncertain. Lawson (1968) states that "It has now been definitely established as an Indian bamboo from the north-west Himalaya mountain range, where it grows at altitudes of between 10,000 and 11,000 feet above sea level in the states of Sikkim, Bhutan, and Garhwal."

The name of this species is still somewhat doubtful. Bahadur and Naithani (1978) claim that *A. jaunsarensis* Gamble is the same as *A. anceps*; they have renamed it *Chimonobambusa jaunsarensis*. *A. jaunsarensis* has never been found in flower while *A. anceps* has flowered somewhere in England almost continuously since 1957 (McClintock 1979). Lin (1974) has published a description of the *A. anceps* flowers. Both flowers and many vegetative features resemble *A. elegans* Kurz (Gamble, 1896). McClintock (1983) has studied herbarium specimens at Kew of both *A. jaunsarensis* and *A. anceps*; he concludes that the former is the same species as *A. anceps*. The material on *A. elegans*, however, is insufficient to reach a conclusion. Because of the uncertainties in both species and genus names, I prefer to keep the name *A. anceps* for the present.

A. anceps is considered to be a perfectly hardy bamboo in England. It is a running bamboo which has a tendency to form multiple clumps spreading by way of long necked rhizomes followed by tillering to produce culms at closer spacing.

Culms up to 12 ft. tall and ¾ in. in diameter spaced separately or in separated clumps; **internodes** at first covered with bluish white powder, then green turning dark brownish green; **nodes** not very prominent; **branches** about 3 from mid to upper nodes the first year, numerous in later years.

Culm leaves persistent for about 6 months; **sheaths** striate, shorter than the internodes, hairless except for long hairs on the sides, tapering to a narrow, straight tip; **auricles** prominent or lacking; **oral setae** numerous, long, scabrous; **ligules** tall, ciliate on the upper margin, wider than the base of the blade; **blades** tapering from base to apex.

Foliage leaf sheaths purple, minutely hairy; **auricles** and **oral setae** well developed; **ligules** medium tall, truncate, minutely ciliate on the upper margin; **blades** about 4 in. long and ½ in. broad, hairless on both surfaces.

Arundinaria nitida Mitford

[*Sinarundinaria nitida* (Mitford) Nakai]
The Fountain bamboo, Blue bamboo

Lawson 1968, Mitford 1896.

A Russian naturalist named Berezovski found this species flowering in the highlands of central China in 1886. Seed was sent back to St. Petersburg and from there it reached England in 1889 where plants were soon established at Kew. *A. nitida* has never been known to flower since 1886, and we do not have descriptions of the flowers.

Mitford (1896) named this bamboo *nitida*, which means shining or polished in Latin, because of "its brilliancy and beauty." The slender, dark purple culms along with small, brilliant green leaves make it one of the most beautiful ornamentals.

Most bamboos will increase in overall bulk by a factor of from 2 to 5 each year, but *A. nitida* is very slow growing, at least in Southern California. This may explain why there are no regular commercial sources of this desirable species even though it is attractive, nonaggressive and very hardy. There is a good size clump growing in the Jungle Garden at the Huntington and small plants growing at Quail and at the San Diego Zoo.

A. nitida is sometimes confused with *A. falcata* because of the bluish cast of the culms. The two are easily distinguished; *A. nitida* has tessellated leaves and branches which originate a short distance above the nodal sheath scar, while *A. falcata* has no leaf tessellation and branches arising immediately above the scar.

Culms usually spaced no more than a few inches apart, up to 15 ft. tall and ¾ in. in diameter, **internodes** dark purple, covered with a bluish grey powder for the first year or two; **nodes** not prominent; **branches** usually not appearing the first season, then 3 to 5 the second season and numerous thereafter, dull purple in color.

Culm leaves persistent, the **sheaths** pale purple with dark purple veins at first, fading to straw; hairless; **auricles** and **oral setae** lacking; **ligules** rather short, fringed on top with minute hairs; **blades** small, bent back, deciduous.

Foliage leaf sheaths dark purple, hairy; **auricles** lacking; **oral setae** fine, delicate or lacking; **blades** about 3½ in. long by ½ in. broad, slightly rough due to minute hairs on the lower surface.

Arundinaria racemosa Munro

[*Fargesia racemosa* (Munro) Yi]

Gamble 1896; Lawson 1968; Mitford 1896; Munro 1868.

A. racemosa is native to the north-east Himalayas in Nepal and Sikkim at elevations from 6,000 to 12,000 ft. According to Gamble, "This species is the

can probably withstand at least -20° F. Unlike most other bamboos it grows slowly. There are several clumps growing at the Strybing Arboretum and a single small plant at Quail.

Propagation of this species is slow, at least in Southern California. The method is to divide the clump with 3 or more culms in each division. Rhizome cutting or divisions with leafless culms have a poor survival rate.

Culms up to 14 ft. tall and ½ in. in diameter, densely spaced, arching out as they become heavy with foliage; **internodes** bright green the first year, aging to deeper green and then dull yellow; **nodes** not prominent; **branches** usually 3 or 4 during the first season.

Culm leaf sheaths shorter than the internodes, pale yellowish brown or pale yellow, hairless except for fine hairs at the base, rounded at the apex; **auricles** and **oral setae** lacking; **ligules** short, hairless; **blades** small, triangular to lanceolate.

Foliage leaf sheaths purple, hairless or nearly so; **auricles** lacking; **oral setae** a few or lacking; **ligules** medium tall; **blades** 3 to 4 in. long by ½ to ¾ in. broad, rough on the lower surface due to minute hairs, hairless on the upper surface.

Thamnocalamus spathiflorus (Trinius) Munro

[*Arundinaria spathiflora* Trinius]

Gamble 1896; Lawson 1968; Mitford 1896; Munro 1868.

T. spathiflorus is native to the Himalaya Mountains of Nepal, Sikkim, and Bhutan at elevations of from 7,000 to 10,000 ft. Gamble says "This is the common high level *ringal* of the North-West Himalaya, common in the undergrowth of the deodar and fir forests in moist localities. It usually flowers gregariously as it did in 1882, the seedlings from which flowering are now (1893) growing up. It is at once distinguished from ... *A. aristata* by ... the absence of a hairy callus to the leaf sheath, and other minor points. The culms are used for pipe-stems, basket work, pea-sticks and other purposes."

Although *T. spathiflorus* was introduced by the U.S. Department of Agriculture some years ago, there is no record that those plants are still alive. Four small plants were obtained from Hillier's Nursery in England and placed in the Quarantine Greenhouse at Quail in early 1983. As of May 1983 all 4 plants are alive and are producing new leaves.

Culms forming closely spaced clumps, 12 to 20 ft. tall and .5 to .8 in in diameter; **internodes** smooth, green, covered with a white scaly coating at first, later turning yellow to reddish brown; **nodes** prominent with a white ring (sheath scar); **branchlets** chiefly from upper nodes, much jointed and bearing straw colored sheaths at the lower joints.

Culm leaf sheaths loose, hairless, margined with hairs on the sides which are parallel until, near the top they narrow by rounding to a narrow straight end with a

few stiff bristles; **ligules** .1 in. tall, fringed; **blades** erect.

Foliage leaf sheaths loose, 2 to 3 in. long, straw colored, striate, ciliate on one edge, truncate on top in a narrow ciliate callus; **auricles** short with a few long purple **oral setae**; **ligules** tall, dark colored, ciliate; **blades** clustered in groups of 2 to 4 at the ends of branchlets, 3 to 5 in. long and .4 to .6 in. broad, ending above in an acute hairy point, hairless on both surfaces or sometimes slightly hairy below.

Thamnocalamus tessellatus (Nees) Soderstrom and Ellis

[*Nastus tessellatus* Nees, *Arundinaria tessellata* (Nees) Munro]
Bergbamboes

Lawson 1968; Munro 1868; Soderstrom and Ellis 1982.

The Mountain Bamboo or 'Bergbamboes', as it is called in Afrikans, is the only native bamboo in South Africa. It grows at elevations between 5,000 and 8,000 ft. from the eastern districts of the Cape through Lesotho and Natal to the eastern Orange Free State. The plants grow along stream edges and are adapted to wet conditions by roots which contain air canals. Bergbamboes is a clumping bamboo with pachymorph rhizomes; the rhizomes necks are up to a ft. long allowing the culms to form open clumps.

Although first described by Nees von Esenbeck in 1841 as a species of *Nastus* Gmelin, flowers were not collected until 1909. The recent study by Soderstrom and Ellis (1982) uses leaf anatomy and epidermis, gross morphology, and flower structure to place Bergbamboes in the genus *Thamnocalamus*. Its present isolation from near relatives in the Himalayas and China may be the result of the separation of Gondwanaland due to continental drift.

Bergbamboes has rarely been cultivated in the U.S. A small clump has been growing at LASCA for several years, flourishing during the rainy season and dying back during the dry summers. It now (May 1983) consists of only a few culms.

Culms from 3 to 16 ft. tall and up to 1 in. in diameter, erect or only slightly arching, forming an open clump due to pachymorph **rhizomes** with necks up to 1 ft. long; thick **roots** with air canals; **internodes** dark maroon when young, becoming straw-colored; **nodes** not thickened, with a single bud; **branches** 5 to 8 from each of the upper nodes, subequal, these rebranching to 10 to 20 branches forming dense tufts of foliage, the branches 4 to 12 in. long.

Culm leaves somewhat persistent; **sheaths** pale maroon with fine, thin stripes when young, later turning pure white; **auricles** and **oral setae** lacking; **ligules** medium tall, truncate and ciliate on upper margins; **blades** narrower than the sheath apex, persistent, at first ascending, later bending down with the tip horizontal.

Foliage leaves 3 to 5 closely overlapping; **sheaths** covered with minute, retrorse hairs, **auricles** short; **oral setae** many, long, straight, and smooth; **ligules** tall, covered with short hairs and ciliate on the upper margin; **blades** rough due to

short hairs on the lower surface, hairless on the upper surface.

3. Locations mentioned in the text.

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

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

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

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

Strybing: The Strybing Arboretum, Golden Gate Park, 9th Ave. and Lincoln Way, San Francisco, CA 94122.

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Table 4 Mountain Bamboos

Species	Culm								Culm Leaf					Foliage Leaf						Hardy
	Total Culm				Internode		Node		Sheath			Ligule		Sheath			Blade			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	ht ft.	diam in.	open clump	arch-ing	dark color	pow-der	ridge	scar	hair	oral setae	per-sist	tall	hair	hair	oral setae	tall ligule	long in.	broad in.	hair	temp ° F.
Arundinaria																				
falcata	20	¾	0	0	0	2	0	2	1	1	0	2	2	0	0	2	4	½	1	15
falconeri	30	1¼	0	1	0	2	1	2	1	0	0	0	1	0	0	2	4	½	0	15
hookeriana	30	2	0	1	0	2	1	1	0	0	1	2	0	0	0	2	7	1	0	15
anceps	12	¾	2	1	1	2	1	1	0	2	1	2	1	1	2	1	4	½	0	0
nitida	15	¾	1	1	2	2	0	1	0	0	2	1	1	2	1	1	3½	½	1	-20
racemosa	15	2	2	0	1	2	0	1	2	0	1	2	2	1	1	0	6	½	1	0
Thamnocalamus																				
aristatus	12	½	0	1	1	1	0	2	1	1	0	0	1	0	1	2	4	½	1	10
spathaceous	14	½	0	2	0	1	0	0	1	0	1	0	0	1	1	1	4	¾	1	-20
spathiflorus	20	¾	0	1	0	1	2	2	0	0	0	0	1	0	2	2	4	½	0	10
tessellatus	16	1	1	0	2	1	0	0	0	0	1	1	0	1	2	2	4	½	1	0

Sulpiz Kurz: **Bamboo and its Use**

Prologue

Sulpiz Kurz was born in Munich circa 1833. He studied with Martius, the Brazilian traveler and professor of botany. He spent several years in Java where he studied bamboos in the field as well as those in the Botanical Garden at Buitenzorg, Java. In 1864 he went to Calcutta to take the post of Curator of the Herbarium of the Royal Botanical Garden. He explored Burma and Pegu and spent three months in the Andaman Islands off the east coast of India. His most extensive work is "Forest Flora of Burma", Calcutta, 1877. He died at Pulo-Penang in January, 1878.

Reprinted below is Part I (of a three part article) on bamboo uses which was published in January, 1876 in Vol. 1, No. 3 of the *Indian Forester*, a journal whose publication continues to this day. This review of bamboo uses was certainly the most complete compilation of the time. Now, over 100 years later I find the information still of great interest. The article is reprinted here word for word; I have updated a few of the more obsolete spellings.

At the end of the article I have added a table of common names of the bamboos mentioned in Kurz's text. In column 1 multiple names are equivalent or refer to variations of one species. In column 2 multiple names are synonyms with the last being the most accepted scientific name in the U.S. today. Column 3 gives the areas where each species is native. Column 4 lists those states in the U.S. where the species is known to grow in culivation. The abbreviations are as follows:

AL = Alabama
CA = California
FL = Florida
GA = Georgia
LA = Louisiana
PR = Puerto Rico

Richard Haubrich

Bamboo* and its Use.

No plant is known in the tropical zone which could supply to man so many technical advantages as the bamboo. The strength of the halms, their straightness, smoothness, lightness combined with hardness and greater or less hollowness; the facility and regularity with which they can be split; the different sizes, various length and thickness of their joints makes them suitable for numerous purposes to serve which other materials would require much labour and preparation. To this must be

* The vernacular names for bamboo generally are bans, *Bengali* ; bamboo, *Malay* ; awie, *Sundanese* ; tring, *Javanese* ; utte, in the Moluccas ; Kây, *Siamese* ; Wa, *Burmese* ; chack or chouw, *Chinese*.

added their abundance and the ease with which they are propagated. They are, as Mr. Alf. Wallace writes, at once the most wonderful and the most beautiful production of the tropics, and the best gift of nature to uncivilized man. Who never has travelled within the warm zone of our globe, can form only a very superficial idea of the real importance of bamboo. Wherever we cast here our eyes, these gigantic grasses meet us either in their natural state or by the industry of man transformed into the most varied objects. Without bamboo the Indian would be poor, very poor indeed!

The present demand for bamboo in forestry and manufacture, and more especially the recent agitation to use bamboo in the fabrication of paper, etc., may well excuse me if I have taken upon me the task of treating, however incompletely, not only the uses of these arboreous grasses, but also of offering some remarks on their general growth and habits, as well as on their specific differences. As however my researches of the British Indian and Eastern Asiatic species are not yet closed, I shall for the present treat those of the Indian Archipelago and of the Malayan countries. In doing so I include now already such general remarks on the continental species, as may not interfere with the special object under view.

The heads under which I arrange the matters connected with the practical treatment of bamboo, are the following:

1. Use of bamboo generally.
2. Habit and growth of bamboo.
3. Species of bamboo.
   a. Those of the Indian Archipelago and Malaya.
   b. Those of China and Japan.
   c. Those of the Indian Continent and adjacent islands.

1. Use of Bamboo Generally.*

One of the most important and prevalent applications of bamboo takes place in house building. Indeed, Indians might be classed into those that use bamboo in the construction of their dwellings, and those that use brick, mud or wood. The dreary aspect and poor condition of the people in mud-houses must gravely press upon the mind of those that have had opportunity to study the habits and healthy condition of the people that live in neat bamboo-houses.

It is of the greatest importance in applying bamboo for any building purpose, to see that the halms are cut in the proper season of the year. If cut just before the

* Besides my own observations and those of friends, numerous books were consulted in the compilation of the uses, but chiefly the following treatises:

A. Wallace, on the bamboo and durian of Borneo (in Hooker's Journ. of Botany, VIII, 225 sqq.)

M. C. D. Edouard Méne Utilisation des bambou en China, (Journ. of Acclimat. Soc of Paris).

Junghuhn's Java, F. Jagor Reiseskizzen Singapore, Malacca, and Java, and various articles contained in the volumes of the Transactions, Journals and Proceedings of the Agri-Horticultural Society of India.

Scientific names to the vernacular ones are only given once, but a list of the vernacular and their botanical equivalents is appended to the end of this paper.

The general working in bamboo may be learnt from Jagor's Reisen in den Phillippinen, p. 36, with figures.

rains, they will be nearly eaten up by weevils ere the rains close; but if felled at the close of the rains, they will often remain strong, and proof against the attacks of xylophagous insects, for 6 or 7 years. Immersion in water for a few weeks before use is generally adopted by the natives and renders them more durable. However much depends upon the amount of silica, and those poorest in it are also the more perishable ones. In the Indian Archipelago the following kinds appeared to me to yield the more durable halms: bamboo bitoong (*Gigantochloa aspera*); b. andong bezar (*G. maxima*); b. atter (*G. atter*); b. hower (*Bambusa vulgaris*): while bamboo booloo (*Schizostachyum brachycladum*); b. awie? (*Sch. Blumei*); b. mayang (*Sch. longispiculatum*) and b. ietam (a variety of *G. atter*) are soon attacked by the boobook (*Bostrichus*). But Mr. Teysmann, whose long experience (over 35 years) in the Archipelago is a guarantee for the value of his observations, tells me that the following are quickly attacked by the boobook: bamboo atter, bitoong, wooloong (*Gig. robusta*); kriesik (*Schizo. Hasskarlianum*); lengka (*Giganto. nigrociliata*); booloo, andong kekeus (a variety of *Gig. maxima*); then follow bamboo ietam and b. dooree (*Bamb. Blumeana*). In return bamboo talie, b. andong bezar, b. hower and b. tootool (only a variety of hower) are those that last longest: although partly just the contrary of my own observations and those of Mr. Riggs of Jasinga (Buitenzorg, Java). On the Indian continent are chiefly used in house-building: behoor bans or Kya Katwa (*Bamb. arundinacea*); balkoobans (*Bamb. balcooa*); pao (*Dendrocalamus Hamiltonii*); kyattounwa (*B. polymorpha*); and kyellowa or wabo (*B. Brandisii*).

In the construction of bamboo-houses the halms of different sorts of bamboo come in use according to their greater or lesser strength, etc. Thus, for example, the Javanese uses by preference the halms (*battang, mal.*) of b. bitoong and b. andong for the principal posts and scaffolding, on account of their strength and greater durability, while those of b. atter and b. apoos (*Schizo. Blumei*) serve more for the construction of walls, etc., because the halms of these two latter species are of less thickness of wood and have no prominent nodes. For this purpose the halms are split into four or five strips, which are flattened out and firmly tied down with rattan or bamboo strings to the rafters; but more usually these broad strips are either lengthwise crossed over the rafters or crosswise laid one upon another in such a way as to give the wall the appearance of a huge chess-board (the alternating strips being usually coloured black and white). Similar but broader strips are used for flooring, and in this case the halms are split on one side only, flattened out so as to form beautiful slabs from 1 to 1½ feet broad, while the sharp prominences inside the nodes are carefully removed with the parang or dah (wood-cutting knives). Such floors are delightful to walk upon barefooted, and still more so to sleep upon with a mat over them on account of their elasticity and undulating nature. The houses are covered with various materials, especially atap (*Nipa fruticans*) leaves, but often enough also with bamboo tiles (sirab mal.) or bamboo halms cut into two (called talapap mal.) laid on in the same way as our wooden ones. Smaller pieces serve for window blinds. Thin split bamboo tied up with silk form roll curtains for verandas, which permit the air to pass, but also agreeably temper the glaring light, especially if, as is usually the case, they are dyed green. Houses build in the manner, as Malays and Burmans do, are not only good looking and comfortable, but also healthy, and this the more so as

they are raised above the ground. They are usually build for a single family only, but the Dayaks of Borneo, like the Naga hill-people and other tribes of the Eastern frontier of Bengal, like the Karens of Burma, build large communal houses often 200 to 300 feet long by 50 to 100 feet broad. These are divided into as many compartments as there are families, which often number up to 100. I have seen tays (this is the name by which the communal Karen houses or rather villages are known), which were as much as 30 feet raised from the ground, and when the people therein rushed to one side, the whole structure would hang over. One cannot look then upon the tay without thinking it in imminent danger of tumbling down, but the elasticity and strength of the numerous supporting bamboo halms effectually prevents any such accidents. The space under these houses usually is used as sheds for cattle, pigs, fowls, etc. Fishermen often build their houses solely of bamboo on bamboo (or palm) poles far out into the tidal rivers and sheltered bays of the sea, so that they stand in the water up to near the floor with every recurring tide. These resemble remarkably the ancient *pile houses* of the Switzer lakes, and are similarly connected amongst another by galleries. The greater part of the inhabitants of Bangkok (Siam) live in bamboo-houses build upon bamboo-rafters and let themselves float with ebb or tide downwards or upwards the river as they choose. The theatres in China are all made of bamboo, and so are the Chinese theatres in the Malay countries. Even in European house building bamboo has become quite indispensable all over India, and bamboo-scaffoldings are in general uses in building the largest palaces and houses in Calcutta, etc.,etc.

If temporary shelter is required, either by the native or the traveller in the jungles, nothing is so convenient as the bamboo, and how quick do they finish such a temporary house! A few hours' patience and the traveller is comfortably housed for the night, having not only shelter above him, but also his table, chair and bali-bali (bedstead) all made of bamboo. The leaves of the wild plantain or other large scitamineae usually form in this case the roofing material.

The younger halms of bamb. talie (so is called the not fullgrown bamb. apoos) are cut into longer or shorter thin strips (talie-string) and serve for cordage. These strings, while fresh, are as firm and strong as ordinary cordage and used for every purpose: the bamboo-slips of the house-walls not only, but also the atap (leaves of *nipa* and *sagguerus, etc.*) and the bamboo tiles that form the roof, are fastened by their aid; loads, heavy or light, or smaller articles bound up in leaves, etc., are fastened with this same material; indeed they are used generally for all purposes for which in a civilized country a rope-maker is required. The aborigines of the Nicobars use the very long cane like halms of *Cinochloa andamanica* (very nearly allied to the Tjangkorreh of Java) instead of ropes, with which they fasten the large masts (a superstitious usage) that are erected in the sea before every larger village somewhat in the way as the masts of a European ship.

Bamboo-bridges are in general use all over India and Eastern Asia, however more so in the Indian Archipelago. Bamboo is admirably adapted for this purpose, although the people rarely bestow much labour upon the keep of these bridges, and thus they are soon decaying or carried off by the flood-waters. But the material is so

plentiful at hand, and it is so quickly replaced, that it is more economical to use bamboo instead of more durable timber. Even in the Himalayas, where cane bridges are preferred, bamboo usually forms in so far part of these as one or a few bamboo-halms are laid on lengthwise and form thus the foot-hold in the structure. In Borneo and elsewhere such bridges consist merely of bamboo halms, crossing each other at the road-way like the letter X, and rising, sometimes on one side, sometimes on both, 3 or 4 feet above it. At the crossing they are firmly bound together, and to a horizontal bamboo, which forms the only foot-path, with another higher up, serving as a hand-rail. In Java, etc., bridges are build of this material over rivers 60 to 80 feet broad, with railings, cross-supports, etc., somewhat after the fashion of suspension-bridges, which look ornamental and deserve all admiration. Over such bridges not only men with loads, but even ponies and light carts pass safely. But also true pontoon-bridges are constructed on the same island, where the pontoons are substituted by strong bamboo-rafts, which rise and fall with rise and fall of the river or of the tides.

Along precipitous declivities in the hills bamboo-bridges and railings are not rarely constructed on the same principle as our engineers in Europe do the wooden ones, but here trees and roots are made use of for suspension. These bridges are traversed daily by men and women, carrying heavy loads, so that any insecurity is soon discovered and immediately repaired. When the path goes over very steep and slippery ground, the bamboo is used to form steps. Pieces are cut, about a yard long, and opposite notches being made at each end, holes are formed, through which pegs (also made of bamboo) are driven, and a ladder or staircase is produced with the greatest celerity. But ladders or substitutes for them are constructed in the most simple way for climbing lofty trees, especially for the purpose of gathering fruit or of obtaining bees wax. This, as Wallace tells us, is done by means of bamboo-pegs driven into the smooth stems of the trees. These pegs are made of old thick bamboo, split to about two inches wide. Each is cut above a joint, which forms a solid head to bear the blows of the mallet, and the point is flat and broad, cut away carefully to the siliceous outer-coating. To the head of each is strongly tied a strip of the rough rind of a water plant. The climber carries forty or fifty of these pegs in a basket by his side, and has a wooden mallet suspended round his neck; he has also prepared a number of strong, but slender bamboos, each from 20 to 30 feet long. One of these he sticks firmly in the ground at the foot of the tree, and close to it; he then drives a peg as high as he can reach, and ties it firmly by the head to the bamboo; climbing up upon this, he drives in and ties 2 other pegs, each about 3 feet from the one below it, passing his arms between the tree and the bamboo, to hold the peg while he is driving in. He soon reaches the top of his pole, when another one is handed up to him, and being bound to the one below, he ascends in the same way another 20 feet. When his pegs are exhausted, a boy brings a fresh basket full up to him, and a long cord enables him to pull up the bamboos as he requires them. This mode of ascent looks perilous, but is in reality perfectly secure. Each peg holds as tightly as a spike nail, besides which the weight is always distributed over a great number of them by means of the vertical bamboos. Exactly the same mode of climbing trees prevails amongst the Nagas of Eastern Bengal (see Peal, a visit to the

Naga Hills; Journ. As. Soc., Beng., 1872, part 1, t. 5, left hand), and similarly amongst the Karens of Burma.

Bamboo-halms are also well adapted for aqueducts of a primary nature. The largest kinds of bamboo are taken for this purpose and split in half, supported on crossed poles of various height according to requirement. Also water-pipes are often made by simply perforating internally the solid nodes.

Although bamboo generally is not fit for the construction of boats or canoes, Chr. Costa tells us of a sort of bamboo in the Moluccos (most probably *Gig. maxima*), which produces such thick halms, that the single joints split in halves are used for little canoes, in which two men are said to find place! For masts and spars of small native vessels bamboo is in general use. The outriggers of canoes peculiar to the Phillipines and Ceylon are all of bamboo. The Nicobarese, who use similar outriggers, make them of light wood, because bamboo is, strangely to say, rare with them. The other parts of a boat, such as cabins, etc., are usually constructed of bamboo on the same principle as houses. Bamboo is in use for rafts all over India and the Archipelago. These are simple or more usually doubled up, and in the latter case often furnished with ornamental railings. The construction of such a raft (including the cutting of the bamboo in the jungle) takes usually between 1 to 1½ hours time if done by men expert in such work. They may carry even a pony over deep waters. For floating of timber bamboo has become also highly important to the forester. For this purpose, of course, size and still more the hollowness of the halms are the principal requisites. Hence in the Archipelago bamb. apoos, b. andong, b. atter and others are useful, and in Burma chiefly waya (*Bambusa longispatha*); tin-wa (*Cephalostachyum pergracile*), wabo or kyellowa (*Bamb. Brandisii*). In Sikkim it is the pao (*Dendrocalamus Hamiltonii*) chiefly that is used for this purpose.

Several sorts of bamboo form good living hedges and are in this regard far superior to the artificial ones on account of their durability. The unarmed small species, especially the so-called China-bamboo (bamboo cheena, mal; Wa-pooloo-Pinang, Burm; *Bamb. nana*) is generally used in the Malay countries and southern parts of India. For hedges intended to prevent the entering of cattle or man, no other bamboo or material is more adapted for the purpose than behoor bans; or, as the Burmese call it, Kyakatwa, while in the Archipelago the very similar bamboo tyoo-tyook (*Bamb. Blumeana*) is still more effective, and forms much denser and impenetrable fences. How easily such hedges may be raised may readily be understood when I mention, that bamboo joints (with nodes on them), put in hedge-row take roots as readily as willows, and grow as rapidly if planted out just after the rains have set in or during the rainy season itself, but when done so in the dry season frequent watering is not always accompanied with success. By trimming, the bamboo hedges can be kept low.

But there is another application of bamboo which seems to be peculiar to the Malayan people, *viz.*, they use bamboo for the construction of triumphal arches and posts. No one who has not seen them can fairly appreciate the skill and taste displayed by the Javanese in this sort of work. Yesterday you saw nothing but a heap of fresh-cut bamboo-halms, and today these rude bamboo-poles gradually become

converted into arches, gates, and structures of the most exquisite patterns. The principal arch with lateral ones, all formed of 4 to 6 cornered columns filled out with skillfully wreathed trellis-work, soon shew the style of workmanship, and, after the skeleton is thus formed, broad and thin-shaven strips of bamboo and the soft yellow sheaths of the plantain-leaves, taken from the interior layers of the trunk, are folded into artificial stars, flowers or mashes, and ornamentally arranged on the archings and columns. To these are also added garlands (of bamboo material) intermingled with natural flowers which gracefully hang down according to tasteful designs. A few bouquets of natural and gorgeous flowers often are added as a finish.

The furniture of the Malays, Burmans and those people that live in tracts of India where bamboo abounds, is made chiefly of bamboo. Table, chair, waving-chairs, bench and other household articles down to the drinking cup are all made of bamboo. The greater portion of a bedstand is entirely of bamboo of different sizes, joined together by means of bamboo-pegs and bamboo-strings. Mattresses, cushions and pillows are often stuffed with bamboo-shavings, although the cotton of *Bombax* and *Gossampinus* are more generally in use for this purpose. The bamboo-halms, says Rumphius, are in daily use for fetching water from the river. The longest joints of the greater sort of bamboo [such as b. andong, b. atter, b. wooloo, b. apoos, or in Burma waboor, kyellowa, waya, teiwa (*Bamb. Tulda*) and kyattounwa; in Sikkim chiefly pao] are taken with both knots left on them, in one of which is cut a small hole through which the water is poured in and the hole is then closed with bamboo or more usually plantain-leaves. Such water-holding joints are called kélé by the Sundanese, and gunyeh in Malay. It is also the custom with these people to have bamboo-poles of two or three joints, of which the uppermost and median knots are perforated, and filled with water; such are called lodong in Malay. The women and girls can daily be seen, with such water-tubes on their shoulders or (like the Karens) having them suspended by bamboo-strips from their forehead, going down to the wells or river, where they fill these tubes with water for the use of the coming day. The water keeps very well in these bamboo tubes without taking any tang if the holes are well closed. A dozen or so of these bamboo tubes stand usually in the corner of every Malay house, serving not only for cooking and drinking, but in time of need for extinguishing fire. In climbing high hills, or when travelling through tracts poor in water, the drinking water is carried in similar water-pipes. Rice, vegetables, coffee, tea and other food is cooked in similar tubes taken from young, and therefore somewhat succulent halms. Food thus prepared partakes of a particular tang, (that of burnt fresh vegetables), but it is never refused by a hungry stomach. Single joints of bamboo andong, and also of the Sikkim pao, serve also well for small water buckets. Thinner halm joints are cut just below the nodes, and the Indian obtains in this way little tubes, solid below, in which he keeps fluids, honey, sugar, salted fish or fruit just in the same way as we do in bottles or jars. Many a Javanese can be seen on market days carrying home in this tube, suspended from bamboo strings, the oil, etc., that he wants in his little household.

Chinese masons use for white-washing brushes made of thin bamboo slips fastened together and secured in a handle of bamboo. The Malay has similar ones, but beats with a mallet the whole end of a bamboo joint until dissolved into fibres.

However pandan air-roots are with him much more in use for this purpose, as they can be beaten more easily into brushes. The small brushes, used in China for colouring pictures, are also made of fine bamboo shavings introduced into a small holder of bamboo. Modellers of the same country use small chisels cut from the hardest part of the bamboo halms, and they are very expert in the use of them for carving plaster and such like soft material.

Also candlesticks are made of bamboo and I confess they are superior to those that European travellers often take refuge to, *viz.*, empty bottles. They select for this purpose thin bamboo joints, whose hollowness is wide enough to receive a candle, leave the node about the middle and cut the portion below this node into threes. A stone between these three segments is secured to them by means of bamboo strings and cross sticks, and so the whole furnishes a tripod candlestick, which is less liable of being upset down than the bottle candlestick.

Bamboo enters also the list of the many contrivances by which fire is obtained by Indians. For this purpose quite dry bamboo joints of 2 to 3 feet length are split into twos. The one half of these is furnished in the centre with a longitudinal slit. The interior of the joint is shaved, and the shavings put inside the longitudinal slit and pressed against it by another piece of bamboo. A longer slab of bamboo, sharpened at one side like a knife, is now rapidly and tightly crossed (like a saw) over the hole from which the bamboo shavings protrude and soon ignites them. This mode of obtaining fire is preferable to the many other contrivances in vogue with natives, care being taken that all the material be perfectly dry, and, therefore, old dead bamboo is usually selected for the purpose. Boyle met even pneumatic fire implements of bamboo with the Dayaks in Borneo.

But the ingenuity of the Indian does not end here, for bamboo is used also for making knives. One side (the outer coating of the Halm) of a flattened bamboo slab is sharpened, and, owing to the great amount of silica it contains, grass and low shrubbery can be mowed down quite well. Small ones, made on the same principle, are used by the Javanese even for the operation of circumcision of their children. Broader slips of bamboo, especially of those kinds that are very rich in silica, serve as whet stones, the surface being used for this purpose. In small pointed pieces they serve for pegs, and still smaller and thinner even for pins (like the spines of rattans) to the great disappointment and disgust of many a zealous entomologist.

The use of bamboo for pikolan (carrying poles) is general amongst Malays, and even children are fond of appending their load (and were it only a few plantains) to a bamboo stick for the purpose of "pikol," as this mode of carrying is generally called. The bamboo halms are very strong, and can resist loads of 100 to 200 and even more pounds, but if exposed too much to the sun they are apt to crack on account of the heating of the air enclosed in their joints. Smaller pikolans are made of a shape somewhat like bows, flattened and the edges rounded. These are often more or less ornamentally carved towards their ends. Loads of equal weight are fastened at both ends so as to keep the balance. When a Javanese has only to one side a load which he cannot divide, he appends as much weight (and were it only a stone) to the opposite end; so innate is custom in man. The carrying of such loads

has its peculiarities, inasmuch as the carrier hastens in a short pat in consonance with the elastic swingings of the bamboo, taking at the same time advantage of every swing that may lessen his burden. In this way he carries with less exertion a larger load than do the monotonously singing palkee bearers of Bengal, whose poles consist of inelastic wood.* For tent poles the bamboo halms are excellent and generally in use all over India. Sedan-chairs are extensively used in China, and the ordinary ones are entirely constructed of pieces of bamboo fitted together, while two long bamboo poles pass under the chair and project beyond it before and behind. Batons for certain classes of mandarins, too, are of bamboo, as also the well-known chopsticks of the poorer classes in China.

Bamboo is also fitted for yokes of cattle, axles and even springs of the smaller carts. In Java, etc., these carts have a sort of a little bamboo house build upon them with a sort of vestibulum in front, wherein the driver comfortably sits, and often falls asleep without knowing it.

If we have in Europe ugly scarecrows and such like for driving away the flocks of depredatory birds from the young sowings and cornfields, so has the Malay also his own invention for the same purpose. This consists usually of long bamboo halms, at the end of which is fixed a wind wheel (also of bamboo) which is moved by the slightest breeze with an ugly rattling noise which scares away the numerous rice thieves, a small finch called booroong klatten (*Fringilla oryzivora*, L.) and the numerous small parrots that swarm on the ripe rice-fields. This noise is very disagreeable to the ear, and continuously interrupts the stillness of tropical nature. The Javanese often places in various parts of his field numerous bamboo sticks of this description, from which are suspended pieces of cloth and other light articles, and connects all these sticks with a bamboo or rattan string. The man who keeps the end of this string, in his hand, pulls them from time to time for the same purpose as above. In such cases he almost invariably erects little bamboo houses on high posts in which he is concealed like a spider, keeping the strings in his hand.

Bamboo loops for weeding (see Peal, Journ. As. Soc. Beng., 1872, Pt. I., t. 4.4) are used by the Nagas as well as by the Malays.

Bamboo joints of the larger bamboos are also used for beehives (see Junghuhn, Java I, p. 180, and Scherzer, Reise der Novara, II. p. 155). For this purpose a closed bamboo joint is used, or more frequently this joint is cut into twos and again tied together by means of strings and horizontally suspended under the roof of the house. A small hole made at one end of it enables the bee (*Melipona minuta*) to enter these hives. It is a very small and harmless bee, but produces handsome wax, used chiefly in coating the figures in sarongs for dyeing purposes.

While the rich have ivory and costly fans, those of the poorer classes are made of slips of bamboo covered with paper adorned with fantastic designs and vivid colours. Hand screens as well as standing ones are made of the same material, similarly constructed and furnished with ornamented paper or silk. The handles and

* Mr. Kurz overlooks here, that the bearer effects the reduction of pressure during the upward swing of the bamboo by an increased pressure during the downward swing. - The Editor.

frame work of the Chinese sun and rain umbrellas (payong) are also made of bamboo, and used not only in Japan, China and the Malay Archipelago but also all over Indo-China as far west as Burma.

For walking sticks are the Malayan and Indian bamboos less in use than the Japanese ones, and are derived chiefly from various species of *Arundinarias*. The Japanese pepper canes are well known and come from a species of *Phyllostachys*. Those of *Phyllost. nigra* are very elegant and smooth, but have, like a few others of the small kinds of bamboo, their joints alternately semiterete. Another kind, (sikak take Jap.) botanically apparently not yet known, is mentioned by V. Siebold (who enumerates not less than 33 varieties of Japanese bamboos in the Verhand. Batav. Genootsch. der Kunsten en Wetensch, XII., p. 4-6), which has square halms. Of this M. Ed. Renard gives an account in the March No. of the Bulletin de la Societè d' Acclimatisation. M. Renard says he met with this bamboo only in the beautiful plains surrounding the large town of Osaka in Japan. It naturally forms a square halm, but the angles are not very sharp. It grows to 30 to 40 feet in height and differs from all the other Japanese bamboos in not having a polished surface to the halms. The joints are rather short and the nodes prominent. It is chiefly cultivated for its ornamental appearance, and the straight halms are used as walking sticks, the root-part being fantasticaly carved. The thin and very strong lateral branches of bamb. hower and its varieties make handsome pipes. Malays will construct huge hookahs in a few minutes by inserting a small bamboo tube for a bowl, at a sharp angel, into a large cylinder, about 6 inches from the bottom, which contains water through which the smoke passes. Smaller pipes of the ordinary pattern are as easily and quickly made, and often used even by the European soldier in India.

In a small bamboo-box, prettily carved and ornamented, the Dayak of Borneo carries his sirih and lime, which he uses in betel-chewing.

The Chinese have games of dominoes almost exactly like ours. They are formed of small pieces of cut bamboo, arranged, glued together; one of the pieces is painted and shews the numbers in black and red. Toys for children are generally made of bamboo, such as long bamboo-sticks terminated by a wind-wheel which are carried against the wind, also smaller sticks on which are put flowers made of fine bamboo-shavings variously coloured, and even articulated bojazzis, coloured and moved by strings, can be seen amongst these native toys. Cages, often very ornamental, for birds, etc., and large ones for tigers, etc., are also made entirely of bamboo. Weaving shuttles of bamboo, and rakes made of a cross bamboo-pole with handle to which the bamboo-teeth are obliquely inserted, are things of daily use.

The sheaths in which the Malay carries his long-bladed knife (parang) are of bamboo, and often carved. The cigar-etuis made of the halms of bamb. booloo koneng (*Schizo. brachycladum*, var.) of a beautiful golden-yellow colour are greatly esteemed in Java. Weirs and fish traps, as well as fish-rodes of bamboo, are used everywhere.

Split and shaved thin bamboo is the strongest material for baskets, and excellent baskets, boxes, conical fish-traps, hencoops, etc., are made of it. For fishery purposes are thin halmed species of bamboo in use, and one sort, *viz.*, booloo seroo,

has got its name on account of its fitness for this purpose. Large bamboo-mats of various qualities are sometimes made by the Malays, while the sacs for exporting sugar from Java (called kranyangs) are usually made of bamb. dooree (*Bamb. Blumeana*). The large hats, called toodoongs, which the Javanese men and women wear, and which resemble more the half of a huge pumpkin, are a close network of thin strips of bamboo, coloured and varnished all over the outer surface. The shalako, or head-dress which Europeans wear at Saigon (Cochin China) is likewise made of bamboo. The Bugginese and Macassers of Celebes make also very fine delicately woven caps of bamboo. The Chinese go so far as to make jackets of the lateral branchlets of a small sort of bamboo. These are about as thick as a crow's quill, and are cut into small pieces about ½ inch long, bound at intervals in rows along a silk-thread and connected into square meshes. Chinesee dandies like to wear such bamboo-jackets on their person in order to protect their white cotton-dresses of sweat. Like in the Malay countries so in Burma, boxes of a peculiar kind are made of tight bamboo-network, which are lacquered all over and usually coloured red. In these not only substances, but also fluids can be kept safely. Small boxes of this sort generally serve as sirih-boxes, and at the same time also for drinking cups. Those from Palembang are covered with a varnish so elastic that they can be turned inside outwards without causing cracks or being damaged. The natives of Behar employ the jungli bans (*Dendrocalamus strictus*) for making neatly-worked plates, hand fans, etc., which are generally sold in the towns through the whole of India.

Bamboo greatly enters into native music, especially in the Indian Archipelago and China. In every bamboo bush, says Jagor, are hidden the musical instruments for a whole orchester! A sort of Aeolian harp is represented by the so-called plaintive or weeping bamboo (booloo perindoo or booloo menangies). Sir Emerson Tennant chronicles this sort of natural music thus: In the Malayan Peninsula (but also all over the Archipelago, etc.) the living bamboo has been converted into an instrument of natural music, by perforating it with holes, through which the wind is permitted to sigh in the most charming manner. Mr. Logan, in 1847, in approaching the villages of Kandingoo, heard sounds, some soft and liquid like the notes of a flute, and others deep and full, like the tones of an organ. On drawing near to a clump of trees, a slender bamboo, 40 feet in height, was observed; and it was ascertained that the musical tones issued from it, and were caused by the breeze passing through the perforations in the halm. Those which Mr. Logan saw had a slit in each joint, so that each halm possessed 14 to 20 notes. Living bamboo is often similarly perforated. One of the former Governor-Generals of Dutch India (Baron van der Sloet) used to have a large number of these plaintive bamboos near his palace in the centre of the Botanical Gardens at Buitenzorg, Java. Flutes and fifes are easily made of bamboo on account of the hollowness of the halms. The Chinese have two kinds of bamboo flutes. One kind is closed at one extremity, either by a natural knot or by a stopper of bamboo shavings; along this flute holes are spaced out at regular distances, the first being the mouth piece, and the others being opened and shut by the fingers of the player. Another flute resembles the foregoing, but the knot at one end is cut to a slope, and an opening effected as in the flageolet. There is also a kind of Chinese violin called the hyi ieng, and an ugly thing it is. It consists of a 3 to 4 inch long and

2 inch thick bamboo joint closed at its extremity by a tightly stretched snake's skin. To this is inserted a bamboo-handle about 2 feet long, to the upper end of which are fixed the 2 strings resting on a bridge on the snake's skin. A piece of split bamboo is used as a bow. The Jakoons in Malacca make also a sort of guitarre consisting of a bamboo-tube about a foot long, on which are lengthwise strained 3 or 4 strings which rest on small pieces of wax instead of the bridge. A kind of very curious whistle is used by the Chinese for driving away evil spirits, etc. Several holes are pierced in a piece of bamboo, two of the natural knots being left, one of which offers an opening out in a slope; to each extremity are fastened 2 long strips of paper from 15 to 18 feet in length and 6 to 8 inches wide. A string is attached to a groove made in the bamboo, and when there is a little wind, this curious kite is sent aloft, remaining in the air as long as the wind is strong enough to keep it up. In this position a monotonous whistling is produced, resembling at times the noise of a jet of steam, sometimes the sighing of the wind in trees. The anklong of the Malays is a very agreeable instrument. It consists of a number of hollow bamboo-joints of various but selected length and thickness which are cut out below and hang down from a bamboo-frame. These give various swinging tones and strength, according to their size on being beaten with a bamboo-staff. On the occasion of festivities, such as marriages, circumcision, etc., Malays greatly use the green halms of bamboo (especially the larger sorts), and have them put in specially prepared fires. The air enclosed in the joints gets heated, and the joints burst with a heavy report, which varies in strength from that of a pistol to that of a small gun according to the sort of bamboo used - smaller halms being usually added which keep up a continuous rattling and crackling noise.

Some attention has been paid of late to the bamboo as a textile plant. A fibre has been obtained from the halms suitable for mixing with wool, cotton, and even silk. It is said to be very soft, and to take dyes very readily. To prepare it, the stems are cut across at the joints, and boiled in caustic soda for a lengthened period. The liquid is then drawn off, the halms washed in fresh water, and again boiled in a solution of caustic soda until the fibre of the halms has become somewhat soft. The halms are next put between heavy rollers and crushed, and finally carded or combed, after which it is made up into bales for exportation. When we consider the lengthened period and apparently complex process of its preparation, the question naturally arises whether it can be produced in sufficient quantities and at a sufficiently low price to be remunerative. Mr. Teysman, during his travels on the Moluccas, has observed that the women of these islands chew the young halms of bamboo booloo (*Schizost. brachycladum*) so long until only the fibres remain, of which they weave coarse cloth, bags, and sacs.

Bamboo is in China the principal, if not only, material for paper-making, and was there used as such when our forefathers were still savages hunting the vast forests of Europe. Cut when quite green, it is scraped and cleaned; the thicker shavings are used for stuffing mattresses and pillows; the finer shavings are macerated in water and reduced to a paste by a special process. This paste is mixed with a certain proportion of isinglass, and sheets of various qualities of paper are manufactured. The unbleached paper is slightly yellowish, but smooth, soft, and of great strength. The shavings of inferior quality are also macerated, converted into paste, then made

into sheets and dried. It is mixed with slaked lime to form a substance with which walls are plastered. This bamboo-paper is also made use of to produce a kind of tinder, very much in request with the lower classes in China, especially the watermen. For this purpose paper rolls are lighted, and as soon as the ignition is complete, the burning role is thrust in a small bamboo tube, which is immediately closed and the flame thus suppressed. When fire is wanted, the burnt end of the paper is kindled by means of flint and steel and the paper burns like ordinary tinder. Blowing on this sharply, once or twice, is sufficient to raise a flame - a result that cannot be obtained with any other kind of tinder.

For defensive works serve especially bamboo dooree (*Bambusa Blumeana*), a species very similar to the behor bans (*Bambusa arundinacea*). It forms an impenetrable fence on account of its numerous dependent branchlets armed with copious recurved sharp thorns (spiny buds), and such fences are very generally planted round and in the trenches of the Malay fortifications and redoubts. These fences form in war serious obstacles to advancing troops, and have been recognised as such by the Dutch military men who employ at present the same instead of pallisades; for they prove more durable, really quite impenetrable, and against which even European artillery can do little. The same sort of bamboo is also extensively employed for fences round villages in tracts where tigers are uncomfortably numerous. The so-called rangyoos are thin bamboo pegs sharpened at both ends which are put in oil and slightly burnt in fire. Such pegs are put vertically in the ground hid in grass. They cause very dangerous wounds, and, in wet weather, can penetrate also the moistened soles of shoes. In the campaign of the Dutch against the Boogginese of Boni (Celebes) in 1859, the Dutch soldiers all carried bundles of such rangyoos, but the Boogginese were not such fools as to run into them, or had the Boogginese rangyoos any effect upon the Dutch troops. Similar bamboo-pegs, prepared in the same way, are used in time of war by all the Malayan tribes and also by the hill-people of Assam and Burma. Against cavalry similar, but much larger, and more solid rangyoos are employed, either placed singly and obliquely in the ground amongst high grass, or more usually crosswise and tied with strings forming thus the so-called spanish riders or chevaux-de-frise. It is a very common custom with Malays and Burmans to place strong bamboo-poles across paths in long grass or dense jungle, fixing them firmly at the one end while the bamboo is tightly strained and fastened at the other end in such a way that it immediately unbuckles as one steps on it or only uncautiously touches the pole, thus striking with all force against the legs of the passers by or the passing enemy. The people of Arracan and Tenasserim have, for catching tigers, a similar method. The bamboo-pole is then vertically planted in the ground and strained downwards by means of a strong rope terminating in a large noose arranged so that the tiger, which preys upon a bait laid for him, must pass and touch the noose, when, of course, he is at once launched into eternity. Blowpipes (sumpitan, mal.) consist usually of 2 bamboo-tubes of 7 feet length by ¾ inch broad, stuck one into the other. The inner opening is about ½ inch in diameter. The arrows, usually 7 inch long, are made of various material, chiefly of the nerves of palm-leaves, wood, or the halms of coarse grasses, rarely of bamboo, and poisoned; they are kept in bamboo-quivers. Most of the savages and independent tribes of tropical Asia still use

spears, the shafts of which are of bamboo, javelins, etc. In Java they use for catching thieves, a curious instrument. It consists of two bundles, as thick as an arm, of the lateral thorny branches of the bamboo dooree, which are fastened fork-like at the end of a bamboo-pole; with this fork they try to catch the person from behind at the neck. As the thorns are all reversed the captive cannot easily escape. In every watchhouse along the roads and in the villages of Java this sort of instrument is in general use, and the Javanese are very expert in its use.

The uses of bamboo, however, are not only restricted to technical purposes, but bamboo furnishes also a share in Indian cookery. The young shoots (called rebong in Malay) just when they burst from the ground like gigantic scaly horns, are a favourite vegetable with the Malay and Chinese. Most of the larger sorts, as bamboo bitong, wooloong, andong, atter and more especially b. kriesik, yield edible rebong, while those of the small kinds are used little, being often of a bitter taste and therefore not edible. These rebongs are cleaned of the sheaths and of the numerous stiff hairs (which act irritating upon the skin), cut into small pieces, and, with other additions and seasoning, form a well-known Malay vegetable (sayor rebong). Pickled they form the atsyar, which is frequently exported. In China are also used the shoots of the smaller sorts, while about 6 to 7 inches long and as thick as one's finger. They are of a very fine light yellow colour, are very tender, and but slightly stringy. Sometimes they are boiled in water, a little salt being added, and resemble then asparagus. They are eaten not only by the Chinese, but also by foreigners sometimes with oil, or with white sauce, or cut in small pieces as salad, or more usually made into the more liked "poison gratiné au bambou." A more important rôle play the seeds of several species of bamboo (usually called by the natives "bamboo-rice") in years of scarcity in India. These resemble somewhat oat-grains, and the yield of a stock of bamboo is enormous. At the same time there is a remarkable tendency in bamboo to flower and fruit in unusually hot and dry seasons when famine and scarcity are the usual concomitants. The seed contained in the hard fleshy pericarp of *Neesha baccifera*, the "berry" bearing bamboo, is a pleasant eating, being not at all austere, though without much flavour. The Arracanese declare also the pericarp edible after baking. The leaves are much in use as fodder for cattle in regions where meadows or other grass are scarce or wanting as in the Sikkim Himalaya. Such was the case for a long time on the Andamans, where pastures are entirely wanting. The young shoots, like the plantain stems, are a most favourite food of the elephants.

In native pharmacopoea we find the water, which often accumulates in the bamboo-joints, especially of very hollow kinds, used against bowel-complaints, with what success I cannot say, but all I can add is that this water in the bamboo halms, like that found in the pitchers of the *Nepenthes*, has often quenched my thirst during my tours in the Java hills. Numerous other medicinal virtues are ascribed to various parts of the bamboo by Loureiro (Flora of Cochin China), and by Father Blanco, in his Flora de Filipinas, but hardly worth mentioning here. The stiff fragile very fugaceous hairs or rather bristles on the sheaths of the shoots are used for poisoning. They are put in the meal, or more usually in the coffee to be partaken, and are said to cause death, not suddenly, but the action is very slow and the victim succumbs only after many months. Tabasheer is a siliceous whitish floury substance which is

found as a secretion, or more probably as a residuum in the interior of the joint of several species (especially *Bambusa arundinacea*) often up to an inch in thickness. It is employed in Western India to cure paralytic complaints, and as a stimulant and aphrodisiac. In China, it plays a great rôle in Chinese medicine, and pretty large quantities of tabasheer are exported especially from India to that country and Arabia. Tabasheer is also used in polishing, a quality it owes to its silicious composition.

Noteworthy is the great amount of silica of most of the species of bamboo, which is so great that the ash of burnt bamboo-halms shews distinctly the silica-skeleton of the structure. This amount of silica, however, varies greatly in one and the same species, as for example in bamboo tamyang of which the one of its varieties (bamboo tamyang sonoh) turns so hard that sparks are emitted from the halms when cut with the parang.

For religious purposes, the bamboo furnishes in the Philippines churches, chapels and crosses. For educational purposes, says F. Jagor, is the rattan far more in vogue, and is vigorously resorted to, so much so that a Philippine proverb says: There sprout a thousand rattans in the jungles for every Indian born. The Chinese cut fantastically-shaped figures from the knobby rhizomes for their temples and house-alters. The peculiar throw-pieces, used in the Chinese temples for auguring the success or failure of an undertaking according to the nature of the fall, are also made of bamboo.

For ornamental purposes and landscape gardening, bamboo forms one of the most picturesque features, of which especially the Chinese understand to make full display of it in their rockeries, etc. This effect is still more enhanced by the gaudy glossy colouring of the halms of many species, and the varieties of bamboo hower and leleba, as well as those of booloo along with the black-stemmed species of Phyllostachys of China and Japan, are more especially noteworthy in this respect, and ought sooner or latter come into general use in the South European gardens. Indeed in Italy bamboo is already much in cultivation in the open air, but the night frosts and occasional snow falls will always form a great obstacle in their open air culture in Europe. Mr. E. B. Fenzi of Florence has given notes in the *Gardener's Chronicle* for 1872, pp. 1228-1229, on the species (or rather varieties, some of which are however enumerated twice under other garden names) that are cultivated and hardy in Italy.

I may now conclude with alluding to a fearful penal punishment, formerly in use in Bali, for the publication of which Dr. F. Jagor must be made responsible. He tells us that the criminal was strained horizontally over the young growing shoots of a bamboo stock, of which the longer halms have been removed. As these grow very rapidly the very hard silica-rich (?) shoots pierce through the unfortunate sufferer.

This resumé of the uses of bamboo, although still meagre, may yet remove any surprise on our side when reading in Rumphius' Amboinsche Kruidboek, IV., p. 13, that the Radjahs of Boutan (Moluccos) were proud in asserting that their forefathers sprung from the womb of a bamboo.

Common Names vs. Scientific Names

Common Name	Scientific Name	Habitat	U.S.
balkoobans	*Bambusa balcooa* Roxburgh	Assam Lower Bengal	
bamboo andong **b. andong bezar** **b. andong kekeus**	*Gigantochloa maxima* Kurz *Gigantochloa verticillata* (Willdenow) Munro	Burma Java Malaya	
bamboo apoos	*Gigantochloa apus* (Schultes) Kurz	Java	CA, PR
bamboo atter	*Gigantochloa atter* Kurz ex Munro *Gigantochloa verticillata* small Var.	Java	
bamboo awie	*Schizostachyum longispiculatum* Kurz *Schizostachyum blumii* Nees	Java Malaya	
bamboo bitoong	*Gigantochloa aspera* (Schultes) Kurz *Dendrocalamus asper* (Schultes) Backer ex Heyne	India Java	CA FL PR
bamboo booloo **b. booloo koneng**	*Schizostachyum brachycladum* (Kurz) Kurz	Java	
bamboo cheena	*Bambusa nana* Roxburgh *Bambusa glaucescens* (Willdenow) Siebold ex Holttum	China	CA, AL FL, GA LA, PR
bamboo dooree	*Bambusa blumeana* Schultes f.	Java Sumatra	
bamboo hower	*Bambusa vulgaris* Schrader ex Wendland	pantropic	CA PR
bamboo ietam	Var. of b. atter		
bamboo kriesik	*Schizostachyum hasskarlianum* Kurz *Gigantochloa hasskarlianum* (Kurz) Backer ex Heyne	Java	
bamboo mayang	same as b. awie		
bamboo talie	immature b. apoos		

Common Name	Scientific Name	Habitat	U.S.
bamboo tooltool	*Bambusa vulgaris* Var. black-blotched culms	Malaya	
bamboo tyoo-tyook	same as b. dooree		
bamboo wooloong	*Gigantochloa robusta* Kurz *Gigantochloa verticillata* large Var.	Java	
behor bans	*Bambusa arundinacea* Retzius	India Burma	CA, FL PR
booloo perindoo	same as b. cheena		
booloo seroo	*Melocanna humilis* Roepert	Amboina Java	
jungli bans	*Dendrocalamus strictus* (Roxburgh) Nees	India Burma	CA, FL PR
kyakatwa	same as behor bans		
kyattounwa	*Bambusa polymorpha* Munro	Bangladesh Burma	CA PR
kyellowa	*Bambusa brandisii* Munro *Dendrocalamus brandisii* (Munro) Kurz	India	
lengka	*Gigantochloa nigrociliata* Kurz *Oxytenanthera nigrociliata* Munro	Burma Java Malaya	
pao	*Dendrocalamus hamiltonii* Nees and Arnott ex Munro	Assam Burma	
sikak take	*Chimonobambusa quadrangularus* (Frenzi) Makino	China	CA AL
teiwa	*Bambusa tulda* Roxburgh	Bangladesh Assam Burma	CA PR
tin-wa	*Cephalostachym pergracile* Munro	Burma	
wabo	same as kyellowa		
wa-pooloo-Pinang	same as b. cheena		
waya	*Bambusa longispatha* Kurz *Dendrocalamus longispathus* (Kurz) Kurz	Bangladesh Burma	

Clone Registration 1982

The following species were raised from seed in 1982. Each seedling has been given a unique registration number which identifies it as a plant that the A.B.S. has some information about. The most important requirement for registration is knowing within a month when the seedling germinated. More detailed records are kept if the information is available. This program is primarily interested in determining the length of time a species takes to reach sexual maturity. Since it is not uncommon for some species to take longer than a reasonable human lifetime, some means of keeping track of seedlings becomes important.

The A.B.S. provides propagules of registered plants free of charge to investigators who agree to report any significant changes in the plants status (ie. flowering, somatic mutations, death, etc...) Conversely, the Society encourages individuals who have raised bamboo from seed to register their seedlings and make available propagules to those interested in doing the research. Inquires about plant material or registration should be directed to the Editor.

Arundinaria simoni (Carr.) A. & C. Riv.	ABS13-A-001 to ABS13-A-011
Bambusa sp.	ABS12-H-001 to ABS12-H-019
Otatea aztecorum (McClure & Smith) Cald. & Soder.	ABS11-A-001 to ABS11-A-005
Phyllostachys vivax McClure	ABS2-A-003 to ABS2-A-011
	ABS2-F-001 to ABS2-F-010

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